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An evaluation of inflation expectations in Turkey☆

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ABSTRACT

Expectations of inflation play a critical role in the process of price setting in the market. Central banks closely follow developments in inflation expectations to implement a successful monetary policy. The Central Bank of the Republic of Turkey (CBRT) conducts a survey of experts and decision makers in the financial and real sectors to reveal market expectations and predictions of current and future inflation. The survey is conducted every month. This paper examines the accuracy of these survey predictions using forecast evaluation techniques. We focus on both point and sign accuracy of the predictions. Although point predictions from CBRT surveys are compared with those of autoregressive models, sign predictions are evaluated on their value to a user. We also test the predictions for bias. Unlike the empirical evidence from other economies, our results show that autoregressive models outperform most of inflation expectations in forecasting inflation. This indicates that inflation expectations have poor point forecast accuracies. However, we show that sign predictions for all inflation expectations have value to a user.

1. Introduction

Due to its crucial role in the process of price setting and wage bargaining, inflation expectations are closely monitored by central banks. For central banks implementing inflation targeting regimes, the purpose of monitoring inflation expectations also includes the need of assessing whether the inflation target is credible or not. The long-term inflation "perceptions" tracked by inflation expectation surveys provides a good indicator of the credibility of the inflations target. If long-term inflation expectations are well anchored by the inflation target, this leads to a decline in inflation persistence. Hence, central banks can control inflation easier. On the other hand contrary to the central banks, inflation expectations surveys are generally used by the market players to assess the future course of inflation. In this paper, we analyze how useful these expectation surveys for the purpose of predicting future inflation for a specific economy.[1]

To monitor inflation expectations, the Central Bank of the Republic of Turkey (CBRT) introduced a semimonthly Survey of Expectations (SE) in August 2001 just before it implemented implicit inflation targeting in 2002.[2] The SE collects data on current month, 2 months ahead and 12 months ahead Consumer Price Index (CPI) inflation expectations as well as data on various other economic indicators.[3] In 2006, the CBRT switched from implicit to full-fledged inflation targeting when the initial policy matured and when macroeconomic and technical pre-conditions for inflation targeting appeared to be more satisfying. To meet the information requirements of the explicit inflation targeting regime, new questions were added to the SE in April 2006 including some that asked about one month ahead and 24 months ahead CPI inflation expectations.

Although the history of the CBRT's SE is relatively short, a number of studies have already analyzed the inflation expectations collected by the surveys. The bulk of these studies have questioned the rationality of these inflation expectations, which requires

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[1] It should be noted that central banks, in addition to the above mentioned purpose, also use inflation expectations as a complementary source of information on future inflation besides their regular structural or reduced form models (Grothe and Meyler, 2015).

[2] Implicit inflation targeting was a stepping stone to full-fledged inflation targeting. The CBRT believed that adopting explicit inflation targeting prematurely posed a serious threat to the credibility of the CBRT (Kara, 2008).

[3] The content of these surveys was not immediately understood by the market. It took more than a year for the market to comprehend that SE presents the expectations of economic actors, not the forecasts of the CBRT (Kara, 2008).

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simultaneous satisfaction of unbiasedness and efficiency conditions (Abdioğlu and Yılmaz, 2013; Kara and Küçük, 2005, 2010; Oral et al., 2011).[4] Kara and Küçük (2005) test both unbiasedness and efficiency of current month, 2 months ahead and 12 months ahead inflation expectations between August 2001 and April 2006. They show that only the current month inflation expectations satisfy both unbiasedness and efficiency conditions, while the others fail to satisfy those conditions. Kara and Küçük (2010) also analyze unbiasedness and efficiency of current month, 2 months ahead and 12 months ahead inflations expectations between August 2001 and October 2007 using time varying parameter approach. Kara and Küçük (2010) show that current month and 2 months ahead inflation expectations are unbiased, whereas 12 months ahead inflations expectations are biased. Furthermore, they point out that current month inflation expectations are efficient, whereas other inflation expectations cannot satisfy efficiency. 2 and 12 months ahead inflation expectations, though they are inefficient, the inefficiency diminishes throughout time. Finally, Oral et al. (2011) analyze unbiasedness of 12 month ahead inflation expectations using disaggregated sectoral data between August 2001 and November 2007 and conclude that inflation expectations are biased. However, the analysis period of these studies include implicit inflation targeting period where inflation had a strong downward trend. Therefore their results may not be easily projected to the current period of explicit inflation targeting regime where the CPI inflation rate is fluctuating between 5% and 10%. In a more recent study, Abdioğlu and Yılmaz (2013) test the rational expectation hypothesis for current month inflation expectations between 2005 and 2012 by using unbiasedness, autocorrelation, efficiency and orthogonality tests. They also find out that inflation expectations are biased, failing already one condition of rational expectation hypothesis.

