

Augmented Taylor Rule Analysis: The Case Of Türkiye*

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Abstract: It might be said that the inflation targeting strategy is one of the most common strategies used to combat inflation, which is one of the most important economic problems experienced in global economies in the recent period. In the inflation targeting strategy, which is one of the most effective methods in solving the inflation problem, which is a global macroeconomic problem, it is observed that short-term interest rates are used as an intermediate target in the widespread literature in the solution of the inflation problem. In this context, while the "Taylor Rule" can be a strategic indicator of the relevant inflation targeting in the inflation targeting strategy in developed country economies, periods have been observed in which central banks have determined policy and intermediate target strategies based on the "Augmented Taylor Rule" in the inflation targeting strategy in developing country economies. Under the assumption that the Turkish economy is also in the class of developing country economies, the expanded Taylor rule equation in which the exchange rate is included for the Turkish economy was tried to be estimated by Autoregressive Distributed Lag Bound Test (ARDL) method for the period 2003:01-2022:08. According to the results of the analysis, it is seen that the CBRT's interest rate decisions are related to the inflation rate, output level and exchange rate.

Key Words: Taylor Rule, ARDL Bounds Test, Turkish Economy

1. INTRODUCTION

Ensuring price stability has a very important place in ensuring economic stability in the economies of countries. In this direction, monetary targeting strategies have been developed in the monetary policies applied. These strategies are included in the literature as monetary targeting, exchange rate targeting and revenue targeting. Strategies such as monetary targeting, exchange rate targeting have been implemented by the economies of many countries. Strategies have guided policy implementations for a specific economic purpose. Thus, in addition to precautionary policies, policy practices carried out according to the rule have come to the agenda. The economic disruptions caused by the arbitrary implementation of prudential monetary policies have revealed the importance of rule-based policies (Gögül and Songur, 2016, p.22).

Following the first orientation of the Reserve Bank of New Zealand to the inflation targeting strategy, the importance of the short-term interest rate, which is an intermediate target for monetary authorities has increased with the adoption of the inflation targeting strategy in many countries' economies as of the 1990s. In the study, Taylor (1993) found that the difference between the realized and targeted inflation rate and the difference in the realized and targeted output level

were effective in adjusting the short-term interest rate of the central bank in the US economy. Thus, Taylor established a rule-based monetary policy for central banks to set the short-term interest rate. Taylor developed a monetary policy rule based on the difference between the actual inflation rate and the target inflation in the initial version of the rule, and the difference between the level of realized output and the potential output level having an effect on the short-term interest rate. In the following period, the inclusion of a closed economic model in the first version of the Taylor rule led to criticism. Accordingly, in line with the studies of Greiber and Herz (2000), Taylor (2001) and Mohanty and Klau (2004), the Augmented Taylor rule was created by adding the exchange rate to the Taylor rule. Thus, the Taylor rule was harmonized with the open economy.

In this study, the equation of Augmented Taylor rule created by including the exchange rate in the Turkish economy was tried to be estimated. The continuous increases in the exchange rate since the mid-2010s, with the transition effect from the exchange rate, have caused both the producer price index and the consumer price index to rise in the Turkish economy in recent years, and accordingly, inflation has risen to double-digit levels again. In this context, monthly data were analyzed and analysis was performed by ARDL boundary test

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method for the period 2003M01-2022M08. In this study, the reaction of the Central Bank of the Republic of Turkey (CBRT), which has been implementing an open inflation targeting strategy since 2006 and whose main purpose is to ensure price stability, to the inflation gap, output gap and exchange rate gap within the framework of the Augmented Taylor rule in which the exchange rate of the policy interest rate is included was investigated. In the first part of the study, explanations about Taylor rule and literature review about Taylor rule will be included in the second part. In the third part, ARDL boundary test analysis, which examines the relationship between the variables with the data set and methodology, will be discussed and in the last part, the results obtained in line with the econometric analysis will be evaluated.

2. TAYLOR RULE

In the implementation of monetary policies, there are studies in the literature on the implementation of policy by central banks according to the rule. The studies carried out by Barro and Gordon (1983) and Kydland and Prescott (1977) on the implementation of the monetary policy towards the rule are among the first studies on the subject. It is very important in terms of ensuring stability in the economy in line with the targets by conducting the monetary policy according to the rules. In this direction, with the development of the literature, inflation targeting strategy was started to be implemented by the Central Bank of New Zealand, a developed country's central bank, in 1990. In the following period, many countries have turned to inflation targeting strategy. The short-term interest rate is included as an intermediate target in the inflation targeting strategy (Aklan and Nargeleçekenler, 2008:23-27). The TCMB has turned to implicit inflation targeting strategy in the 2002-2005 period and to explicit inflation targeting strategy since 2006 (Bulut and Tokatlıoğlu, 2022: 983).

