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ARE THERE SHIFTS IN PERSISTENCE IN THE TURKISH INFLATION RATES?

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1. Introduction

In an earlier paper (Erlat, 2002) we investigated the persistence of Turkish monthly inflation using both unit root tests and fractional integration procedures. We found that whether the Consumer Price Index (CPI) and Wholesale Price Index (WPI) based series contained unit roots may be debatable but that they had statistically significant long-memory components appeared to be quite evident. The unit root testing results took account of the outliers in the data that were the outcomes of financial crises such as the one in 1994 and of shifts in the deterministic terms in the autoregressions formed to perform the unit root tests.

The objective of the present paper is to see if the results previously obtained may be due to the fact that the Turkish inflation series may have moved from being difference stationary to being trend stationary or vice versa. There are two approaches to testing such hypotheses. One is based on tests where the null hypothesis is stationarity and the other, where the null hypothesis is nonstationarity. We shall use both approaches in this paper.

There is a growing literature regarding tests of shifts in persistence but, as far as we have been able to determine, there is only one empirical application aside from the somewhat illustrative applications found in the methodological papers; namely, Sollis (2006). This application is not to the inflation rate. One may, however, find applications to the inflation rate in the illustrative applications. For example, Kim (2000), Busetti and Taylor (2004) and Taylor (2005a) investigate shifts in persistence in quarterly U.S. inflation rates. Thus, the present study will the firts one to carry out such an application for non-illustrative purposes.

Hence, in the next section we describe the tests. In Section 3 the data is introduced and, in Section 4, the empirical results are presented. Section 5 contains our conclusions.

2. Testing for Changes in Persistence

There are two approaches to testing if a time series shows a shift in persistence; i.e., if it moves from being difference stationary to being trend stationary or vice versa. One is based on tests of persistence under the null hypothesis that the series is stationary while the other is based on the null that it is nontstationary. The contributions to the first approach that we shall consider are due to Kim (2000), Kim, Belaire-French and Amador (2002), Busetti and Taylor (2004) and Taylor (2005a). They are, essentially, based on using the ratios of the numerators of the Kwiatowski, Phillips, Schmidt and Shin (KPSS) (1992) statistic (Kim (2000), Kim et al (2002), Busetti and Taylor (2004)) and of the fluctuation statistics of Xiao (2001) and Lo (1991) (Taylor, 2005a), obtained sequentially. The contributions to the second approach

derive from the earlier paper by Banerjee, Lumsdaine and Stock (BLS) (1992) in using the ADF statistic (Taylor (2005b), Leybourne, Kim and Taylor, (2006)) and Elliot, Rothenberg and Stock's (1996) DFGLS statistic (Leybourne, Kim, Smith and Newbold (LKSN), 2003)\ recursively. The tests using the first approach are usually referred to as the *ratio tests* while those obtained from the second approach are called *regression-based tests*.

a. Ratio Tests

These tests assume that the series is I(0) under the null and that, under the alternative hypothesis they either switch from I(0) to I(1) or from I(1) to I(0). We may formalize the first case as

$$\begin{aligned} H_0 &: y_t = \beta' d_t + u_t, \quad u_t \sim I(0), \quad t = 1,\ldots,T \\ H_{01} &: y_t = \beta' d_t + u_{t,0}, \quad u_{t,0} \sim I(0), \quad t = 1,\ldots,[\tau T] \\ &: y_t = \beta' d_t + u_{t,1}, \quad u_{t,1} = u_{t-1,1} + \varepsilon_t \quad t = [\tau T]+1,\ldots,T \end{aligned}$$

where $d_t = 1, \beta = \beta_0$ or $d_t = (1,t)'$, $\beta = (\beta_0, \beta_1)'$, and $\tau = T_B / T$, T_B being an unknown shift point with [.] indicating the integer part of the argument. The second case, on the other hand, may be expressed as,

$$\begin{aligned} H_0 &: y_t = \beta' d_t + u_t, \quad u_t \sim I(0), \quad t = 1,\ldots,T \\ H_{10} &: y_t = \beta' d_t + u_{t,1}, \quad u_{t,1} = u_{t-1,1} + \varepsilon_t, \quad t = 1,\ldots,[\tau T] \\ &: y_t = \beta' d_t + u_{t,0}, \quad u_{t,0} \sim I(0) \quad t = [\tau T]+1,\ldots,T \end{aligned}$$

We, of course, may have no a priori expectation as what direction the switch in persistence may take so that we may wish to test the hypothesis

$$\begin{aligned} H_0 &: y_t = \beta' d_t + u_t, \quad u_t \sim I(0), \quad t = 1,\ldots,T \\ H_1 &: H_{01} \cup H_{10} \end{aligned}$$

Since the null hypothesis is stationarity, it is natural to consider statistics developed to test this hypothesis and the most popular such statistic is the KPSS statistic, which we may express as

$$KPSS = \frac{\sum_{t=1}^{T} S_t^2 / T^2}{\hat{\sigma}^2} \tag{1}$$

where $S_t^2 = \sum_{i=1}^{t} \hat{u}_i^2$, the $\hat{u}_i$ being obtained from the OLS estimation of the model under H_0, and $\hat{\sigma}^2$ is the estimator of the long run variance of the u_t. Now, consider calculating the KPSS statistic for the first $[\tau T]$ and the remaining T-$[\tau T]$ observations *separately*, (i.e., based on separate estimates of the null model for the two subsamples). If the magnitudes of these two KPSS statistics are both small enough not to reject stationarity in both subsamples, then there would be no evidence of a switch from I(0) to I(1) or from I(1) to I(0). We may conclude that such a switch has taken place only if one KPSS statistic is large enough for H_0 to be rejected while the other is not.

