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TESTING THE RATIONAL EXPECTATIONS HYPOTHESIS: AN EMPIRICAL EVIDENCE FROM TURKEY**

Ümit YILDIZ*[1]

Bülent GÜNSOY[2]

ABSTRACT

The rational expectations hypothesis suggests that economic agents make accurate forecasts about the future using all available information effectively. According to the hypothesis, even if the economic agents make incorrect estimates, they shape the expectations for correcting the error made using the available information and do not make systematic errors.

In this study, the validity of the rational expectations hypothesis for Turkey, using expectations of the inflation rates, is tested. In this context, it is examined whether the expectations are rational or not by examining the unbiasedness and the efficiency of the expectations about the price by using ordinary last squares regressions. According to results, while the efficiency hypothesis is accepted for the expectations of inflation, the unbiasedness for expectations is rejected in the study. This means that although the current information is being used, economic agents can not make the accurate forecasts. Thus, the rational expectations hypothesis for inlation expectations for Turkey is rejected. However, results also show that although the expectations are biased, professional forecasters take into account many variables while forecasting the inflation. This implies

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[1] Assist. Prof., Bayburt University, Faculty of Economics and Administrative Sciences, umityildiz@bayburt.edu.tr, ORCID ID: https://orcid.org/0000-0002-2677-2098

[2] Prof. Dr., Anadolu University, Faculty of Economics, bgunsoy@anadolu.edu.tr, ORCID: https://orcid.org/0000-0001-6370-189X

***Sorumlu Yazar (Corresponding Author)**

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that policies can be partially effective if expectations are taken into account in the implementation of economic policies.

Keywords: Price Expectations, Rational Expectations Hypothesis, Unbiasedness, Efficiency

Jel Classification: C12, C32, D84, E31

RASYONEL BEKLENTİLER HİPOTEZİNİN TESTİ: TÜRKİYE İÇİN AMPİRİK BİR ÇALIŞMA

ÖZ

Rasyonel beklentiler hipotezine göre, ekonomik birimler mevcut tüm bilgiyi etkin şekilde kullanarak gelecekle ilgili doğru tahminlerde bulunurlar. Hipoteze göre ekonomik birimler hatalı tahminlerde bulunsalar dahi, mevcut bilgiyi kullanarak yapılan hatayı düzeltmeye yönelik beklentilerini şekillendirirler ve bu şekilde sistematik hata yapmazlar.

Bu çalışmada Türkiye için rasyonel beklentiler hipotezinin geçerliliği enflasyon beklentileri özelinde test edilmiştir. Bu kapsamda çalışmada en küçük kareler yöntemiyle fiyatlara ilişkin beklentilerin yansızlığı ve etkinliği test edilerek beklentilerin rasyonel olup olmadığı araştırılmaktadır. Çalışmanın bulgularına göre, enflasyon beklentileri için etkinlik hipotezi kabul edilirken, beklentilerin yansızlığı hipotezi reddedilmektedir. Bu durum, mevcut bilgilerin kullanılıyor olmasına rağmen ekonomik birimlerin doğru tahminler yapamadığını ima etmektedir. Bu nedenle Türkiye için enflasyon beklentilerine ilişkin rasyonel beklentiler hipotezi reddedilmektedir. Ancak sonuçlar, beklentilerin yanlı olmasına rağmen, profesyonel tahmincilerin enflasyonu tahmin ederken birçok değişkeni dikkate aldığını da göstermektedir. Bu ise beklentilerin dikkate alınması durumunda, ekonomi politikalarının uygulanmasında politikaların kısmen etkili olabileceği anlamına gelmektedir.

Anahtar Kelimeler: Fiyat Beklentileri, Rasyonel Beklentiler Hipotezi, Yansızlık, Etkinlik

Jel Kodları: C12, C32, D84, E31

INTRODUCTION

Inflation is an important macroeconomic indicator that influence the economies through many different ways. From the implementation of economic policies to the effectiveness of policies, the overall policy implementation process is closely linked to changes in prices. Therefore, prices are the focus of all economic policies. In particular, the central bank, whose main objective is to ensure price stability, closely follows the general level of prices and develops policies in line with its target. This increases the importance of expectations about prices. Central Bank's expectations about prices will determine both the right policies and the effectiveness of the policies implemented. For this purpose, the central bank determine the price expectations of economic agents and develops appropriate policies. However, the effectiveness of these policies will vary depending on how much the expectations are in line with the real values. This is related to whether the price expectations are rational or not.

According to the rational expectations hypothesis, economic units make accurate expectations about prices by effectively using all available information. However, many studies that test the hypothesis of rational expectations in literature have concluded that rational expectations are often not valid. The aim of this study, by analyzing price expectations for Turkey, to determine whether the rational expectations hypothesis is valid or not for Turkey. In this context, in the study, the rational expectations hypothesis for Turkey is tested for price expectations. The study mainly consists of five topics: theoretical framework, literature, method, findings and conclusion.

1.THEORETICAL FRAMEWORK

Expectations in the economy have been discussed for many years among economists. Moreover, the importance of the expectations is increasing especially in recent years. Expectations for macroeconomic variables are effective on all economic policies and play a decisive role in the effectiveness of the policies implemented. For this reason, the future expectations of economic units are followed by economists and they are the subject of many studies due to its importance.

In order to better understand the expectations of the economy, the place of expectations in economic theory should be well known. When we are examine the expectations in this

aspect, we encounter two types of expectation definition. The first one is the adaptive expectations put forward by the Monetarists. The second one is the rational expectations which are the basis of New Classical Economics and accepted by the New Keynesian Economics also. According to economic theory, economic units shape their future expectations according to adaptive expectations or rational expectations. According to adaptive expectations hypothesis economic units adjust their expectations of the future based on recent past experiences. In other words, according to adaptive expectations, individuals use past forecast errors in order to adjust their current expectations. The hypothesis of adaptive expectations is expressed as follows (Fisher, 1992, p.18):

$$y^a_t = y_{t-1} + \lambda\ (y^a_{t-1} - y_{t-1}) \qquad (1)$$

In equation 1, y^a_t represents the expectations of individuals at the end of y_{t-1} for the t period for y variable. y^a_{t-1} is the forecasted value for t-1 period and it is estimated according to the information obtained at the end of t-2 period. $y_{t-1}$is the actual y variable for the t-1 period.