Short-term interest rates, which are chosen as intermediate targets in the inflation targeting strategy, are mostly considered together with the Taylor rule. In his study, Taylor (1993) provided guidance on designing the interest rate chosen as an intermediate target by a central bank adopting an inflation targeting strategy. In Taylor's study, it was stated that if the actual inflation rate exceeds the target inflation rate or the actual output level exceeds the potential output level, the short-term nominal interest rate reacts by increasing and decreasing in the opposite case. The Taylor

equation included in the study of Taylor (1993) is as follows;

$$i_t = r + \pi_t + \alpha(\pi_t - \pi_t^*) + \beta(y_t - y_t^*) \dots \dots \dots (1)$$

In the above equation; i_t is the nominal interest rate (policy rate), r is the real interest rate in long-run equilibrium, π_t is the inflation rate in period t , π_t^* is the inflation rate targeted by the central bank in period t , y_t and y_t^* current and potential output in period t where α is the response coefficient to the inflation gap and β is the response coefficient to the output gap. Taylor (1993) took the trend economic growth rate as 2.2% per annum for the 1984-1992 period in his study.

As it can be understood from the first equation of Taylor's rule, there have been criticisms since a closed economy model is examined in the equation. The effect of exchange rate on macroeconomic indicators, especially in developing country economies, has led to debates about adding the exchange rate to the classical Taylor rule. As a result of this situation, Greiber and Herz (2000) and Taylor (2001) added the exchange rate to the Taylor response function in their studies. The augmented Taylor rule created by including the exchange rate is as follows;

$$i_t = r + \pi_t + \alpha(\pi_t - \pi_t^*) + \beta(y_t - y_t^*) + \delta(e_t - e_t^*) \dots \dots \dots (2)$$

In the above equation; e_t and e_t^* denote the realized and equilibrium exchange rate in period t , and δ the exchange rate response coefficient, respectively. The analysis was turned into an open economy analysis by adding the exchange rate among the determinants of the interest rate together with the relevant equation.

3. LITERATURE REVIVAL

In this part of the study, some of the studies including empirical analyses of Taylor's rule are included. A large part of the studies described below involves an Augmented analysis of Taylor rule in which exchange rate is included. The sample of the studies includes the period in which the analysis was performed, the data and the results expressed in the studies.

In the study Zortuk (2007) investigated the determination of short-term interest rates in the Turkish economy within the framework of Taylor's rule. In the study, the central bank's overnight lending rate, inflation gap, exchange rate gap (nominal exchange rate) and output gap data were analyzed monthly by ARDL limit test method for the period 2001:08-2006:12. The results expressed in

the study; that there is a relationship between the short-term interest rate and the exchange rate gap, inflation gap and output gap in the long term, that the inflation gap and output gap coefficients are positive and meaningful, and that the CBRT takes into account the exchange rate, inflation rate and output level in determining interest rates (Zortuk, 2007: 65-66).

In the study Ateşoğlu (2009) investigated the explanation of the Fed fund ratio by comparing the Taylor rule with the rule developed by the author himself. In the study, the selected quarterly data for the period 1994:2-2007:4 were analyzed by the Least Squares method. The results expressed in the study; It is stated that the Fed manages the fund rate used as a tool in conducting monetary policy in accordance with Keynesian rules rather than Taylor rule and that Keynesian monetary policy rules within the framework of neutral interest rate are suitable for interpreting the Fed's monetary policies (Ateşoğlu, 2009: 490).

In their study Civcir and Akçağlayan (2010), they investigated the TCMB's reaction functions related to monetary policy. In the study, overnight interest rate, inflation gap, output gap and exchange rate gap (nominal effective exchange rate) data were analyzed monthly by vector autoregression (VAR) model for the period 1987:01-2001:12 and 2002:01-2009:05. The results expressed in the study; In the post-crisis period, the main variable that the central bank reacts to is the exchange rate, the central bank intervenes in case of shock or accidental fluctuation in the exchange rate, there is a transition from the exchange rate, and during the inflation targeting strategy period, the reaction of the interest rate to the output gap is weak while the reaction to the exchange rate is relatively high (Civcir and Akçağlayan, 2010: 23).

In their study, Lebe and Bayat (2011) investigated the validity of the Augmented Taylor rule, which includes the exchange rate, for the Turkish economy. In the study, different models were created with different interest rates. In the study where interbank interest rate, deposit interest rate, rediscount interest rate, output gap and inflation gap as well as exchange rate gap (nominal exchange rate) were included, monthly data for the period 1986:05-2010:09 were analyzed with VAR model. The results expressed in the study; In the case of examining the rediscount interest rate as a short-term interest rate, the Taylor rule is late and that interest rates react positively to the shocks caused by them (Lebe and Bayat, 2011: 107).