As outlined above the previous studies have questioned the rationality of the survey expectations. Rationality is certainly a desirable property of a good predictor, however, it does not guarantee a good forecasting performance. Unlike previous literature, in this study, we analyze point and sign accuracy of Turkish inflation survey expectations. To accomplish this task, we conduct a thorough evaluation of forecasting performance of current month, next month, 2 months ahead, 12 months ahead and 24 months ahead CPI inflation expectations between January 2006 and November 2016. Furthermore, we also test unbiasedness of inflation expectations as in previous studies.

First, we test whether inflation expectations are biased using Mincer and Zarnowitz (1969) test as in Abdioğlu and Yılmaz (2013), Kara and Küçük (2005, 2010). We also perform Holden and Peel (1990) test. Unlike previous literature, we use a richer set of inflation expectations and a longer evaluation period for testing unbiasedness. Another distinguishing feature of our study is that we use both SEs collected in the 1st week and the 3rd week of each month. Results for Mincer and Zarnowitz (1969) test show that all inflation expectations are biased, whereas Holden and Peel (1990) test indicates that only 12 months ahead and 24 months ahead inflation expectations are biased.

Then, we analyze the point forecasting performance of inflation expectations by comparing the root mean square errors (RMSE) of inflation expectations with those of autoregressive (AR) models. If predictions of inflation expectations are informative for economic agents, they should be expected to outperform predictions of benchmark statistical models. Ang et al. (2007) and Gil-Alana et al. (2012) analyze the forecasting performance of survey based inflation expectations for United States, and they show that survey based expectations outperform time series models. Furthermore, Grothe and Meyler (2015) test the prediction power of survey based inflation expectation for both United States and Euro Area and conclude that inflation expectations are informative predictors. In contrast to the literature, we show that AR models have higher predictive power than inflation expectations except current month inflation expectations.

Finally, we evaluate the sign forecasting performance of inflation expectations by using Fisher's exact test and the test used by Pesaran and Timmermann (1992, 2004) point out that the directional forecasting analysis is an increasingly popular metric for evaluating forecasting performance in the literature. Information about whether inflation will accelerate or decelerate in the future may help central banks for adjusting stance of monetary policy, so directional predictions of inflation expectations are also important for policy makers in central banks. Our results show that directional forecasting accuracy of inflation expectations are better than forecasting accuracy of a naive model, so they have the potential of providing value to decision makers.

The remainder of this paper proceeds as follows. Section 2 introduces the Survey of Expectations. Section 3 presents the results of unbiasedness tests. Section 4 shows the point forecasting performance of inflation expectations. Section 5 analyzes the sign forecasting performance of inflation expectations, and section 6 concludes.

2. Survey of expectations

The CBRT introduced the SE to the public in August 2001. The survey collects data on the expectations of decision makers in the financial and real sectors regarding inflation, interest rates, exchange rates, the current account deficit, and the GDP growth rate. In the initial version of the SE, there were 4 different questions on inflation expectations. In that initial version, respondents were expected to provide information on their expectations of the following: a) “current month monthly CPI inflation”; b) “2 months ahead monthly CPI inflation”; c) “end of year annual CPI inflation”, and d) “one year (12 months) ahead annual CPI inflation”. In April 2006, additional questions were added to the SE to meet the information requirements of the explicit inflation targeting regime. Regarding inflation, respondents were additionally asked to provide their expectations of “next month monthly CPI inflation”, and “2 years (24 months) ahead annual CPI inflation”. In this study, we evaluate the forecasting performance of all inflation expectations except “end of year annual CPI inflation” because forecasts of such fixed events require different analysis tools and should, therefore, be evaluated separately from the other “rolling type” forecasts.

In this study, we restrict our analysis to the period in which the full-fledged targeting policy was in effect. One of the reasons for this restriction is that inflation had a strong downward trend in the period of implicit inflation targeting. During the period of implicit inflation targeting, inflation reduced to single digits from 30%. Hence, along this downward trend, forecasters have easier time to predict inflation, so it should be a stark difference in the prediction power of inflation expectations between the implicit inflation targeting period and the explicit inflation targeting period where inflation doesn't have any clear trend. In addition to this, the new CPI was introduced in 2005, and the new CPI has a different structure than the old CPI. Therefore, expectation data before January 2006 are excluded from the analysis.

The CBRT conducted the SE semimonthly in the first and the third week of each month until the end of 2012. In the beginning of

[4] Another strand of this literature has focused on the determinants of inflation expectations (Başkaya et al., 2008, 2010, 2012), whereas other recent studies have assessed the credibility of the CBRT by testing whether inflation expectations are anchored or not (Çiçek et al., 2011; Çiçek and Akar, 2014).