We can illustrate the hypothesis of adaptive expectations in a macroeconomic variable. For example, price expectations. According to the adaptive expectations hypothesis, if the inflation in an economy is on the rise, economic units expect the prices to rise in the future. In this context, price expectations based on adaptive expectations can be formulated as follows:

$$\pi^e = \pi^e_{-1} + \propto (\pi_{-1} - \pi^e_{-1}) \qquad (2)$$

In equation 2, π^epresents the current inflation rate expectation, $\pi^e_{-1,}$ show the expected inflation rate in the previous period, and π_{-1} represents the actual inflation rate in the previous period. $\propto$ represents the coefficient that shows the effect of the difference between the expected inflation rate on the previous period and actual inflation rate on the previous period on current expected inflation rate. We can show the inflation expectations as follows based on the adaptive expectations by generalizing this equation. By generalizing of this equation, price expectations based on adaptive expectations can be expressed as follows:

$$n=0\infty\propto i\pi n \qquad (3)$$

As it can be understood from the equation, the inflation expectations of the current period are shaped by the inflation rates of the previous periods. Therefore, according to adaptive expectations, all other factors that affect inflation are ignored while inflation expectations are formed. Accordingly, if the economic units make a forecast error with the effect of various shocks in the process, the inflation forecasts for the other period will be inaccurate. This cause economic units to make a systematic error in future forecasts. For this reason, these assumptions proposed by theadaptive expectations hypothesis had been criticized and the rational expectations hypothesis was suggested.

The rational expectations hypothesis was originally suggested by John Muth in his article "Rational Expectations and the Theory of Price Movements" in 1961. According to this hypothesis, while economic decision units make a prediction of the future value of a variable, they have full knowledge about all the factors affecting the value of the variable and use it in full effective manner. According to the hypothesis, information is scarce and the economic system generally does not waste this scarce knowledge (Muth, 1961, p.316). This definition is the general description of the rational expectations hypothesis but it does not mean that economic units will not make mistakes when estimating the future value of a variable. According to the rational expectations hypothesis, economic units can make a forecast error but they do not continue to make this mistake. In other words, the rational expectations hypothesis tells us that economic units will not systematically make forecast error using all available information effectively. In this context, the fact that individuals do not make systematic mistakes constitutes the starting point of rational expectations hypothesis (Begg, 1982, p.29).

The rational expectations hypothesis is based on the assumption that economic units do not make systematic errors. However, many studies have shown that forecasters make systematic errors in their expectations. These results are based on some basic reasons. Those who argue that rational expectations are not always valid firstly argue that it is quite difficult for forecasters to reach all available information while making forecast about the future. Because it takes time and effort to reach all the necessary information in order to forecast the future value of a variable correctly. However, not all decision-making units may have these opportunities. Therefore, the units that can not reach all the available information can make mistakes in their forecasts about the future. The second criticism

of the rational expectations hypothesis is related to the correct economic model. For example, in order to make a rational forecast of inflation, economic units need an accurate model of the economy. But even economists cannot agree on the right economic model, so it is very difficult for all economic agents to know the correct model of the economy (Snowdon and Vane, 2012).

The most important assumption that differentiates rational expectations from the adaptive expectations is that forecasted variable does not includes only to the past actual values of the variable, and this forecast includes all current information about related variable. Accordingly, the hypothesis of rational expectations, contrary to the hypothesis of adaptive expectations, argues that the economics agents do not make systematic errors. This does not mean that the economics units do not make any forecast error. However, it is based on the assumption that these errors do not be systematic. Because, even if they make mistakes, economic units adjust their expectations for correcting the errors by using the available information (Snowdon and Vane, 2012).

While economic units form expectations in the context of rational expectations, they know not only the use of all available information but also the mathematical modeling that will shape the expectations using the information they have. According to this, the rational expectations model can be shown as follows (Begg, 1982, p.72):

$$E\,(y_{t+k} \mid I_t) \qquad (4)$$

The model of rational expectations that we have defined above has the following properties (Begg, 1982, pp. 72-73):

$$I. \quad E\{[E(y_{t+i+j} \mid I_{t+i})] \mid I_t\} = E(y_{t+i+j} \mid I_t) \qquad (5)$$

$$II. \quad E\{[y_{t+i} - E(y_{t+i} \mid I_t)] \mid S_t\} = 0 \qquad (6)$$

$$III. \quad \{y_{t+1} - E(y_{t+1} \mid I_t)\} = 0 \qquad (7)$$

The first property of the rational expectations model implies that individuals do not have a basis for changing their expectations of future values. This feature suggests that expectations are consistent. The second property is that the error term has zero mean. It

means that the value realized for the variable is equal to the estimated value. So this tells us that the model of rational expectation is unbiased. According to the third property of the rational expectations model, it is expected that the error terms estimated for each period have zero mean and no relationship with their past values. This condition implies that there should be no correlation between forecast errors and past information (Miskin, 1983, p.10). More specifically, this property tells us that error terms should not include autocorrelation. All of the properties mentioned for the rational expectations model are considered in the analyzes to determine whether the expectations of inflation rate are rational.

2.LITERATURE

When the literature about the rational expectations is researched, it is seen that there are quite an extensively literature and the studies that test whether the expectations is rational or not are concentrated on the price expectations. In this part of the study, national and international studies that stand out are discussed. Related studies can be summarized as follows:

Turnovsky (1970) in his study investigating the price expectations for the US economy during the post-Korean War period, tested the rational expectations hypothesis using Livingston's[3] 6-month and 12-month ahead expectation data. In the study, rational expectations hypothesis is tested for two sub-periods in the period 1954-1964 and 1962-1969 and different results are reached for each period. While the rational expectations hypothesis is rejected for the 1954-1964 period, which is called the early period, it was concluded that there is a significant improvement in the expectations for the period of 1962-1969, which is calleda late period. And for the late periof, price expectations of the businessmen are closer to the Muth condition. So, the rational expectations hypothesis is accepted for 1962-1969 period.