In their study, Erdem and Kayhan (2011) investigated the validity of the Taylor rule within the

framework of inflation targeting in the Turkish economy according to the TCMB governors. In the study, interbank interest rate, inflation gap, output gap and exchange rate gap (real exchange rate) data were analyzed monthly with the VAR model for the period 2002:01-2009:11. As a result of the study; It was stated that the output gap and exchange rate were not taken into account in determining the interest rate in the period 2002-2006, that the output gap and exchange rate were taken into account in the determination of the interest rate in the period 2006-2009 and that the inflation gap in the period 2002-2009 was effective in interest rate decisions (Erdem and Kayhan, 2011: 23).

Wang vd., (2015) investigated the validity of Taylor's rule in selected Middle Eastern European countries (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and the Slovak Republic). In the study, short-term interest rate, output gap, inflation gap and exchange rate gap (real exchange rate) data were analyzed monthly for the period 2000-2013 by means of flexible Fourier function and stationary test. As a result of the study; It has been stated that monetary policy practices in the relevant economies are greatly influenced by Taylor's rule (Wang vd., 2015: 681).

In their study, Korhonen and Nuutilainen (2017) investigated the monetary policy practices of the Central Bank of Russia. Oil price data were included in the study due to the fact that oil prices have strong effects on macroeconomic indicators in the Russian economy. One-week repo interest rate, inflation gap, output gap, exchange rate gap (nominal effective exchange rate) and oil price data were analyzed monthly with the Generalized Moments Method (GMM) for the period 2004-2017. As a result of the study, it was stated that the monetary policy carried out by the central bank could be explained by the Taylor rule since 2006 (Korhonen and Nuutilainen, 2017: 375).

In their study, Bal and Ildirar (2019) investigated the validity of the Augmented Taylor rule for the Turkish economy. In the study where the interbank interest rate, output gap and inflation gap as well as the exchange rate gap (real effective exchange rate) were included, the monthly data for the period 2001:08-2017:09 were analyzed by GMM method. The results expressed in the study; that the output gap and inflation gap coefficients are far from the coefficients obtained in the Taylor (1993) rule, that the exchange rate gap has a strong effect on the interest rate and that the Taylor rule is not valid on the Turkish economy (Bal ve Ildirar, 2019, 286-287).

In their study, Zougali and Belarbi (2019) investigated the reaction function of the Central Bank of Algeria within the framework of Taylor's rule. In the study, money supply (M2), inflation gap, interbank interest rate, exchange rate gap (real effective exchange rate) data were analyzed with Kalman filter algorithm for the period 2000:01-2019:01 as a quarter. The conclusion expressed in the study is that the country's central bank instrument does not have an effect on the output gap and inflation gap (Zougali and Belarbi, 2019: 25).

In the study, Owusu (2020) prospectively investigated and compared the Taylor-type reaction function for the Central Bank of Sweden (Riksbank) and the European Central Bank (ECB). In the study, short-term interest rate, output gap, inflation gap, exchange rate gap (real exchange rate), monetary growth, Fed fund rate and oil prices data were analyzed monthly by GMM method for the period 2003:01-2018:12. The results expressed in the study; It is stated that the reaction of Riksbank to the output gap and expected inflation is higher than that of the ECB, that the interest rates of other countries and especially the Fed interest rate have an effect on the monetary policy carried out by the ECB, that the short-term interest rate of the ECB is effective in the monetary policy carried out by Riskbank and that the real exchange rate is effective in explaining the monetary policy of Riskbank (Owusu, 2020: 418).

In the study, Czudaj (2021), the compliance of expectations for the European Central Bank's policy interest rate for the Eurozone with the Taylor rule is investigated. In the study, ECB's policy interest rate, inflation gap, output gap and unemployment rate data were analyzed with the fixed effects model for the period 2002:01-2020:02 as a quarter. The results expressed in the study; that professionals have developed their expectations within the framework of the Taylor rule is that the link between the expectations of professionals and the Taylor rule for the period when the policy interest rate reaches zero is weakened (Czudaj, 2021: 16).