2013, however, the frequency of the SE was reduced to once per month.[5] One of the distinguishing feature of our study is that we use both SEs collected in the 1st week and the 3rd week of each month and try to understand whether economic actors gain additional information in these 2 weeks. To achieve our goal, we compare inflation expectations released in the 1st week and the 3rd week of each month between 2006 and 2012. In addition this, we also evaluate the full data sample until November 2016 or last available data point[6] in the sample by combining inflation expectations released in the 3rd week of each month before January 2013 and inflation expectations after January 2013.[7]

CPI figures for the previous month are released around the third day of each month, with an approximately one month delay. Therefore, when forming inflation expectations for $t+h$ at time t, survey participants only possess inflation figures up to $t-1$. h is the forecast horizon and can assume the values of $0, 1, 2, 12$, or 24.

Figs. 1 and 2 show the actual inflation at time $t+h$ and the inflation expectations for time $t+h$ collected at time t. It is clear from the figures that the expectations formed in the 1st week and the 3rd week are very close to each other. As expected, current month inflation expectations follow the actual inflation closely. Next month and 2 months ahead inflation expectations also seem to have good predictive powers, but they cannot capture spikes as accurately as current month inflation expectations. According to Fig. 2 and 12 months ahead and 24 months ahead annual inflation expectations have very low predictive power. Başkaya et al. (2012) show that these predictions are governed mainly by past inflation numbers and the inflation targets of the CBRT.

3. Unbiasedness

The analysis of inflation expectations requires the examination of whether the expectations fulfill certain desired properties. The critical property is unbiasedness. In this context, unbiasedness requires that the expectations do not systematically overestimate or underestimate the actual level of the underlying economic variable. To determine the unbiasedness of inflation expectations we perform a Mincer and Zarnowitz (1969) test which is the most frequently used test for unbiasedness in the literature. To obtain the test results the following regression is performed:

$$y_{t+h} = \alpha + \beta y^{ie}_{t+h|t} + \varepsilon_{t+h}; \quad h = 0, 1, 2, 12, 24. \tag{1}$$

where y_{t+h} is the actual inflation rate in time $t+h$, and $y^{ie}_{t+h|t}$ is the inflation expectation for time $t+h$ based on the information set at t. The test is based on the idea that if inflation expectations are unbiased, then this would mean that the joint hypothesis of $\alpha = 0$ and $\beta = 1$ cannot be rejected. This hypothesis can be tested by using a standard Wald test.[8] Table 1 presents Wald test statistics. As can be observed from Table 1, the null hypothesis of unbiasedness is rejected for all inflation expectations. According to Mincer and Zarnowitz (1969) test, all inflation expectations exhibit systematic forecast errors for our test period.

However, Holden and Peel (1990) point out that Mincer and Zarnowitz (1969) test is too restrictive and the joint hypothesis of $\alpha = 0$ and $\beta = 1$ provides sufficient but not a necessary condition for unbiasedness. Holden and Peel (1990) show that $\frac{\alpha}{E(y_t)} + \beta = 1$ is a necessary and sufficient condition for unbiasedness. They argue that this more general condition should be used for testing unbiasedness. They propose the following equation:

$$y_{t+h} - y^{ie}_{t+h|t} = \alpha + \eta_{t+h}; \quad h = 0, 1, 2, 12, 24, \tag{2}$$

where η_t is a moving average process with an order of $h-1$. If inflation expectations are unbiased, then $\alpha = 0$.[9] Table 1 presents t-statistics for the test. Unlike the Mincer and Zarnowitz (1969) test, the Holden and Peel (1990) test shows that current month, next month and 2 months ahead inflation expectations are unbiased. Fig. 1 also implies that results of Holden and Peel (1990) test are more plausible.

4. Point forecast accuracy of inflation expectations

We calculate the forecasting accuracy of inflation expectations in terms of root mean square errors (RMSE). To compare the accuracy of inflation expectations against a benchmark model, we construct the following AR model:

$$y_t = \alpha + \sum_{i=1}^{p} \beta_i y_{t-i} + \sum_{k=1}^{11} \delta_k d_{k,t} + \varepsilon_t, \tag{3}$$

where y_t is the monthly CPI inflation, and p is selected to minimize the Akaike Information Criterion (AIC) with a maximum lag of 10. The CPI exhibits seasonality[10], so we also use monthly seasonal dummies ($d_{k,t}$).

We start our forecasting exercise from the beginning of 2006. First, we assume that $t =$ "January 2006"[11] and estimate equation (3) with y_{t-1} on the left hand side. Then, we produce $0, 1, 2, 12$ and 24 months ahead out of sample forecasts using the following equation:

$$\widehat{y}_{t+h|t} = \widehat{\alpha} + \sum_{i=1}^{p} \widehat{\beta}_i y_{t+h-i} + \sum_{k=1}^{11} \widehat{\delta}_k d_{k,t}, \tag{4}$$

where $\widehat{y}_{t+h|t}$ refers to forecasted values of y_{t+h} for the current month ($h=0$), next month ($h=1$), 2 months ($h=2$), 12 months ($h=12$), and 24 months ($h=24$). $\widehat{\alpha}$, $\widehat{\beta}_i$, and $\widehat{\delta}_k$ refer to the estimated values of the corresponding coefficients. When $h>0$, to obtain forecasts, we iterate a one period forecasting model by feeding the previous period forecasts as regressors into the model. This means that when $t+h-i>t$, y_{t+h-i} is replaced by $\widehat{y}_{t+h-i|t}$.