[3] The survey, which was first conducted in 1946 by columnist Joseph Livingston, is the oldest economic expectations survey. The survey summarizes the economic forecasts of industries, government, banking and academia. Federal Reserve Bank of Philadelphia took responsibility for the survey in 1990.

https://www.philadelphiafed.org/research-and-data/real-time-center/livingston-survey Date Accessed:18/04/2017

Pesando (1975) applied the efficiency test to Livingston data to test rational expectations hypothesis. Although the data are reached until 1946, the test are applied for two periods of 1959-1969 and 1962-1969, on the grounds that there is an important structural break in 1959.In the study, which used the 6-month consumer price index data, the weak efficiency is tested with 5 lags. The weak efficiency is rejected for both periods.In the study, consistency of expectations is tested for the same periods and consistency is rejected for both periods also.

Carlson (1977), using Pesando's (1975) method, applied rationality, efficiency, and consistency tests to the Livingston data which is reviewed. As a result of the study, Carlson rejected all three hypotheses with the consumer price index data but could not reject hypothesis with the wholesale price index data. The overall result of the study is the rejection of rationality.

Mullineaux (1978) suggest in his study that there is a significant deficiency in Pesando's (1975) and Carlson's (1977) studies. According to Mullineaux, the Chow (1960) tests performed in both studies are not valid due to the heteroskedasticity in the estimated equations. In her study, Mullineaux propose a new weak efficiency test that examined the relationship between expectation forecast errors and lagged values of the actual series, and he tested the rationality with the data used by both Pesando (1975) and Carlson (1977).As a result of the study, the rationality is rejected by Livingston data used by Pesando (1975), and rationality is accepted by the adjusted Livingston data used by Carlson (1977).As a result of the study, the rationality is rejected when using Livingston data used by Pesando (1975), and rationality is accepted when using the adjusted Livingston data used by Carlson (1977).

Pearce (1979) tests the rationality of the expectations for the US for the period of 1952M12-1960M6 by using the data of the period of 1947M1-1959M4 by applying the Box- Jenkins method. As a result of the study, it is concluded that the expectations are rational and he suggest that univariate estimation models could yield better results than Livingston data.

Figlewski and Watchel (1981) test the unbiasedness of expectations with Livingston data using the least squares and weighted least squares method. According to estimation

results, the hypothesis of unbiasedness is rejected and it is concluded that the estimation error of the previous period is important explanatory factor of the current estimation error.

Uygur (1983) tests the unbiasedness and effectiveness of the price expectations for Turkey's manufacturing industry and sub-sectors. At the end of the study, in 5 out of 16 sub-sectors, unbiasedness and efficiency hypotheses are accepted and it is concluded that the price expectations of these sectors are rational. On the other hand, it is concluded that the price expectations of other sectors are not rational because the forecasts do not fulfill the assumptions of unbiasedness and efficiency.

Keane and Runkle (1989) test whether the price expectations obtained from ASA-NBER are rational or not for the period of 1968Q4-1986Q3 for the US by using the ordinary least squares method. In the study, they suggest that the price forecasts of the professionals are rational because the estimation errors are not predictable. Test results also do not reject the hypothesis that information is most optimally used when estimating.

Razzak (1997) test the rationality to inflation expectations using the survey data of the National Bank of New Zealand for the period 1985Q1-1996Q4.In the study, the null hypothesis of unbiasedness, efficiency and orthogonality tests are not rejected. In addition, it is stated in the study that the predictive power of the survey data is stronger than the random walking and ARIMA models but that ARIMA has better predictive power than the survey data in the period of 1992Q1 - 1996Q1 when inflation is low and stable. According to the author, the results of the study are not inconsistent with rationality.

Thomas (1999) tested the rational expectations for the United States for the period of 1960Q1-1997Q4 by using the survey data from Livingston, Michigan (Survey of Consumers, University of Michigan) and SPF (Survey of Professional Forecasters).In the study, the unbiasedness and efficiency of the expectations for two different periods before and after 1980 are investigated. In the study, it is concluded that the survey data generally did not support rationality.

Bilgili (2001) test the rationality of price expectations obtained from CBRT Business Tendency Survey with the help of unbiasedness and efficiency tests for Turkey for the period of 1999-2001.Both the unbiasedness and efficiency hypotheses are rejected

according to the estimation results. The rationality of the expectations obtained by the Box-Jenkins method is tested also in the study. In this way, while the efficiency hypothesis is accepted, unbiasedness is rejected again.

Mehra (2002) compared the expectations of the consumer price index of Livingston, Michigan and professional forecasters (SPF) for US. In the study, the accuracy, estimation content and rationality of expectations are evaluated. In the study, 1961M1-2001M3 period is examined in two sub-periods (1961M1-1980M2 and 1980M3-2001M3) and Granger causality analysis is used as the method. In the study, it is concluded that Michigan data is relatively more accurate, unbiased and effective for the medium-term inflation forecast.

Oral (2002) test the reliability of the Business Tendency Survey and rationality of inflation expectations derived from the survey for Turkey. In the study covering the period of 1997-2001, the tests of unbiasedness, efficiency and orthogonality are applied and it is concluded that the expectations are not rational. In this study, it is concluded that the changes in the exchange rate of dollar and the weighted average of compound interest rates have an effect on the inflation expectations obtained from the Business Tendency Survey.

Forsells and Kenny (2002) analyze the inflation expectations obtained from the European Commission's Consumer Survey for the period of 1986-2001 for the Euro Area. In the study in which the empirical characteristics of the expectations are tested, it is concluded that inflation expectations provided some of the necessary conditions of rationality. According to the study, it is argue that inflation expectations are unbiased forecasts and that although there are deviations in expectations, consumers do not make systematic errors. As a result, it is accepted that inflation expectations for the Euro Area are rational.

In Lyziak's (2003) study, the unbiasedness and macroeconomic effectiveness of the monthly inflation expectation data obtained from the Ipsos-Demoscope survey for the period of 1992-2000 for Poland are tested. In the study, it is concluded that inflation expectations are not unbiased predictors and they are biased predictors of the inflation rate for a long time. As a result expectations do not provide the requirements of rational expectations hypothesis.

Nielsen (2003) investigate whether the inflation expectations are rational by using data obtained from the consumer survey for the European Union, which is conducted by the European Commission on a monthly basis. In the study that used monthly data for the period of 1986-2001, since the series are not stationary at level, cointegration methods are preferred.The results of the analysis reveal that the rational expectations hypothesis for the European Union should be rejected in the relevant period.