In the study, Akdeniz (2021), the validity of Taylor's rule for the Turkish economy is examined. In the study where the interbank overnight interest rate, output gap and inflation gap as well as the exchange rate gap (nominal exchange rate) were included, the data for the period 1986:05-2019:12 were analyzed with the parameterized vector autoregressive (TVP-VAR) model that changed over time. The results expressed in the study; that the magnitude of the interest rate responses to the output gap and inflation gap shocks varies over time, that the size

and direction of the interest rate responses to exchange rate gap shocks vary over time, that the interest rate responses to the output gap and inflation gap shocks are significant in the period examined in the study, and that the meaningful reactions to exchange rate shocks at the interest rate are mentioned in certain periods. and that short-term interest rates act according to the Taylor rule for the Turkish economy (Akdeniz, 2021: 295).

In their study, Goncalves and Guimaraes (2021) investigated the validity of Taylor's rule in selected country economies. In the study, nominal interest rate, inflation gap, output gap data were analyzed annually for the periods 1915-1945 and 1987-2017 by the Least Squares method within the scope of 18 countries (Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and USA). In the study, exchange rate was used as a control variable. The results expressed in the study; It is believed that following the Taylor rule reduces the fluctuations in the inflation rate, that interest rates are almost insensitive to inflation in the period up to 1972, that the reaction of the interest rate to inflation increases in the following period, and that the Taylor rule seems to be valid in the relevant countries in recent years (Goncalves and Guimaraes, 2021: 14).

In their study, Anderl and Caporale (2022) investigated the determinants of interest rates for the economies of eight countries: Sweden, New Zealand, Australia, Canada, the United Kingdom, the United States, the Eurozone and Switzerland, taking into account Taylor's rule. In the study, exchange rate gap (real exchange rate), inflation gap, output gap and short-term nominal interest rate data were analyzed monthly with linear and nonlinear Vector Error Correction Model (VECM) for the period 1993:01-2020:12. The results expressed in the study; that when the central bank's creditworthiness is high and Taylor rule deviations are low, the pace of adjustment is higher, and the inflation targeting strategy tends to provide high credibility for central banks (Anderl and Caporale, 2022: 1827).

In their study, Guizani and Wierzbowska (2022) investigated monetary policy behavior in the Tunisian, Moroccan and Egyptian economies within the framework of Taylor's rule. In the study, nominal interest rate, inflation gap, output gap and exchange rate gap (nominal effective exchange rate) data were analyzed monthly by Least Squares (OLS) method to cover the 2000-2017 period for Tunisia and 2007-2017 for Egypt and Morocco. The

results expressed in the study; indicators of rule-based monetary policies in the relevant countries are weak, there is interest rate inertia in the decisions of central banks in the relevant countries, policy interest rates in Tunisia and Egypt are affected by changes in exchange rates, and there are signs of a move towards rule-based monetary policy in the relevant countries (Guizani and Wierzbowska, 2022: 90).

In their study (2022), Elsayed vd. investigated monetary policy reaction functions for Bahrain, Kuwait, Saudi Arabia and the United Arab Emirates. In the study, short-term money market interest rate, inflation gap, output gap, exchange rate gap (real effective exchange rate) and financial stability indicators data were analyzed by NARDL method for the period 2006:04-2020:02 as a quarter period. The results expressed in the study; that the reactions of monetary authorities to independent variables vary, that monetary authorities react significantly to shocks in financial stability of countries, and that it is more appropriate to include financial stability for the economies of the countries concerned (Elsayed vd, 2022: 15).

In their study Mendonça and Maia (2022), they investigated the content and rationality of interest rate expectations for monetary policy for the Brazilian economy. In the study, monetary policy interest rate, inflation gap, output gap and exchange rate gap data were examined monthly by regression analysis for the period 2003:01-2020:07. The results expressed in the study; It is believed that the interest rate expectations determined according to the Taylor rule performed more successfully than the expectations provided by the central bank survey and that the Taylor rule and the central bank survey provided complementary information in predicting the future interest rate (Mendonça and Maia, 2022: 4542).

In his study Taş (2022), he examined the validity of the Augmented Taylor rule in which the exchange rate was included. The weighted average funding cost, output gap, inflation gap and exchange rate gap (real effective exchange rate) data obtained by taking the weighted average of the TCMB's overnight lending rate and policy interest rate were analyzed monthly by the Fourier cointegration test for the period 2011:01-2022:05. As a result of the study, it is stated that the expanded Taylor rule can be said to be valid in the Turkish economy if the weighted average funding cost is determined as a monetary policy tool (Taş, 2022: 69).