Then, we re-estimate equation (3) updating our data set by one period and produce another set of forecasts up to 24 months ahead. This process is continued until the end of the dataset.

Note that this procedure provides only monthly inflation forecasts, i.e., $\widehat{y}_{t+12|t}$ refers to the forecasted monthly inflation rate a year ahead. Therefore, 12 months ahead and 24 months ahead annual inflation forecasts are needed for comparison with 12 months ahead and 24 months ahead inflation expectations from the SE. These annual forecasts are computed as follows:

[5] Inflation expectations after January 2013 are collected in the second week of each month.

[6] Latest Data Points are November 2016, October 2016, September 2016, November 2015 and November 2014 for current month, next month, 2 months ahead, 12 months ahead and 24 months ahead CPI inflation expectations, respectively.

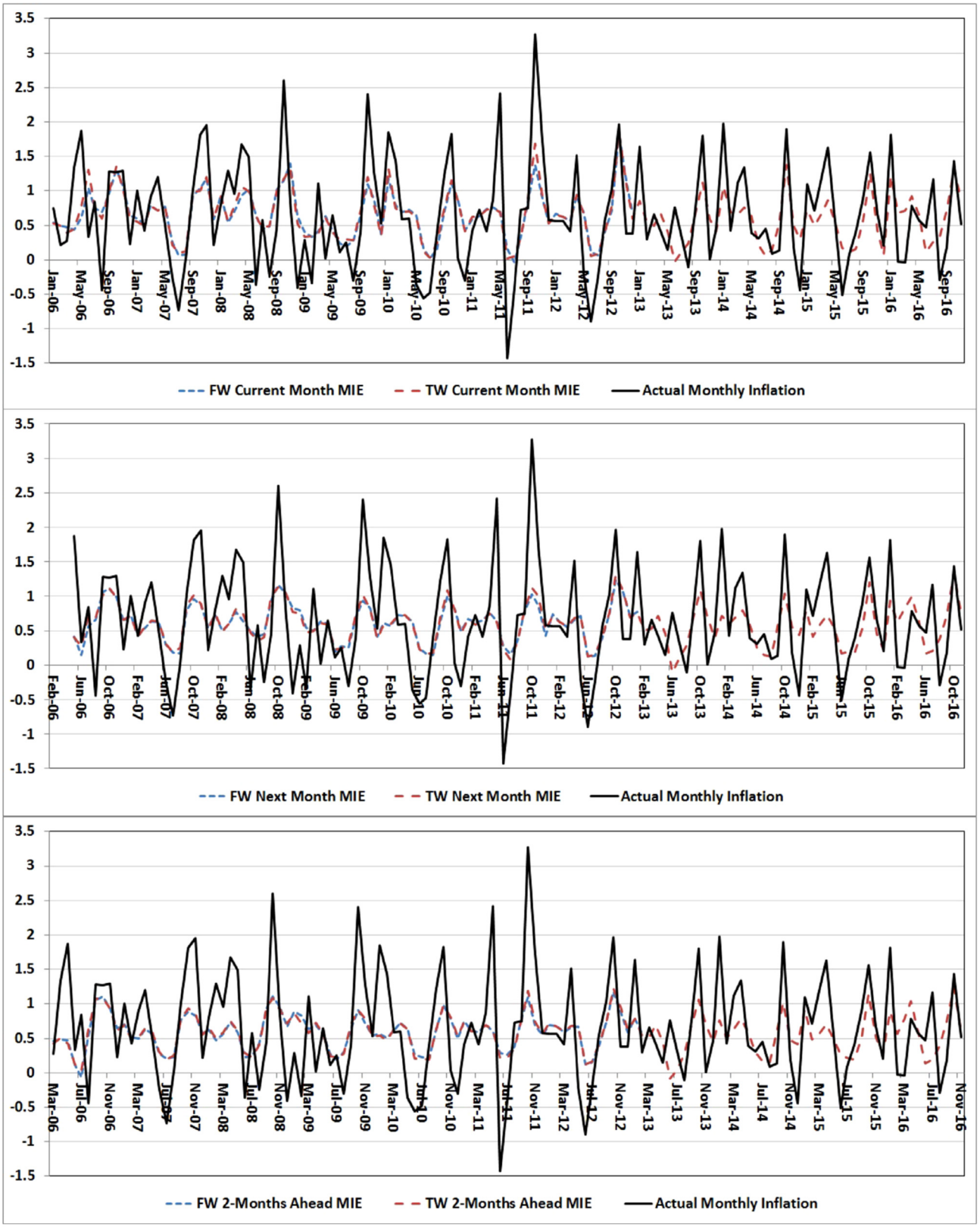
[7] We show that inflation expectations released in the 1st week and the 3rd week are very similar, so it makes no difference to use inflation expectations released in the 1st week of each month before January 2013 for combining inflation expectations.