Bakhshi, Kapetanios and Yates (2005) test the rational expectations hypothesis for the UK using the expectation data prepared by Merrill Lynch fund managers for the period 1994-2000.Unbiasedness, efficiency and variance bounds tests are applied to expectations in the study and it is conclude that price expectations are biased and expectations are not rational.

Kara and Küçük-Tuğer (2005) test the rationality of price expectations obtained from The CBRT Survey of Expectations, CBRT Business Tendency Survey and Manufacturing Industry Tendency Survey by the help of unbiasedness and efficiency tests for the period of 2001M1-2004M6.In the study it is concluded that expectations, except the one month ahead forecasts, are biased and inefficient. According to results, 12-months-ahead CPI and WPI expectations consistently overestimate the level of inflation. In addition, WPI expectations have a relatively higher bias proportion compared to CPI expectations. On the other hand, while the 1-month ahead manufacturing sector inflation expectations exhibit a downward bias, 2-months-ahead CPI inflation expectations show an upward bias. Furthermore, according to study there are significantly correlations between errors related to both the next 2 months' CPI inflation and next months' manufacturing sector inflation expectations and exchange rate depreciation.

Jonsson and Osterholm (2012) aim to investigate the characteristics of inflation expectations for Sweden in the period of 1996-2009. For this purpose, in the study, unbiasedness and efficiency of inflation expectations are tested by using data obtained by the survey conducted Prospera. The results of the study indicate that inflation expectations for Sweden for the related period are biased and expectations are not efficient. The results are interpreted as the inflation expectations of economic units are not optimal.

Riaz (2012) test the efficiency of quarterly food prices inflation expectations and consumer price index expectations for 1975-2008 for Pakistan. In the study, different results are obtained for the two index. The results show that food prices expectations are consistent and efficient. Also results show that food prices expectations provide weak and strong rationality requirements, while consumer price expectations are weak efficient.

Soybilen and Yazgan (2017), test the unbiasedness of monthly inflation expectations for the current month, 1 month ahead and 2 months ahead and yearly inflation expectations for the 12 months ahead and 24 months ahead. They also examine the forecast performance of the inflation expectations. In the study that used the data of 2006M1-2012M12 period, the unbiasedness of inflation expectations is analyzed with the help of Mincer and Zarnowitz (1969) test and Holden and Peel (1990) tests. According to Mincer and Zarnowitz (1969) test, all inflation expectations are biased. However, according to the Holden and Peel (1990) test results, only 12 months ahead and 24 months ahead yearly inflation expectations are biased.

Studies on rational expectations take a large part in the literature. However, only studies examining whether inflation expectations are rational are included in this section. In the next section, the method used in the study is mentioned.

3.METHODOLOGY

In this part of the study, the price expectations for Turkey are tested using a variety of econometric methods to determine whether expectaitions are rational or not. In this context, for the price expectations, the unbiasedness and the efficiency tests, which used in many studies, are carried out. And, monthly consumer price Index data obtained from CBRT Electronic Data Delivery System and the monthly CPI expectation data obtained from the CBRT Survey of Expectations are used for the 2007M1-2016M12 period. Stata 12 and Eviews 9 programs are used to analyzes.

The first condition to suggest that expectations are rational is that expectations are unbiased. This means that the average forecasts of the decision units are not different from the actual value. This is the requirement imposed by Muth (1961) for expectations to be rational and expectations are unbiased. (Turnovsky, 1970, p.1445). In this context,

firstly, the unbiasedness test is used for the price expectations. The equation used in the estimation of this test is as follows:

$$\pi_t = \propto + \beta\pi^e_t + \mu_t \qquad (8)$$

In equation 8,π_t is the actual inflation rate for t period, π^e_t is the inflation expectation for t period, $\propto$ is constant coefficient, β is the coefficient for the explanatory variable and ,μ_t is the error term. The hypothesis tested to determine whether price expectations are unbiased or not is as follows:

$$H_0 : \propto = 0 , \ \beta = 1$$

Acceptance of the null hypothesis means that expectations are unbiased. In other words, in order to say that the price expectations are unbiased, it must be that the constant coefficient is equal to 0 and the coefficient of the explanatory variable is equal to 1.

Another condition for deciding whether the expectations are rational or not is that the expectations are efficient. It means that all the available information is used when forecasting. To determine this, we investigate both the weak-form and strong-form efficiency of inflation expectations. We use the method suggested by Mullineaux (1978), to determine expextations are weak-form efficient. On the other hand, the method which is suggested by Friedman (1980) is used to determine whether expectations are strong-form efficient. The functional form to be used in determining weak-form efficiency is as follows:

$$\varepsilon_t = \beta\pi_{t-1} + \mu_t \qquad (9)$$

In equation 9, εt shows the error terms obtained in the estimated model for the unbiasedness test, and π_{t-1} shows the past value of the actual inflation rate. We can generalize this equation for *n*lags and write the new equation as follows:

$$\varepsilon_t = \sum_{i=1}^{n} \beta_i \pi_{t-i} + \mu_t \qquad (10)$$

There must be no relations between the error terms and the past values of the actual inflation rate in order to say inflation expectations are weak-form efficient. So we expect all β coefficients to be equal to zero simultaneously. For this purpose, thehypothesis to be tested is as follows:

$$H_0: \beta_i = 0$$

This hypothesis tells us that all explanatory variable coefficients are equal to zero simultaneously. So, the null hypothesis must not be rejected in order to say that expectations are weak-form efficient. Therefore, if the null hypothesis is not rejected, we can say that the available information including the lagged values of actual inflation is used effectively when forecasting of the future rate of inflation.

On the other hand, the functional form to be used in determining strong-form efficiency is as follows:

$$\varepsilon_t = \beta_i I\pi_{t-i} + \mu_t \qquad (11)$$

In equation 11, $I\pi_{t-i}$ represents earlier information of macroeconomic variables closely related to inlation and considered to have an impact on inflation rate. The aim is to determine whether the estimated coefficients of macroeconomic variables affecting the actual inflation rate are equal to zero simultaneously. For this purpose, thehypothesis to be tested is as follows:

$$H_0 : \beta_1 = 0, \beta_2 = 0, \ldots, \beta_i = 0$$

This hypothesis is tested to determine whether the forecasts are strong-form efficient. The fact that the coefficients of the explanatory variables are equal to zero at the same time means that the expectations are strong-form efficient. The acceptance of the zero hypothesis means that all available information is used when forecasting for inflation rate.

