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Monetary Approach to Exchange Rate Determination under Flexible Exchange Rate Regime: Empirical Evidence from Turkey

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Abstract

The aim of this paper is to analyze empirically flexible price monetary approach to exchange rate determination in Turkey under flexible exchange rate regime. The cointegration analysis and error correction model is used to test long-run relationship and short-run effects respectively. The cointegration analysis show that there is a long-run relationship between nominal exchange rate, money supply differential and nominal interest rate differential. So, it could be said that flexible price monetary model is valid in the long-run in Turkey under flexible exchange rate regime. The money supply differential positively and nominal interest rate differential negatively affect the nominal exchange rate as expected. In the short-run, nominal interest rates are more responsive to correct long-run disequilibrium of nominal exchange rates.

JEL classification numbers: F31, C12, C32
Keywords: Exchange rate determination, flexible exchange rate regime, monetary approach, cointegration analysis, error correction model

1 Introduction

The exchange rate concept; i.e., the price of foreign currency in terms of domestic currency, became one of the most challenging fields of the empirical studies in

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the economics with the adoption of flexible exchange rate regime in 1973. In the flexible exchange rate regime, exchange rate is determined in the foreign exchange market by demand and supply. So, increase or decrease of exchange rate or depreciation or appreciation of domestic currency relative to foreign currency depends on the factors that affect demand or supply of foreign exchange in the market. These factors could be money supply, real income, interest rate, inflation, government trade policy or consumer preferences.

However, it is highly difficult to predict exchange rates by using monetary variables. In the literature, there are both theoretical and empirical studies about exchange rates determination and exchange rate forecasting. Taylor, 1995; Frankel and Rose, 1995; Meese and Rogoff, 1983 give a general overview studies about exchange rates. In the literature many models are developed to determine the factors that affect the exchange rates. One of the models of exchange rate detemination is that the balance of payments approach. The balance of payments can be explained by using monetary approach, absorption approach and elasticity approach. The monetary approach can be divided into the flexible price monetary model, the sticky price monetary model and the sticky price asset model. Among them, the flexible price monetary approach is viewed as long-run version of exchange rate determination.

The validity of monetary approach in the long-run is supported by Bruyn, Gupta and Stander (2013) for South Africa, Chin, Azalı and Matthews (2007) for Malaysia and Miyakoshi (2000) for Korea. Regarding Turkey, Tümtürk (2017), Uz and Ketenci (2010) and Uz and Bildir (2009) found long-run relationship between exchange rates and monetary variables.

In this study, the flexible price monetary approach to exchange rate determination is analyzed for Turkey under flexible exchange rate regime. Since, monetary approach is a long-run version of exchange rate determination, the cointegration analysis will be appropriate to test the existence of long-run relationship. As compared to previous empirical studies about Turkey, the time period covered and the econometric model used are different from the previous empirical studies about Turkey. Besides, this research uses different data source from the previous empirical studies. The structure of the study is organized as follows: In the second part, theoretical framework of the study is explained. In the third part, variables used in the empirical part of the study and data sources are explained. In the fourth part, procedure of the study and empirical results are presented and discussed. The last part concludes the study.

2 Theoretical Framework

After the adoption of flexible exchange rate regime in 1973, the monetary approach to exchange rate determination with flexible prices became dominant exchange rate model (Taylor, 1995; MacDonald and Taylor, 1994, 1993 and 1991;

Boughton, 1988; Woo, 1985; Bilson, 1978; Frankel, 1976). The exchange rate can be defined as the relative price of two monies, and monetary model can be described as relative price in terms of relative supply of and demand for these two monies.[3] The demand for money depends on price level, real income and nominal interest rate. The money demand function for domestic and foreign country can be written as follows:

$$m_t = p_t + y_t - i_t \quad (1)$$
$$m_t^* = p_t^* + y_t^* - i_t^* \quad (2)$$

where m_t is the demand for money at time t, y_t is the real income at time t, i_t is the nominal interest rate at time t and "*" denotes the foreign country. All the variables except nominal interest rates are in logarithmic forms.

The flexible price monetary model assumes continuous purchasing power parity. The absolute purchasing power parity states that the exchange rate is equal to the ratio of the domestic and foreign price levels. The absolute purchasing parity can be stated as an estimation equation as follows:

$$e_t = \mu + B\, p_t + B^*\, p_t^* + u_t \quad (3)$$

The absolute purchasing parity is tested whether the restrictions $B = 1$ and $B^* = -1$ is valid. In the case of continuous purchasing power parity, in equation (3), it is assumed that $B - B^* = 1$, price indices are normalized and μ is set to 0. So, equation (3) can be written as follows:

$$e_t = p_t - p_t^* \quad (4)$$

Equation (4) states that exchange rate is determined by relative prices. Since domestic money supply determines the domestic price level and foreign money supply determines the foreign price level, the exchange rate is determined by relative money supplies. Combining Equation (1) (2) and (4) and solving for exchange rate gives the flexible price monetary approach exchange rate equation:

$$e_t = (m_t - m_t^*) + (y_t - y_t^*) + (i_t - i_t^*) \quad (5)$$

or

$$\ln e_t = B_1 \ln(m_t - m_t^*) + B_2 \ln (y_t - y_t^*) + B_3(i_t - i_t^*) \quad (6)$$

The expected signs of the coefficients in Equation (6) can be summarized as follows:

B_1 = An increase in domestic money supply relative to foreign country money supply lead to increase of exchange rate, i.e., depreciation of domestic

[3] For more information, please look at Taylor (1995): 21-22.

currency in terms of foreign currency. So, the sign of the coefficient is expected to be positive.