[8] Usually, prediction errors are heteroskedastic, so the regression covariance matrix is calculated using the Newey and West (1987) procedure.

[9] El-Shagi et al. (2014) point out that the reduction in degrees of freedom due to the moving average process reduces the power of the test in small samples.

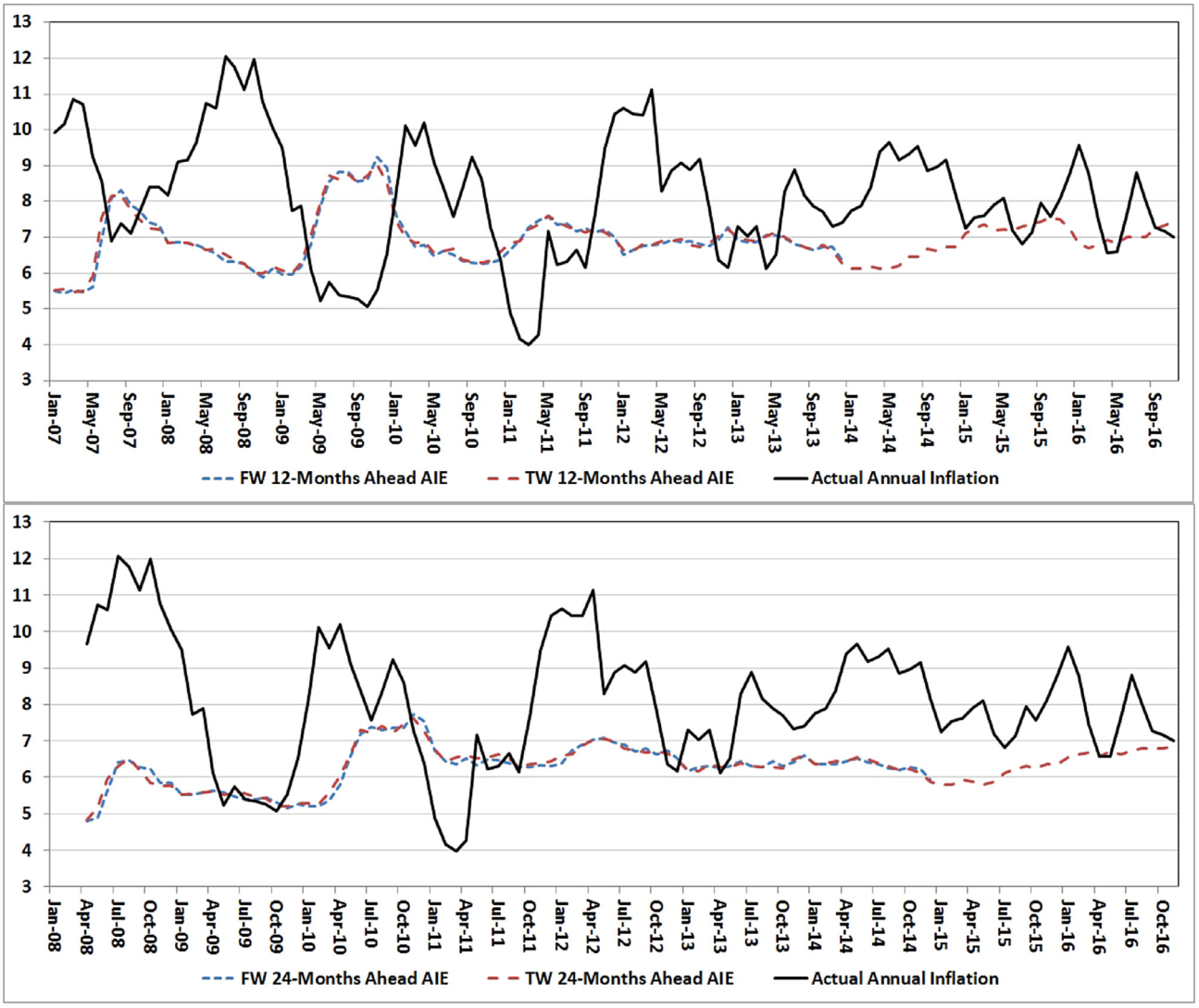
[10] In Turkey, only the non-seasonally adjusted CPI is released.

[11] At that time, dataset contains CPI data from January 2003 to December 2005.



Note: FW and TW refer to the 1st week and the 3rd week, respectively. MIE refers to the monthly inflation expectations. After 2012:12, inflation expectations released in the 2nd week are used.