Bulut and Tokatlıoğlu (2022) investigated the Augmented Taylor equation for the Turkish economy, including the exchange rate. In the study,

where the interest rate, output gap and inflation gap applied to the deposits opened by banks in Turkish Lira were included as well as the exchange rate gap (nominal effective exchange rate), the monthly data for the period 2003:01-2021:10 were analyzed by the Sliding Window method and the ARDL Limit Test. The results expressed in the study; The Taylor equation is valid in the Turkish economy, the growth response coefficient of the interest rate is 0.20, the inflation reaction coefficient of the interest rate is 0.8, the exchange rate reaction coefficient is 0.18, and the relationship between nominal interest rates and other variables in the equation is positive (Bulut and Tokatlıoğlu, 2022: 995).

4. DATA SET AND METHODOLOGY

4.1. DATA SET

In the study where the validity of the Taylor rule Augmented with the exchange rate was investigated in the Turkish economy, the monthly observation values for the period 2003M01-2022M08 of the Turkish economy were used. In the analysis of the short- and long-term relationship between the variables that are the subject of the study; 2010-based consumer price index data were used for the inflation rate, 2010-based industrial production index data published monthly for the output level variable, nominal effective exchange rate index as the exchange rate variable and TCMB policy interest rate (1-week repo rate) data were used as the short-term interest rate variable. From the data analyzed in the study, consumer price index, interest rate and industrial production index data were obtained through International Financial Statistics (IFS) and exchange rate data were obtained through Bank for International Settlements (BIS). In the study, since the variables in the Taylor equation are rate variables, the index data were converted into rate variables by taking the percentage changes compared to the same month of the previous year.

Within the framework of the expanded Taylor rule, in order to obtain the exchange rate gap, inflation gap and output gap, it is necessary to obtain the trend values of the exchange rate, inflation rate and output level. By subtracting trend values from the current values of these variables, exchange rate gap, inflation gap and output gap data are created. From this point of view, the relationship between inflation gap, exchange rate gap and output gap data and policy interest rate is investigated. In order to obtain the trend values of the exchange rate, inflation rate and output level in the study, Hodrick-Prescott (1997), which is one of the frequently used filter methods in the literature, was applied as in (Bulut and Tokatlıoğlu, 2022: 986), (Lebe ve Bayat,

2011: 100), (Örücü, 2019: 204), (Akdeniz, 2021, 300) and (Aktemur ve Öztürk, 2019, 122). In the analysis, the policy interest rate was used as the dependent variable, and the inflation gap obtained by subtracting inflation from the trend values of inflation as the independent variable, the output gap obtained by subtracting from the trend values of the industrial production index and the exchange rate gap data obtained by subtracting the exchange rate from the trend values were used. The analysis carried out within the framework of these variables was tested in the Eviews 12 program. The variables used in the analysis are summarized in Table 4.1.

Table 4.1. Variables Determined for Use in Analysis

Simge	Explanation	Variable	Source
INF	Inflation Rate	Independent Variable	IFS
INFA	Inflation Gap	Independent Variable	
IPI	Industrial Production	Independent Variable	IFS
IPIA	Output Gap	Independent Variable	
ER	Nominal Exchange Rate	Independent Variable	BIS
ERA	Exchange Rate Gap	Independent Variable	
PC	Policy Rate	Dependent Variable	IFS

4.2. METHODOLOGY

Autoregressive Distributed Lag Bound Test (ARDL) and Engle-Granger cointegration tests are used to determine the existence of a long-term relationship between the series. The biggest disadvantage in applying the Engle-Granger cointegration test is that the variables to be analyzed must be stationary of the same order. In addition, variables must be stationary at their first difference in order to perform Engle-Granger and Johansen cointegration tests (Banerjee vd., 1986).

The ARDL bounds test, on the other hand, is a method that can be used to investigate the long-term relationship between variables, even when the variables are stationary at different levels. In order to be able to analyze with the ARDL bounds test, the quadratic differences of the variables should not be stationary (Paseran vd., 2001). Therefore, as long as the series are not stationary in the second difference, analysis can be made with the ARDL bounds test (Narayan, 2005: 21). In order

to perform the analysis with the ARDL bounds test, the Unrestricted Error Correction model (UECM) must be estimated first. Then, the optimal lag length values are determined with Akaike or Schwarz information criteria. The fact that the F statistic value obtained in the analysis performed exceeds the upper limit critical value means that there is a cointegration relationship between the variables (Toker, 2020:85).

The ARDL method was preferred for the econometric analysis of the data set based on the 2003M01-2022M08 time interval created for the study, due to its advantages such as being applicable when the variables have different levels of stationarity apart from their second differences, and estimating the coefficients related to the model in the short and long term.

In the study, Phillips-Perron (PP), unit root test were used to determine the stationarity levels of the data. The null hypothesis of the Phillips-Perron unit root test is that the analyzed variables are not stationary. The alternative hypothesis of the related test is that the variable in question is stationary. Table 4.2. presents the results of PP, unit root tests.