Here, hypotheses constructed for unbiasedness test, weak-form efficiency test and strong-form efficiency tests are tested with the help of the Wald Test.

4.RESULTS

In this section, the results of the analysis of the rationality of price expectations are presented. In this context, the graphs of the actual and expected inflation rates and the estimation results are respectively discussed in this part of the study. But, firstly it would be useful to explain the variables used in the study and the descriptive statistics of these variables. Table 1 and Table 2 were prepared for this purpose. The actual and expected inflation rates used in the study are shown together with their explanations and sources in Table 1. In the study, CPI is used to represent inflation, as percentage change in CPI means inflation.

Table 1. Variables of Actual and Expected Inflation

Variable	Explanation	Source
Actual Inflation	Monthly CPI (% Change)	CBRT
Expected Inflation	Monthly end of the current month CPI Expectations(% Change)	

Here, while the Consumer Prices Index is used as the actual inflation, end of the current month consumer price expectations obtained from the CBRT Expectations Surveys represent the expected inflation. While CPI data were obtained from the CBRT's database, the data related to the CPI expectations were compiled from the Expectations Surveys[4] published regularly by the CBRT each month. Table 2 shows the descriptive statistics of the actual and expected inflation rate series.

Table 2. Descriptive Statistics

	Actual Inflation	Expected Inflation	Forecast Errors
Mean	0.65279	0.62375	0.02904
Maximum	3.27213	1.85000	1.73083
Minimum	-1.43074	-0.02000	-1.45074
Standard deviation	0.79424	0.36736	0.57762
Skewness	0.45612	0.55004	0.23444
Kurtosis	3.37064	3.38445	3.06891
Number of observations	120	120	120

As it can be understood from the table 2, the mean value of the actual inflation rate is higher than the mean value of the end of the month inflation rate expectation. This means that monthly actual inflation is higher than expected in the related period. It is also observed that the standard deviation of the actual monthly inflation rate is higher than the standard deviation of expected inflation in the this period. In this case, it can be said that the current period inflation expectations are more stable than the current period actual inflation.

[4]The survey intends to monitor the expectations of experts and decision makers from financial and real sectors related to various economic variables. The statistics cover indicators produced for tracking short-term and long-term expectations related to macroeconomic variables such as consumer inflation rate, interest rates, exchange rates, GDP growth rate and current account balance. The results compiled for monitoring these expectations include mean, standard deviation, median, mode, modified mean, point estimate, interval estimate and average interval estimate for each question. The participants are selected among the decision makers and experts from the financial and real sectors as well as professionals from academia and other institutions.

http://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Statistics/Tendency+Surveys/Survey+of+Expectations/ Date accessed: 10/03/2018

On the other hand, the interpretation of the descriptive statistics of forecast errors is useful before interpretation of the analysis results. In this context, when we examine the mean value of forecast errors, we see that this value is about 0.03.As mentioned earlier, economics units make forecast error. However, these errors do not be systematic. In other words, economic agents may make mistakes in their forecasts, but they do not maintain it, according to the rational expectations hypothesis. So, expectations are consistent over the long term. Therefore, we expect that the mean values of the forecast errors must be 0 in order to say that the expectations of the prices are rational. Here, the mean value of forecast errors is very close to 0. The interpretation of this value may gives an idea prior to analysis. However, it does not confirm the assumptions of rational expectations hypothesis. For this reason, a number of analyzes based on properties of rational expectations function must be carried out in order to clarify whether the expectations are rational or not.

After the show of descriptive statistics, It will be appropriate to present the graphical display of the time series of actual and expected inflation. For this purpose, Graph 1 was prepared in which the current month actual and expected inflation series are included.

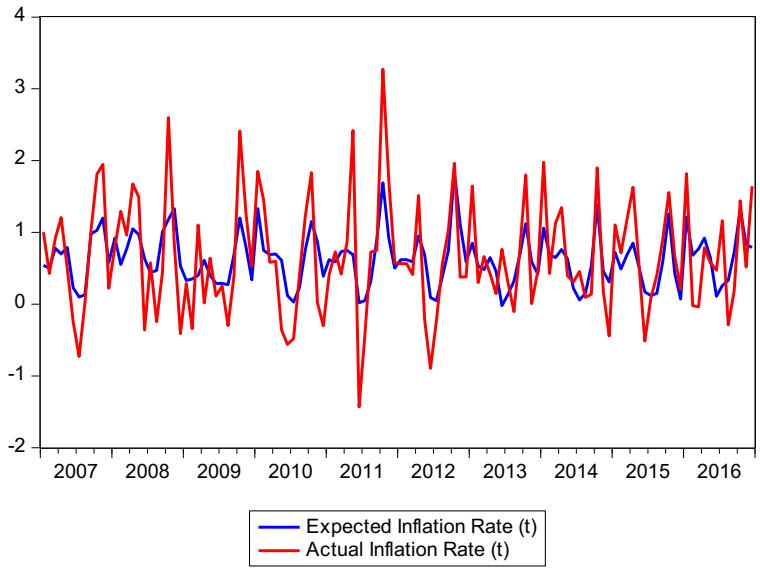

Fig 1. Actual and Expected Time Series of Inflation

The series, shown in blue in the graph, represents the expected inflation in the current period obtained from the CBRT Survey of Expectations, while the red color series represents the actual inflation announced by the CBRT in the same period. As can be seen

from the graph, the actual inflation series in the related period is quite fluctuating in contrast to the expected inflation series. In other words; the current period inflation expectation series is more stable than the current period actual inflation series. This also means that the variance value of the forecasted inflation series is smaller than the variance value of the actual inflation series. If the expectations are rational, the sum of the variance of the expectations and the variance of the forecast errors are equal to the variance of the actual series. Thus, in this case, the variance value of the actual series is bigger than the variance value of the forecasted series [$var(y_t)>var(y^e_t)$ If threre is $var(y_t)=var(y^e_t)+var(\varepsilon_t)$]. Accordingly, $var(y_t)>var\ (y^e_t)$ is another test that determines rationality (Maddala, 1992, p. 434). In short, if expectations are rational, $var(y^e_t)$ is smaller than the $var(y_t)$. Therefore, we can obtain important information about rationality for price expectations for Turkey, by examining variance values actual and expected inflation rate series. Table 3 prepared for this purpose shows $var(\pi_t)$ and $var(\pi^e_t)$.