Fig. 1. Monthly inflation expectations and actual inflation (%).



Note: FW and TW refer to the 1st week and the 3rd week, respectively. AIE refers to the annual inflation expectations. After 2012:12, inflation expectations released in the 2nd week are used.

Fig. 2. Annual inflation expectations and actual inflation (%).

Table 1
Mincer-Zarnowitz and Holden-Peel test results.

	Week	Sample	χ^2 (p-value)	*t*-test (p-value)
Current month MIE	1st	2006:01–2012:12	14.24 (0.00)	−0.02 (0.99)
	3rd	2006:01–2012:12	17.39 (0.00)	−0.16 (0.87)
	3rd+2nd	2006:01–2016:11	11.57 (0.00)	0.43 (0.67)
Next month MIE	1st	2006:04–2012:12	14.46 (0.00)	0.64 (0.52)
	3rd	2006:04–2012:12	20.13 (0.00)	0.55 (0.59)
	3rd+2nd	2006:04–2016:10	−0.34 (0.01)	0.85 (0.40)
2 Months ahead MIE	1st	2006:01–2012:12	6.67 (0.04)	1.11 (0.27)
	3rd	2006:01–2012:12	7.93 (0.02)	1.07 (0.29)
	3rd+2nd	2006:01–2016:09	7.44 (0.02)	1.70 (0.09)
12 Months ahead AIE	1st	2006:01–2012:12	149.65 (0.00)	6.89 (0.00)
	3rd	2006:01–2012:12	173.98 (0.00)	6.95 (0.00)
	3rd+2nd	2006:01–2015:11	182.00 (0.00)	13.25 (0.00)
24 Months ahead AIE	1st	2006:04–2012:12	22.81 (0.00)	8.31 (0.00)
	3rd	2006:04–2012:12	22.36 (0.00)	8.27 (0.00)
	3rd+2nd	2006:04–2014:11	27.47 (0.00)	9.72 (0.00)

Note: MIE and AIE refer to the monthly inflation expectations and the annual inflation expectations, respectively. Results for Mincer-Zarnowitz test are shown under χ^2, and results for Holden-Peel test are shown under *t*-test.

Table 2
RMSEs of inflation expectations and AR(AIC).

	Monthly inflation predictions			Annual inflation predictions	
	Current month	Next month	2 Months ahead	12 Months ahead	24 Months ahead
Period: 2006–2012					
1st Week-IE	0.65	0.73	0.74	2.77	2.70
3rd Week-IE	0.63	0.72	0.73	2.74	2.69
AR(AIC)	0.66	0.66	0.64	2.11	1.94
Period: Full sample					
IE	0.58	0.65	0.67	2.48	2.48
AR(AIC)	0.62	0.62	0.61	1.84	1.78

Note: IE refers to inflation expectations.

Table 3
Diebold-Mariano test results.

	Monthly inflation predictions			Annual inflation predictions	
	Current month	Next month	2 months ahead	12 Months ahead	24 Months ahead
Period: 2006–2012					
1st Week	−0.29 (0.77)	1.81 (0.07)	2.84 (0.01)	2.14 (0.04)	1.81 (0.07)
3rd Week	−1.32 (0.19)	1.51 (0.13)	2.91 (0.00)	2.06 (0.04)	1.79 (0.08)
Period: full sample					
IE	−2.28 (0.02)	1.10 (0.27)	2.12 (0.04)	2.37 (0.02)	1.86 (0.07)

Note: p-values are in parantheses. In the first (second) row, the forecasting accuracies of the 1st (3rd) week inflation expections and the AR(AIC) are compared. In the last row, the forecasting accuracy of inflation expectations for the full sample and AR(AIC) are compared.

$$\prod_{i=h-11}^{h}\left(1+\widehat{y}_{t+i|t}\right);\quad h=12,24. \tag{5}$$

If inflation expectations are useful predictors for economic agents, then the forecasting performance of inflation expectations are expected to be better than the forecasting performance of an AR model. Table 2 presents RMSEs of inflation expectations and those of the AR model chosen by AIC (AR(AIC)). RMSEs of inflation expectations formed in the 1st and 3rd weeks are very close. This could be one of the reasons why the CBRT reduced the frequency of the SE from twice per month to once per month. Interestingly, only current month inflation expectations perform better than the AR(AIC) model. The RMSEs of all other inflation expectations are worse than those of the AR(AIC) model. The largest differences in the RMSE are observed between annual inflation expectations and the AR(AIC). The RMSEs of the 12 months ahead inflation expectations are approximately 23–26 percent worse than those of the AR(AIC) model, and the RMSEs of the 24 months ahead inflation expectations are approximately 28 percent worse than those of the AR(AIC) model. Using full sample or a sample covering between 2006 and 2012 does not alter these results. These results indicate that inflation expectations except current month inflation expectations have poor point forecast accuracies. Therefore, information contained in inflation expectations isn't very beneficial for policy makers and market participants for assessing future price developments. This result contrasts with that is provided by Ang et al. (2007), Gil-Alana et al. (2012) and Grothe and Meyler (2015) where survey based inflation expectations outperform time series models.