Table 4.2. Unit Root Test Results

Variable	Model	PP Test Statistic (P-value)	PP Test Statistic (P-value) 1.DIFF
INF	Intercept	2.44377 (1.0000)	-7.868592 (0.0000)
	Trend & Intercept	1.68700 4 (1.0000)	-8.252339 (0.0000)
	None	1.92505 8 (0.9872)	-7.813285 (0.0000)
INFA	Intercept	- 2.84991 (0.0530)	-9.117788 (0.0000)
	Trend & Intercept	- 2.73966 9 (0.2217)	-9.163161 (0.0000)
	None	- 2.86884 9 (0.0042)	-9.128254 (0.0000)
IPI	Intercept	- 8.60966 4 (0.0000)	-40.92967 (0.0000)

		-	
	Trend & Intercept	8.59850 6 (0.0000)	-40.76141 (0.0001)
	None	6.76459 6 (0.0000)	-41.06256 (0.0001)
	Intercept	9.99020 5 (0.0000)	-53.19054 (0.0001)
IPIA	Trend & Intercept	9.97176 (0.0000)	-56.40666 (0.0001)
	None	10.0087 7 (0.0000)	-53.39589 (0.0001)
	Intercept	2.93601 6 (0.0428)	-9.901267 (0.0000)
ER	Trend & Intercept	4.29063 1 (0.0039)	-9.936321 (0.0000)
	None	2.10112 4 (0.0345)	-9.93077 (0.0000)
	Intercept	4.80374 7 (0.0001)	-10.16896 (0.0000)
ERA	Trend & Intercept	4.78501 2 (0.0006)	-10.15133 (0.0000)
	None	4.81194 4 (0.0000)	-10.20603 (0.0000)
	Intercept	3.68709 2 (0.0049)	-13.54266 (0.0000)
PR	Trend & Intercept	3.88211 2 (0.0142)	-13.5224 (0.0000)
	None	3.67912 9 (0.0003)	-13.56691 (0.0000)

In Table 4.2, which include the PP unit root test findings, the levels at which the stationarity of the variables are determined are determined. Since the stationarity of the data to be analyzed was provided at the level or at the first differences, no stationarity was determined for the second differences. Since the data are not stationary in their second difference, there is no obstacle to the application of the ARDL limit test in investigating the cointegration relationship between the ERA, IPIA and INFA variables and the PR variable. In this direction, ARDL analysis was carried out in the study.

Table 4.3 shows the optimum delay selection results for the model according to the Akaike information criterion. According to the values in the table, ARDL (6, 6, 0, 0) was selected as the optimal model among twenty models. For this reason, the analyzes performed in the study will be carried out according to the ARDL (6, 6, 0, 0) model.

Table 4.3. Optimal Latency Based on Akaike Information Criteria

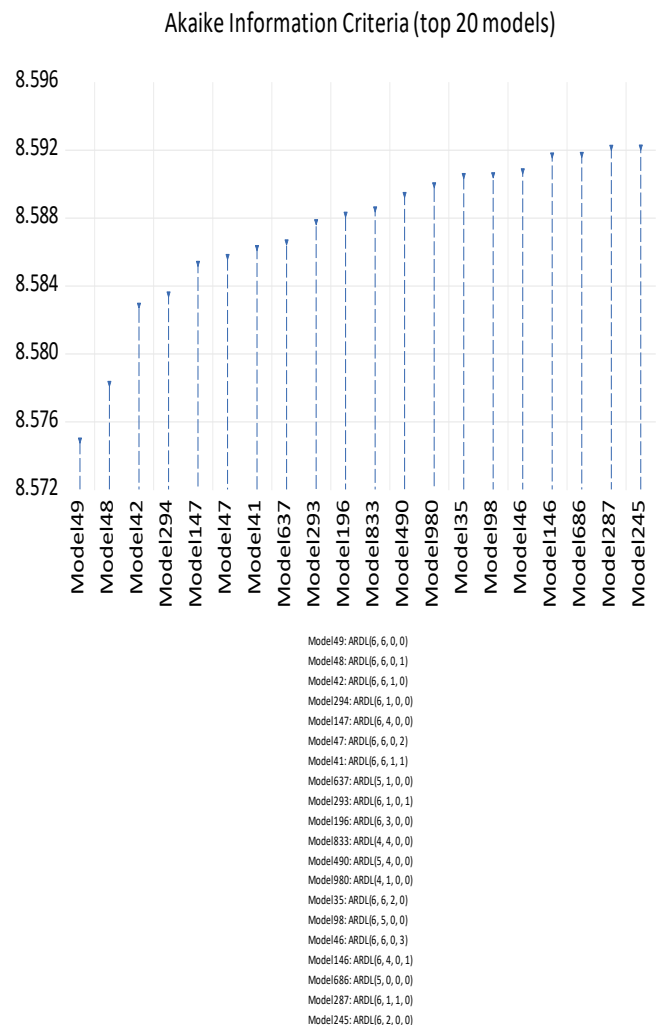


Table 4.4 shows the ARDL limit test results. According to the data in the table, the upper limit critical value in I(0) and I(1), as F-Statistics is