Table 3. Variance Bounds Test

	Actual Inflation	Expected Inflation
Var	0,63081	0,13495

When the variance values are compared, we see that the variance value of the forecasted inflation series is smaller than variance value the actual inflation series for the related period. This approach gives an important idea about the rationality of expectations but, to be able to say whether the price expectations are rational, various econometric analysis must be carried out to be based on the properties of the rational expectations function. As mentioned earlier, the rational expectations hypothesis suggests that expectations must be unbiased and efficient. Therefore, in this part of the study, unbiasedness and efficiency tests are applied to the expectations in order to determine the rationality of the price expectations.

4.1.Unbiasedness Test

The first conditon of rational expectations suggested by Muth (1961) is that expectations must be unbiased. This means that the error term must be a random variable that has zero mean and it does not involve the problem of auotocorrelation. The equation to be estimated in order to determine whether expectations of inflation rate are unbiased is as follows:

$$\pi_t = \propto + \beta\pi^e_t + \mu_t \qquad (12)$$

Here, with the help of this equation, the unbiasedness of expectations, which is the first condition of the rational expectations hypothesis, is tested. In equation, π_t shows the actual inflation for period t, π^e_t presents the inflation expectation for the period t, μ_t is the error term, $\propto$ is the constant coefficient and β is the coefficient of the explanatory variable. Here, the null hypothesis defined as H_0: $\propto = 0$, $\beta = 1$ must not be rejected in order to determine that the price expectations are unbiased. In this context, firstly, the above equation is estimated by OLS method. However, it is important to investigate the stationary of the actual and forecasted inflation series in order not to encounter spurious regression problems before estimating of the regression. Various problems are encountered in testing of unbiasedness and efficiency of expectations without investigating the stationary of the series. According to Jeong and Maddala (1991), the traditional tests of rationality are not valid in the presence of unit roots.

In this part of the study, Augmented Dickey-Fuller Unit Root Test and Augmented Dickey-Fuller Unit Root Test with Breakpoint are used to investigate the stationary of the series. The results of unit root tests are shown in detail in Table 4.

Table 4. Unit Root Tests

			Actual Inflation	Expected Inflation
ADF unit root test*				
None	**I(0)**	**Stat.**	-6.2556	-3.1545
		Prob.	0.0000	0.0018
Intercept	**I(0)**	**Stat.**	-8.6173	-8.2669
		Prob.	0.0000	0.0000
Trend and Intercept	**I(0)**	**Stat.**	-8.5781	-8.2780
		Prob.	0.0000	0.0000
ADF unit root test with breakpoint*				
Intercept	**I(0)**	**Stat.**	-9.3938	-8.6113
		Prob.	<0.01	<0.01
		Break Date	2012M6	2008M11
Trend and Intercept	**I(0)**	**Stat.**	-9.3096	-8.6357
		Prob.	<0.01	<0.01
		Break Date	2012M6	2008M11

*The appropriate lag length is determined according to the Schwarz Information Criteria.

As can be seen from the table 4, both the actual and expected inflation series are stationary at the level. On the other hand, according to the breakpoint root unit test results, structural break is observed in both series (June 2016 and November 2011). However, both series

are stationary at the level according to both tests. So, we can use the I(0) for both variables.

After the investigation of the stationary of the series, we can make analysis regarding the unbiasedness of expectations. The results of the estimated equation are shown in Table 5 in order to determine whether the expectations are unbiased or not.

Table 5. Unbiasedness Test Results

	$\propto$	β	X^2	R^2
π_t	-0.3458 (-3.5755) [0.0005]	1.6009 (11.9696) [0.0000]	20.5414 [0,0000]	0.54

The t statistics are in parantheses

The probablities are in square brackets

According to the rational expectations hypothesis, the hypothesis H_0: $\alpha = 0$, $\beta = 1$ must not be rejected and there must not be first order serial correlation in order to say that expectations are unbiased. But, Wald test results (Prob = 0.0000) reject the null hypothesis. So, unbiasedness are rejected. This result means that the price expectations are biased for Turkey for the related period.

Moreover, it is useful to show diagnostic tests results for the estimated model. For this purpose, White Test is made to determine the heteroskedasticity and Breusch-Godfrey LM test is carried out to determine whether there is an autocorrelation problem in the model. And normality is tested with the help of Jarque-Bera Test. Table 6 shows the results of these tests.

Table 6 .Diagnostic Tests for the Unbiasedness

	White	***LM***	***JB***
μ_t	1.1032 [0.3352]	1.2199 [0.2990]	0.1759 [0.9157]

The probablities are in square brackets

Here, it is invastigated whether there is heteroskedasticity problem by appliyng the White Test. White suggested defining, the squares of the explanatory variables, and possibly their cross-products. Mostly, the variables that affect the variance are the same as those in the mean function. In addition, the quadratic function is used for the White test (Hill, Griffiths and Lim, 2008, p.215). For the White Test, the following equation is estimated:

$$\mu_t^2 = \propto + \beta_1 \pi_t + \beta_2 \pi_t^2 + v_t \qquad (13)$$

In equation 13, μ_t^2 represents the square of error terms, π_t represents actual inflation rates, and π_t^2 represents the squares of actual inflation rate. Here, the hypothesis as defined $H_0 = \beta_1 = \beta_2 = 0$ tested. H_0 hypothesis is that the errors have constant variance and the alternative hypothesis is that there is problem of heteroskedasticity in the model. According to the White test statistic (Prob: 0.3352) H_0 hypothesis can not be rejected. So, there is not problem problem of heteroskedasticity in the model. It means that erros have constant variance.

On the other hand, the problem of autocorrelation is investigated by Breusch-Godfrey LM test. In the test developed by Breusch (1978) and Godfrey (1978), the error terms obtained from the OLS estimation, lags of error terms and the estimators in the original model are modeled. (Baltagi, 2008, s.115). The following equation is estimated for this test:

$$\mu_t = \propto + \beta_1 \pi_t + \beta_2 \mu_{t-1} + v_t \qquad (14)$$

In equation 14, the null hypothesis shows that there is no autocorrelation problem in the model. According to LM test p-value (0.2990), there is no autocorrelation problem in the model. This means that there is not a systematic relationship between the error terms in the estimated equation.