We employ Diebold-Mariano (DM) tests (Diebold and Mariano, 1995) to determine whether these differences between inflation expectations and the AR(AIC) model are statistically significant. The suggested DM statistics are distributed as standard normal under the null hypothesis of equal forecast accuracy, as shown by DM.

The null hypothesis of the DM test is that two forecasts have equal forecast accuracy. This null hypothesis is stated as follows:

$$E\left(L\left(e_t^{ie}\right)-L\left(e_t^{f}\right)\right)=0$$

where $L(e_t^{ie})$ and $L(e_t^{f})$ are time-t quadratic loss functions for inflation expectations and AR forecasts, respectively. We use squared errors as the loss function in our study. The DM statistic can be calculated easily by regressing the difference between loss functions on an intercept using Newey-West corrected standard errors (Diebold, 2015).

Table 3 presents DM test statistics that compare the forecasting accuracy of inflation expectations and the AR(AIC) model. The results show that current month inflation expectations for the full sample significantly outperform the AR(AIC), but we cannot reject the null hypothesis of the equal predictive ability of current month inflation expectations and the AR(AIC) for the period of 2006–2012. Furthermore, the null hypothesis of the DM test for next month and 24 months ahead inflation expectations cannot be rejected at a 5 percent significance level for all sample sizes. However, Table 3 indicates that the AR(AIC) significantly outperforms 2 months and 12 months ahead inflation expectations. These results also show that point predictions of inflation expectations are unreliable for forecasting inflation except current month inflation expectations for the full sample period. Table 3 also points out that predictive power of current month inflation expectations improved after 2012.

5. Sign forecast accuracy of inflation expectations

Like point forecasts, sign forecasts also provide important information for decision makers. The performance of the inflation expectations' sign forecasting is tested by Fisher's exact test (Merton, 1981; Schnader and Stekler, 1990; Sinclair et al., 2010) (FE test) and Pesaran and Timmermann (1992) test (PT test).

To compute FE and PT test statistics, a 2 × 2 contingency table is

Table 4
Contingency table.

	A > 0	A≤ 0	Row total
F > 0	n_{00}	n_{10}	$n_{00}+n_{10}$
F≤ 0	n_{01}	n_{11}	$n_{01}+n_{11}$
Column total	$n_{00}+n_{01}$	$n_{10}+n_{11}$	N

Table 5
Continengcy table, FE test and PT test results.

	Week	A> 0	A> 0	A≤ 0	A≤ 0	Correct predictions	p-values	
		F> 0	F≤ 0	F> 0	F≤ 0		FE	PT
Period: 2006–2012								
Current month MIE	1st	39	8	10	27	78.6%	0.00	0.00
	3rd	39	8	11	26	77.4%	0.00	0.00
Next month MIE	1st	37	6	9	29	81.5%	0.00	0.00
	3rd	37	6	9	29	81.5%	0.00	0.00
2 Months ahead MIE	1st	33	8	8	35	81.0%	0.00	0.00
	3rd	34	7	8	35	82.1%	0.00	0.00
12 Months ahead AIE	1st	17	23	1	43	71.4%	0.00	0.00
	3rd	17	23	1	43	71.4%	0.00	0.00
24 Months ahead AIE	1st	14	27	0	40	66.7%	0.00	0.00
	3rd	15	26	0	40	67.9%	0.00	0.00
Period: Full sample								
Current month MIE	3rd+2nd	57	14	14	46	78.6%	0.00	0.00
Next month MIE	3rd+2nd	55	11	13	48	81.1%	0.00	0.00
2 Months ahead MIE	3rd+2nd	50	13	15	51	78.3%	0.00	0.00
12 Months ahead AIE	3rd+2nd	19	38	1	61	67.2%	0.00	0.00
24 Months ahead AIE	3rd+2nd	15	37	0	52	64.4%	0.00	0.00

Note: MIE and AIE refer to monthly inflation expectations and annual inflation expectations, respectively.

constructed as shown in Table 4. In Table 4, 'A' equals $y_{t+h} - y_t$, and 'F' equals $y^{ie}_{t+h|t} - y_t$. y_{t+h} is the actual inflation in $t+h$, and $y^{ie}_{t+h|t}$ is the inflation expectation for time $t+h$ based on the information set at t. Each cell shows how many observations satisfy the conditions defined in the corresponding rows and columns. FE test doesn't produce a test statistic, and the probability is directly calculated using the hyper-geometric distribution. Using Table 4, the probability of independence for the FE test is calculated as follows:

$$p = \frac{\binom{n_{00}+n_{10}}{n_{00}}\binom{n_{01}+n_{11}}{n_{01}}}{\binom{N}{n_{00}+n_{01}}} = \frac{(n_{00}+n_{01})!(n_{10}+n_{11})!(n_{00}+n_{10})!(n_{01}+n_{11})!}{n_{00}!n_{01}!n_{10}!n_{11}!N!}. \quad (6)$$

The null hypothesis of the FE test is that there is no relationship between inflation expectations and actual inflation. In other words, this test is calculating whether a given set of forecasts is significantly differed from forecasts derived from a naive model (Schnader and Stekler, 1990). If forecasts used in the test outperform those obtained from a naive model, it means that forecasts have value to the decision maker.