11,77513, exceeds the upper limit critical value at 1%, 5% and 10% significance levels. Based on this, it has been determined that there is a long-term relationship between output gap (IPIA), inflation gap (INFA) and exchange rate gap (ERA) variables and policy interest rate (PR) variables. Therefore, there is a co-integrated relationship between exchange rate gap, inflation gap and output gap and policy interest rate variables. In addition, the coefficient estimates that determine the direction and degree of the relationship between the analyzed variables are reported in equation 1.

$$EC = PR - (6.3960*INFA + 2.1340*IPIA - 1.9449*ERA).....(3)$$

Table 4.4. ARDL Bounds Test Results

F-Statistic		Critical Values	
11.77513			
Significance	I(0)Bound	I (1) Bound	
10%	3.47	4.45	
5%	4.01	5.07	
1%	5.17	6.36	

Long-term coefficients and short-term analyzes are given in Table 4.5 and Table 4.6 in order to determine the relationship between the variables analyzed in the long-term. Since the probe values in Table 3.5 are below 0.10, the relationship between exchange rate gap, inflation gap, output gap and policy interest rate is statistically significant. In addition, the coefficients for the relevant variables are positive for the inflation gap and output gap, while they are negative for the exchange rate gap. Accordingly, while the inflation gap and the output gap affect the policy interest rate in the same direction, the exchange rate gap affects the policy interest rate in the opposite direction.

Table 4.5. Long-run Coefficients of ARDL (6, 6, 0, 0) Models

Variables	Coefficient	t-statistic	Prob Value
INFA	6.395956	3.039332	0.0027
IPIA	2.133976	2.477934	0.0140
ERA	-1.944886	-2.035602	0.0430

Table 4.6 and Table 4.7 shows the estimation results of the Short-run & Diagnostic Results of ARDL analysis and the short-run coefficients. According to the table, although the cointegration coefficient has

a negative sign for the ARDL (6, 6, 0, 0) model, the probability value of the mentioned coefficient is 0 (zero). In addition, as can be seen from the test results in Table 3.6, the probe values of Breusch-Godfrey Serial Correlation LM Test, Breusch-Pagan-Godfrey Heteroskedasticity Test and Ramsey RESET Test are above 0.10. This situation shows that there is no problem in terms of autocorrelation, changing variance and model determination in the analysis performed. Therefore, the realization of the probe values of the relevant tests above the 10% significance level means that the H1 hypotheses of statistical significance tests such as autocorrelation, heteroskedasticity and incorrect determination of the model are accepted.

Table 4.6. Short-run Results of ARDL (6, 6, 0, 0) Model

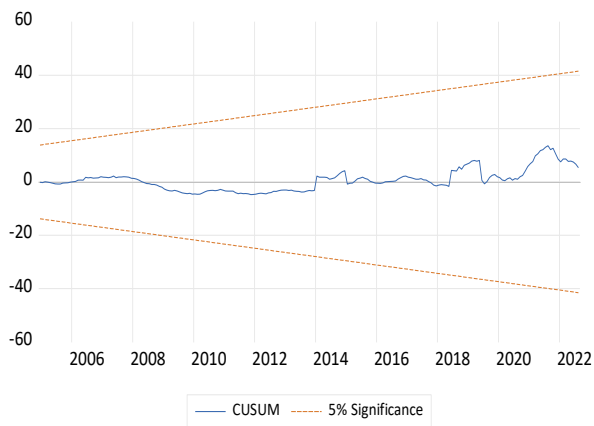
Variable	Coefficient	t-Statistic	Prob Value
C	5.771268	2.384047	0.0180
@TREND	0.055858	2.832003	0.0051
D(PR(-1))	0.133219	2.111827	0.0359
D(PR(-2))	0.090258	1.418352	0.1575
D(PR(-3))	0.305643	4.824387	0.0000
D(PR(-4))	0.121323	1.800831	0.0731
D(PR(-5))	0.169245	2.464083	0.0145
D(INFA)	2.584509	3.159780	0.0018
D(INFA(-1))	-0.241470	-0.253324	0.8003
D(INFA(-2))	-1.004203	-1.045191	0.2971
D(INFA(-3))	-1.779530	-1.878510	0.0617
D(INFA(-4))	-0.089963	-0.093887	0.9253
D(INFA(-5))	-2.205795	-2.485195	0.0137
CointEq(-1)*	-0.170140	-6.911144	0.0000
EC = PR - (6.3960*INFA + 2.1340*IPIA - 1.9449*ERA)			