Finally, normality is tested with the help of Jarque-Bera Test. The Jarque-Bera test statistic is shown as follows (Baltagi, 2008, p.98):

$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right] \qquad (15)$$

In equality, n represents the number of observations, while S represents the skewness, K represents the kurtosis of the error terms obtained from the OLS estimation. For the normal distribution, the skewness value must be ‘0', and kurtosis value must be '3'. So, the hypothesis defined as H_0: S=0, K=3 is tested with JB statistics. Here, the null hypothesis is that the data is normally distributed while the alternative hypothesis means that the data does not come from a normal distribution. When the p-value of the test is examined (0.9157), it is concluded that the null hypothesis cannot be rejected, in other words, the error terms are normally distributed.

4.2. Efficiency Test

The fact that the expectations are unbiased means that the mean forecasts of the economics units are not different from the actual value. In other words, the unbiasedness of expectations means that the mean of forecasts errors is 0. However, this does not give an idea of the assumption that all available information is effectively used while forecasting. In this context, in this part of the study, the aim is to determine whether professional forecasters use all available information effectively while forecasting about the price for Turkey in the related period. For this purpose, this section includes analyzes aimed at testing the efficiency of price expectations.

Efficiency tests are usually applied in two headings: weak-form efficiency test and strong-form efficiency test. Here, the results of the weak-form efficiency test and the strong-form efficiency test are discussed respectively. The weak-form efficiency test examines the relationship between the forecast errors and the lags of actual inflation rate. On the other hand, for the strong- form efficiency test, it is analyzed the relationship between actual inflation rates and macroeconomic variables, which are considered to have an impact on the inflation rate. To determine of strong-form efficiecy, some macroeconomic variables that are thought to affect inflation are included in the model and it is investigated whether there is a relationship between the these variables and the forecast errors.

Firstly, the estimated equation for the weak-form efficiency test is:

$$\mu_t = \beta_1\pi_{t-1} + \beta_2\pi_{t-2} + \beta_3\pi_{t-3} + \beta_4\pi_{t-4} + v_t \qquad (16)$$

In equation 16, μ_t indicates the error term, π_{t-1}, π_{t-2}, π_{t-3} *and* π_{t-4} indicates the lags of actual inflation rate. The weak-form efficiency test results are shown in Table 7.

Table 7. Weak-Form Efficiency Test Results

	β_1	β_2	β_3	β_4	X^2
μ_t	-0.0008	-0.1103	0.1173	-0.1002	7.8079
	(-0.0140)	(-1.8167)	(1.9152)	(-1.7472)	
	[0.9888]	[0.0719]	[0.0580]	[0.0833]	[0.0989]

The t statistics are in parantheses

The probablities are in square brackets

The appropriate lag length is determined according to the Schwarz Information Criteria.

Table 7 shows that there is no significant relationship between the first lag of actual inflation rate and the error term. However, the second, third and fourth lags are statistically significant at the 0.10 level. It means that, the hypothesis H_0 is accepted at the 0.05 level while rejected at the 0.10 level. These results show us that, weak-form efficiency is accepted at the 0.05 level while rejected at the 0.10 level.

Another method of determining the weak-form efficiency of expectations is the Wald test. In the last column of the table, X^2 test statistic and p-values for Wald test are shown. Here, the hypothesis defined as $H_0 : \beta_1 =0, \beta_2 =0 =\beta_3 =0, \beta_4 = 0$is tested using the Wald test. In this way, it is investigated whether the estimated coefficients of the lags of actual inflation are equal to 0 simultaneously. While the null hypothesis indicates that expectations are efficient, acceptance of the alternative hypothesis rejects the efficiency of expectations. Thus, to say that the prices expectations are weak-form efficient in Turkey, we must not reject the null hypothesis. According to X^2 statistic (Prob: 0.0989), weak-form efficiency is accepted at the 0.05 level while rejected at the 0.10 level.

Table 8 presents diagnostic tests results for the weak-form efficiency test. Here, White, Breusch-Godfrey LM and Jarque-Bera tests are applied as before.

Table 8.Diagnostic Tests for Weak-Form Efficiency

	White	***LM***	***JB***
μ_t	1.4139	0.9038	0.3065
	[0.1842]	[0.4080]	[0.8578]

The probablities are in square brackets

When the tests results are examined, it is understood that there is no problem of heteroscedasticity or autocorrelation in the model. The error terms are normally distributed.

According to the rational expectations suggested by Muth (1961), all the available information is used while the expectations are being created. Thus, it must be determined whether all available information is used. For the weak-form efficiency test, the relationship between the forecast errors and the lags of actual inflation rates is examined. However, this method does not fully indicate whether the current information is used effectively or not. As metioned before, rational expectations hypothesis implies that, while economic decision units make a prediction of the future value of a variable, they

have full knowledge about all the factors affecting the value of the variable and use it in full effective manner. To determine this, in addition to weak-form efficiency test, strong-form efficiency test is frequently used in the literature.

Friedman (1980) proposed a method for the strong-form efficiency of expectations. This method makes it possible to examine the relationship between forecast errors and macroeconomic variables which affect the price level. For this analysis, the number 17 equation is estimated:

$$\mu_t = \propto + + \beta\Omega_{t-n} + v_t \qquad (17)$$

In equation, μ_t represents the error term in the period of t, Ω_{t-n} represents the macroeconomic variables known in the period of t-n. Here, it is aimed to reveal whether the forecast errors are explained by other macroeconomic variables. For this purpose, the hypothesis defined as H_0: $\beta = 0$ is tested by the Wald test. The null hypothesis must not be rejected in order that we can say that the estimation errors of inflation expectations are not explained by other variables, in other words, the error term must be orthogonal. This means that inflation expectations are strong-form efficient.

Macroeconomic variables which are used for strong-form efficiency test are selected by following the literature in accordance with economic theory. These variables are shown in Table 9, together with their explanations and data sources.