B_2 = An increase in domestic country real Gross Domestic Product (GDP) relative to foreign country real GDP may lead to excess demand for domestic money supply. This excess demand causes appreciation of domestic currency in terms of foreign currency. So, the sign of the coefficient is expected to be negative.

B_3 = An increase in domestic interest rate relative to foreign country interest rate may lead to capital inflows, and the demand for domestic currency increases. Increase of demand for domestic currency leads to an appreciation of domestic currency in terms of foreign currency. So, the sign of the coefficient is expected to be negative.

3 Variable Definitions and Data Sources

In this study, the major determinants of nominal exchange rate in Turkey are analyzed under flexible exchange rate regime using flexible price monetary approach. Since, the implementation of flexible exchange rate regime started in Turkey after financial crisis in February 2001, the study covers the period from 1st. Quarter 2002 to 4th. Quarter 2013. The United States of America (the US) is taken as foreign country. All the data, except nominal interest rates, are in logarithmic forms. The names of the variables, their calculations and data sources can be described as follows:

Nominal exchange rate (e_t): The amount of Turkish lira per US dollar. Source: International Financial Statistics (IFS) of the International Monetary Fund (IMF).

Real Turkish GDP (y_t): Nominal Turkish GDP deflated by Turkish CPI. Source: Electronic Data Dissemination System (EDDS) of the Central Bank of Republic of Turkey (CBRT).

Real US GDP (y_t*): Nominal US GDP deflated by the US CPI. Source: FREDII (stlouisfed.org).

Turkish CPI and US CPI: Turkish and the US Consumer Price Indices. Source: IFS of the IMF.

Turkish money supply (m_t): The Turkish money supply (M2). Source: EDDS of the CBRT.

US Money Supply (m_t*): The US money supply (M2). Source: FREDII (stlouisfed.org).

Turkish deposit rate (i_t): The weighted average interest rates for Turkish lira deposits. Source: EDDS of the CBRT.

US deposit rate (i_t*): The percentage change at annual rate for US dollar deposits. Source: FREDII (stlouisfed.org)

4 Procedure of the Study and Empirical Results

In the empirical part of the study, the flexible price monetary approach to exchange rate determination for Turkey is tested. In this framework, cointegration test is done if there is a long-term relationship and error correction model is estimated to see if there is short-term adjustments. Since, cointegration test is done using non-stationary variables, firstly variables are tested whether they have a unit root.

4.1 Unit Root Test

Firstly, each of the variable is tested using Augmented Dickey Fuller (ADF) test whether the variable has a unit root. The ADF test consists of regressing each series on its lagged value and lagged difference terms. The ADF test results are shown in Table 1. The ADF test results show that nominal exchange rate, relative money supply and relative interest rates are nonstationary in their levels and they are integrated of order one (1). The real output differential variable is stationary in its level. Next, in order to analyze long-run and short-run effects of money supply differential, interest rate differential on nominal exchange rate cointegration analysis and error correction models are used.

Table 1: ADF Unit Root Test Results

Variable	Level	First Difference
e_t	-1.0003	-6.3396
$(m_t - m_t^*)$	-2.3138	-5.8510
$(y_t - y_t^*)$	-4.1714	-
$(i_t - i_t^*)$	-3.4155	-6.9304

Note: McKinnon critical values are -3.58 at 1 % level, -2,92 at 5 % level and -2,60 at 10 % level.

4.2 Cointegration Analysis

The validity of flexible price monetary model in the long-run can be tested whether the variables in Equation (6) are cointegrated. The Johansen test statistics (trace and maximum eigenvalue) are used for the cointegration analysis. It should be mentioned here is that since real output differential is stationary in its level, it is not included in the cointegration analysis. Because, to do the cointegration analysis the variables should be integrated in the same order.

The cointegration test results for nominal exchange rate, money supply differential and interest rate differential are presented in Table 2. Trace test indicates two cointegrating equations at the 0.05 level. The existence of two

cointegrating vector indicates that flexible price monetary model is valid in the long-run. In other words, the existence of cointegration between variables means that there is a long-run relationship among nominal exchange rate, money supply differential and interest rate differential.