We also estimate PT test statistics for the 2 × 2 case as follows:

$$S_n = \frac{\hat{p} - \hat{p}_*}{(\widehat{var}(\hat{p}) - \widehat{var}(\hat{p}_*))^{1/2}} \sim N(0,1), \quad (7)$$

where $\hat{p} = (n_{00}+n_{11})/N$ is the probability of correctly predicted signs; $\hat{p}_* = \hat{p}_y\hat{p}_x + (1-\hat{p}_y)(1-\hat{p}_x)$ is the estimator of $\hat{p}$ under the null hypothesis; $\hat{p}_x = (n_{00}+n_{10})/N$ is the probability of the predicted positive changes; $\hat{p}_y = (n_{00}+n_{01})/N$ is the probability of the actual positive changes; $\widehat{var}(\hat{p}) = N^{-1}\hat{p}_*(1-\hat{p}_*)$, and $\widehat{var}(\hat{p}_*) = N^{-1}(2\hat{p}_y-1)^2\hat{p}_x(1-\hat{p}_x) + N^{-1}(2\hat{p}_x-1)^2\hat{p}_y(1-\hat{p}_y) + 4N^{-2}\hat{p}_y\hat{p}_x(1-\hat{p}_y)(1-\hat{p}_x)$. The null hypothesis of the PT test is that inflation expectations have no predictive power.[12]

Table 5 shows the contingency table values and probabilities for the FE and PT test statistics. The results indicate that the null hypotheses of the FE and PT tests are rejected for all inflation expectations. Therefore, all inflation expectations' sign predictions have value to a user. In other words, they are useful predictors for forecasting the acceleration and deceleration of inflation. As with the point forecasts, the sign forecasting performance of inflation expectations collected in the 3rd week and the 1st week are very close. As expected, monthly inflation expectations have a higher number of correct predictions than annual inflation expectations. One surprising result is that the 12 months ahead and 24 months ahead inflation expectations have a very high underestimation percentage. In an environment of rising inflation, the 12 months and 24 months ahead inflation expectations underestimate actual inflation more than 50 percent of the time.

6. Conclusion

In this study, we test the unbiasedness of current month, next month, 2 months ahead, 12 months ahead and 24 months ahead CPI inflation expectations as well as the point and sign forecasting performance of these expectations. First, we test the unbiasedness of the inflation expectations. Results for Mincer and Zarnowitz (1969) test show that inflation expectations exhibit systematic forecasting errors for our evaluation period, but Holden and Peel (1990) test results indicate that only 12 months ahead and 24 months ahead inflation expectations are biased. Next, we analyze the forecasting performance of inflation expectations. We show that the forecasting accuracy of inflation expectations reported in the 3rd week and the 1st are very similar. Additionally, we compare the inflation predictions against a benchmark model. Our analysis indicates that only current month inflation expectations perform better than an AR(AIC) model, and an AR(AIC) model outperform all other inflation expectations. Then, we perform a Diebold-Mariano (DM) test to understand whether these differences between inflation expectations and the AR(AIC) model are statistically significant. Only current month inflation expectations for the full sample outperform the AR(AIC) significantly. All other inflation expectations have either equal predictive ability or significantly worse than the AR(AIC). It is highly interesting for a simple univariate model to have same or better predictive power than most of inflation expectations. These results are in sharp contrast with previous studies conducted for other countries. Therefore, we can conclude that Turkish inflation expectations are not proved to be useful for predicting feature price levels. Finally, we analyze the sign forecasting

[12] For the 2 × 2 special case, the null hypotheses of the FE and PT tests are the same (Tsuchiya, 2013).

performance of the inflation expectations and find that they are beneficial for determining whether inflation will increase or decrease over time. Interestingly, 12 months ahead and 24 months ahead inflation expectations have a very high underestimation rate.

Even though directional forecasting accuracy of inflation expectations is better than that of a naive model, the poor point forecasting performance of inflation expectations is disappointing. Our results imply that if survey participants had used naive statistical models, they would have been less mistaken in their forecasts. Even though the CBRT mainly uses inflation expectations to analyze whether inflation expectations are anchored in the long term, if an appropriate design possible, the current survey can be reconsidered to improve its forecast accuracy, especially in the short term.

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