Table 9. Macroeconomic Variables

Variable	Explanation	Source
dlint	Weighted average interest rates for deposits in TL (Monthly % change)	CBRT
dlreer	CPI based real effective Exchange rate (2003=100) (Monthly % change)	
dlipi	Industrial production Index (2010=100) (Monthly % change)	
dlm1	M1 money supply (Monthly % change)	

Here, the first and second lags of the % changes in the macroeconomic variables are taken and the number 18 regression equation is estimated:

$$\mu_t = \propto + \beta_1 dlint_{t-1} + \beta_2 dlint_{t-2} + \beta_3 dlreer_{t-1} + \beta_4 dlreer_{t-2} + \beta_5 dlipi_{t-1} + \beta_6 dlipi_{t-2} + \beta_7 dlm1_{t-1} + \beta_8 dlm1_{t-2} + v_t$$

(18)

The strong-form efficiency test results are shown in the following table:

Table 10. Strong-Form Efficiency Test Results

	$\propto$	β_1	β_2	β_3	β_4	β_5	B_6	B_7	B_8	X^2
μ_t	-0.0272	-0.0032	0.0012	-0.0109	0.0050	0.0009	0.0025	0.0231	-0.0112	4.1522
	(-0.4125)	(-0.7341)	(0.2805)	(-0.4669)	(0.2288)	(0.1604)	(0.4065)	(1.3034)	(-0.6577)	
	[0.6807]	[0.4645]	[0.7796]	[0.6415]	[0.8194]	[0.8728]	[0.6851]	[0.1962]	[0.5121]	[0.7621]

The t statistics are in parantheses

The probablities are in square brackets

The appropriate lag length is determined according to the Schwarz Information Criteria

According to Table 10, no coefficient is statistically significant. In other words, there is no significant relationship between the first and second lags of the selected macroeconomic variables and the forecast errors. The X^2 test statistic represents the Wald test result. By the Wald test, the hypothesis defined as $H_0 = \beta1 = \beta2 = \beta3 = \beta4 = \beta5 = \beta6 = \beta7 = \beta8 = 0$ is tested. Similarly, according to the Wald test, the hypothesis that the coefficients simultaneously are equal to zero is not rejected. This result shows us that the error terms are orthogonal, meaning that the expectations are strong-form efficient. In other words, it is concluded that the available information is used effectively when the expectations about inflation rates are being created. It means that inflation expectations for the current period fulfill the efficiency condition of the rational expectations hypothesis.

On the other hand, diagnostic tests results for the strong-form efficiency test are shown in the Table 11.

Table 11. Diagnostic Tests for Strong-Form Efficiency

	White	*LM*	*JB*
μ_t	0.9108	0.8276	0.3081
	[0.6257]	[0.4399]	[0.8572]

The probablities are in square brackets

According to tests results, it is shown that there is no problem of heteroscedasticity and autocorrelation in the model. And the error terms are normally distributed.

CONCLUSION

Expectations of macroeconomic variables are quitely important for economies. It is known that many economic activities (consumption, investment etc.) are shaped by expectations. Accordingly, expectations in the economy are closely monitored by economic agents and policy makers. In particular, central banks, which are the main conductor of monetary policy, are the most important policy makers focusing on expectations.

As it is known, the primary objective of the CBRT is to achieve and maintain price stability. Although there are many sub-aims, it is aimed to ensure price stability on the basis of all monetary policies implemented by the CBRT. For this reason, the CBRT also follows the trend of inflation along with a number of economic variables. In this context, inflation expectations are very important for the CBRT.

Expectations are examined under two main headings as adaptive and rational expectations in the economic theory as mentioned in the previous sections. According to adaptive expectations hypothesis, economic units adjust their expectations of the future based on recent past experiences. But then, according to rational expectations hypothesis, while economic decision units make a prediction of the future value of a variable, they have full knowledge about all the factors affecting the value of the variable and use it in full effective manner. In this way, forecast errors will not be systematically repeated.

In this study it is aimed to investigate the rationality of price expectations for Turkey. For this purpose, the rationality of the price expectations is investigated with reference to the properties of the rational expectations function in the study. In this study, rationality of the price expectations is investigated with the help of unbiasedness and efficiency tests. The results of the analysis given in detail under the heading of results are summarized in Table 12.

Table 12. Summarized Results of Rationality

	%1	*%5*	*%10*
Unbiasedness	Reject	Reject	Reject
Weak-form Efficiency	Accept	Accept	Reject
Strong-form Efficiency	Accept	Accept	Accept
Rationality	Reject	Reject	Reject

According to the results of the analysis, it can be seen that inflation expectations for the current month for the period of 2007M1-2016M12 in Turkey do not pass the test of unbiasedness. This means that professional forecasts made in the relevant period are biased. This result rejects the assumption that economic units do not make systematic errors when predicting the future.

On the other hand, when the results of the efficiency tests are examined, it is seen that different results are obtained from the weak-form and strong-form efficiency tests. According to efficiency tests, while weak-form efficiency is accepted at the 0.05 level while rejected at the 0.10 level, strong-form efficiency is accepted at both level. Accordingly, the general result of the efficiency tests is that the expectations are efficient. This implies that all of the available information is being used effectively when forecasting the inflation rates for the current month.

As previously mentioned, the expectation have to be both unbiased and efficient in order to say that the expectations are rational. However, according to the results of the analysis, inflation expectations for Turkey for the related period are efficient but biased. Therefore, it is concluded that inflation expectations for the current month in the period of 2007M1-2016M12 for Turkey are not rational. These results are consistent with a large number of studies made for Turkey in the literature.

It is also important to evaluate these results and to discuss the causes of the results. First of all, we can say that the using of inflation expectations for the current month in the analyzes may have affected the results. Because, it is possible that the forecasts made in the short-term are biased, and that their performance is low compared to long-term forecasts. Analyzes made with the 2-months-ahead and 12-months-ahead inflation expectations of CBRT may give closer results to rationality. This provides an important clue for future studies.

Consequently, the results can be also evaluated in terms of policy effectiveness. For example, we can say that the economic policies that will be conduct with reference to price expectations will be partially effective. Because, in the study, the assumption that all of the available information is used is not rejected. Therefore, these results show us that although the forecasts are biased, professional forecasters take into account many

variables while shaping their expectations about inflation. This suggests that policies may be partially effective if expectations are taken into account in the implementation of economic policies.

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