Table 2: Cointegration Test Results

	Eigenvalue	Trace Statistics***	0.05 Critical Value	Probability**
None*	0.335	34.298	29.797	0.014
At most 1	0.247	15.521	15.494	0.049
At most 2	0.051	2.424	3.841	0.119

(*) Trace test indicates no cointegrating equation at the 0.05 level.
(**) MacKinnon-Haug-Michelis (1999) p-values.
(***) Trace test indicates 2 cointegration equations at the 0.05 level.

The estimation of cointegrating relationship for nominal exchange rate, money supply differential and nominal interest rate differential are given in Table 3. This estimation results show the long-run effects of explanatory variables on nominal exchange rate. It is expected that money supply differential positively nominal interest rate differential is negatively related to nominal exchange rate.

Table 3: Estimation of Cointegrating Relationship

$$lne_t = B_1 \ln(m_t - m_t^*) + B_2 \ln (y_t - y_t^*) + B_3(i_t - i_t^*) + u_t$$

lne_t	$\ln(m_t - m_t^*)$	$(i_t - i_t^*)$
	1.904**	-0.025**
	(4.52)	(3.84)

Note: "**" denotes the coefficient is statistically significant at 5 percent level. The values in the parenthesis are t-values.

As can be seen in Table 3, the signs of the explanatory variables are as expected as a whole. The sign of the money supply differential is positive and statistically significant as expected. An increase in domestic money supply relative to foreign country money supply leads to increase of nominal exchange rate which means depreciation of domestic currency in terms of foreign currency. The sign of the interest rate differential is negative and statistically significant as

expected. An increase in domestic interest rate relative to foreign country interest rate may lead to capital inflows and so, demand for domestic currency increases. Increase of demand for domestic currency leads to an appreciation of domestic currency in terms of foreign currency.

4.3 Error Correction Model

As a third step, the Error Correction Model (ECM) is estimated. The ECM examine the short-run behavior of nominal exchange rate with respect to interest rate differential and nominal interest rate differential. The cointegration will be supported if the coefficient of the lag of the error correction model (ECM_{t-1}) carries a negative and statistically significant coefficient. Besides, the coefficient of ECM_{t-1} represents the proportion of the disequilibrium in nominal exchange rate in one period corrected in the next period. To do the ECM estimation, five period lags of the independent variables are included in the regression and it is estimated. The statistically insignificant variables are dropped from the regression and the statistically significant ones are kept in the regression and it is re-estimated.

The ECM estimation result is presented in Table 4. As can be seen in Table 4, the coefficient of ECM_{t-1} has a negative sign but is not statistically insignificant. This result can be interpreted as deviations from the long-run values may not be corrected in the short-run. Uz and Dalan (2009) also found statistically insignificant error correction model coefficient for Turkey.

In the estimation of ECM, the coefficient of interest rate differential variable has a negative sign and is statistically significant. This estimation result could be interpreted as nominal interest rates are more responsive to correct long-run disequilibrium of nominal exchange rates. The coefficient of relative money supply variable is statistically insignificant. This result could be interpreted as money supply is not responsive to correct long-run disequilibrium of nominal exchange rates.

Table 4: Estimation of Error Correction Model (ECM)

$$\Delta lne_t = Bo + B_1 \Delta ln(m_t - m_t^*) + B_2 \Delta(i_t - i_t^*) + B_3 ECM_{t-1} + u_t$$

Δlne_t	B_o	B_1	B_2	B_3	R^2	DW
	0.004	-0.257	0.001**	-0.050	0.10	1.62
	(1.01)	(-0.69)	(1.93)	(-0.63)		

Note: "**" denotes the coefficient is significant at 5 percent level. The values in the parenthesis are t-values.

5 Conclusion

This paper analyzed empirically the existence of flexible price monetary approach to exchange rate determination under flexible exchange rate regime in Turkey. Since, monetary approach is a long-run version of exchange rate determination, the cointegration analysis is used. Besides, to see the short-run effects, the Error Correction Models are used.

The empirical results indicate the existence of cointegration between variables. This means that there is a long-run relationship among nominal exchange rate, money supply differential and interest rate differential. Since real GDP differential is stationary in level, it is not included in the cointegration analysis. This estimation result is also an indicator of validity of flexible price monetary approach to exchange rate determination in the long-run.

The estimation results of long-run relationship are as expected in the study. An increase in domestic money supply relative to foreign country money supply leads to increase of nominal exchange rate which means depreciation of domestic currency. An increase in domestic interest rate relative to foreign country interest rate leads to decrease of nominal exchange rate which means appreciation of domestic currency. The ECMs show how deviations from long-run values are corrected in the short-run. The ECM estimation result shows that nominal interest rate differential is more responsive to correct long-run disequilibrium of nominal exchange rates, but its effect is minimal.

Consequently, it could be said that under the flexible exchange rate regime, money supplies and nominal interest rates are effective on nominal exchange rates in the long-run, while only nominal interest rates are effective on nominal exchange rates in the short-run.

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