Table 4.7. Diagnostic Results of ARDL (6, 6, 0, 0) Model

Diagnostic Tests	
Tests	Test Value (Prob.)
Breusch-Godfrey Serial Correlation LM Test	0.506400 (0.6034)
Breusch-Pagan-Godfrey Heteroskedasticity Test	1.177814 (0.2876)
Ramsey RESET Test	0.981728 (0.3229)

The Cusum test in Figure 4.1. supports the stability of the previously reported ARDL (6, 6, 0, 0) model at the 5% significance level.

Figure 4.1. Cusum Test



CONCLUSION

In the inflation targeting strategy, which has a wide application area in the fight against inflation, short-term interest rates are used as an intermediate target. The Taylor rule, which reveals the relationship between the output gap and the inflation gap with short-term interest rates and which is included in the economic literature with the analysis made on the US economy, was a guide for the central banks of developed countries that adopted the inflation targeting strategy in the early periods. It has a wide application area in the fight against inflation. In the inflation targeting strategy, which has an interim target, short-term interest rates are used. The Taylor rule, which reveals the relationship between the output gap and the inflation gap with short-term interest rates, and which is included in the economics literature with the analysis made on the US economy, was in a sense a guide for the central banks of developed countries that adopted the inflation targeting strategy in the early periods. The fact that Taylor's rule has a closed analysis for emerging open country economies in globalizing markets has led to debates about the development of the rule in question. In this direction, the Augmented Taylor rule has taken its place in the literature with the inclusion of the exchange rate in the Taylor rule.

The exchange rate has an effect on macroeconomic indicators in the Turkish economy. This situation can be evaluated as the pass-through effect from the exchange rate. Although high inflation is a serious problem for the economies of many countries, the inflation rate did not fall below 10% in the period from the 1980s to 2004 in the Turkish economy, which has been struggling with the inflation problem for many years. In fact, in the period after the 1980s, the inflation rate was below 10% for the first time in 2004. In the Turkish economy, where the exchange rate anchor-based

strategy was adopted in 2000, with the Transition to a Strong Economy Program, which was started to be implemented in 2001, the inflation rate decreased compared to the 1990s. With the decline in the inflation rate, the TCMB implemented the implicit inflation targeting strategy in the 2002-2005 period, and adopted the explicit inflation targeting strategy as of 2006. Today, within the framework of the inflation targeting strategy, the CBRT uses the 1-week repo auction rate as the policy interest rate. This situation makes it possible to investigate the Augmented Taylor rule in the Turkish economy, which is an open economy where the short-term interest rate is used as an intermediate target and the inflation targeting strategy is adopted.

In the study, the Augmented Taylor rule equation, which includes the nominal effective exchange rate for the Turkish economy, has been tried to be estimated using the ARDL bounds test method with monthly data for the 2003M01-2022M08 period. In the analysis carried out, it has been determined that the inflation gap, output gap and exchange rate gap are cointegrated with the policy interest rate and therefore are statistically significant. In line with the ARDL boundary test method, the inflation gap and output gap coefficients were positive, but 6.395956 and 2.133976 respectively, while the exchange rate gap coefficient was negative but -1.944886. This shows that the inflation gap and the output gap affect the policy interest rate positively, while the exchange rate gap affects the policy interest rate negatively. When the response coefficients of the policy interest rate are examined, it is determined that the inflation response coefficient is higher than the output and exchange rate. Positive values of output gap and inflation response coefficients appear in accordance with Taylor's rule, as in the studies conducted by (Zortuk, 2007: 70), (Bulut ve Tokatlıoğlu, 2022: 994) and (Akdeniz, 2021: 306).

However, the negative value of the exchange rate gap coefficient indicates an inconsistent situation in terms of Taylor's rule. This situation can be associated with the fact that the real effective exchange rate index in the Turkish economy over the period of 2003M01-2022M:08, when the analysis was carried out, was over 100 in the 2004-2014 period. The fact that the real effective exchange rate index is over 100 indicates that the Turkish Lira is overvalued for the 2004-2014 period (Yalçın, 2020: 92). The negative value of the exchange rate gap coefficient in the ARDL bounds test analysis can be thought of as the link between the exchange rate and the interest rate due to the overvalued Turkish Lira in most of the analysis period.

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