We may express these outcomes as a single statistic by considering the ratio of the two KPSS statistics. Large values of this statistic will indicate that a switch has taken place. However, as both Kim (2000) and Busetti and Taylor (2003) have shown, the limiting distribution of these ratio statistics do not depend on the long-run variance appearing in the denominator of the KPSS statistic. Hence, the ratio statistic will be formed by simply using the numerators of the two KPSS statistics. For H_{01} we shall obtain

$$KL(\tau) = \frac{\sum_{t=[\tau T]+1}^{T} S_{t,1}^2 /(T - [\tau T])^2}{\sum_{t=1}^{[\tau T]} S_{t,0}^2 /[\tau T]^2} \tag{2}$$

In other words, if the KPSS statistic obtained from the second subsample is larger than that obtained from the first subsample, $KL(\tau)$ will be large and, if significant, indicate that a shift from I(0) to I(1) has taken place. For H_{10} we simply use the inverse of $KL(\tau)$, $KL(\tau)^{-1}$.

Alternative tests for the null of stationarity have been suggested by Xiao (2001) and by Cavaliere and Taylor (2005). Xiao (2001) maintains that since nonstationary series fluctuate more than stationary series, flutuation tests, designed to monitor structural shifts, may be utilized to test for stationarity. The statistic suggested for this purpose is

$$KS = \frac{\max_{t=1,\ldots,T} | S_t | / T^{1/2}}{\hat{\sigma}^2} \tag{3}$$

Within this context, Cavaliere and Taylor (2005), based on Lo (1991), have suggested the following range statistic to test the null of stationarity:

$$RS = \frac{[\max_{t=1,\ldots,T} S_t - \min_{t=1,\ldots,T} S_t]/T^{1/2}}{\hat{\sigma}^2} \tag{4}$$

Based on these two statistics, Taylor (2005a) suggests the following two statistics for H_{01}:

$$KS(\tau) = \frac{\left[\max_{t=[\tau T]+1,\ldots,T} |S_{t,1}(\tau)|\right] \Big/ [T - [\tau T]]^{1/2}}{\left[\max_{t=1,\ldots,[\tau T]} |S_{t,0}(\tau)|\right] \Big/ [[\tau T]]^{1/2}} \tag{5}$$

$$RS(\tau) = \frac{[\max_{t=[\tau T]+1,\ldots,T} S_{t,1}(\tau) - \min_{t=[\tau T]+1,\ldots,T} S_{t,1}(\tau)]/(T - [\tau T])^{1/2}}{[\max_{t=1,\ldots,[\tau T]} S_{t,0}(\tau) - \min_{t=1,\ldots,[\tau T]} S_{t,0}(\tau)]/[\tau T]^{1/2}} \tag{6}$$

For H_{10} the statistics simply become $KS(\tau)^{-1}$ and $RS(\tau)^{-1}$.

All six statistics described above constitute sequences of statistics indexed by τ and τ lies in the closed subset $[\tau_L, \tau_U]$ of the interval (0, 1). Thus, we need to answer two questions:

i. How do we summarize the information in these six sequences to give us six single statistics? All the authors cited above consider three alternatives. If we let $K(\tau)$ stand for $KL(\tau)$, $KS(\tau)$ and $RS(\tau)$ and $K(\tau)^{-1}$ for $KL(\tau)^{-1}$, $KS(\tau)^{-1}$ and $RS(\tau)^{-1}$, we may express these as

$$K_1 = \max_{\tau \in [\tau_L, \tau_U]} K(\tau), \qquad K_1^{-1} = \max_{\tau \in [\tau_L, \tau_U]} K(\tau)^{-1} \tag{7}$$

$$K_2 = \frac{1}{T^*} \sum_{\tau=\tau_L}^{\tau_U} K(\tau), \qquad K_2^{-1} = \frac{1}{T^*} \sum_{\tau=\tau_L}^{\tau_U} K(\tau)^{-1}$$

$$K_3 = \ln\left\{\frac{1}{T^*} \sum_{\tau=\tau_L}^{\tau_U} \exp(\tfrac{1}{2} K(\tau))\right\}, \qquad K_3^{-1} = \ln\left\{\frac{1}{T^*} \sum_{\tau=\tau_L}^{\tau_U} \exp(\tfrac{1}{2} K(\tau)^{-1})\right\}$$

where $T^* = [\tau_U T] - [\tau_L T] + 1$. K_1 and K_1^{-1} are due to Andrews (1993), K_2 and K_2^{-1} to Hansen (1991) and, K_3 and K_3^{-1} to Andrews and Ploberger (1994).

ii. How do we estimate the switch point, $\hat{\tau}$ or $\hat{T}_B$? Kim (2000) and Busetti and Taylor (2003) explicitly, and Taylor (2005a) implicitly suggest the following criterion:

(8) $$\Lambda(\tau) = \frac{\sum_{t=[\tau T]+1}^{T} \hat{u}_{t,1}^2 / (T - [\tau T])^2}{\sum_{t=1}^{[\tau T]} \hat{u}_{t,0}^2 / [\tau T]^2}$$

If H_{01} is being tested, then $\hat{T}_B$ is estimated by maximising $\Lambda(\tau)$, while for H_{01}, $\hat{T}_B$ is estimated by minimizin $\Lambda(\tau)$.

Finally, to test $H_{01} \cup H_{10}$, the statistics to use may be formulated, in most general terms, as

(9) $$K_i = \max\left\{K_{i-3}, K_{i-3}^{-1}\right\}, \quad i = 4,5,6$$

Thus, e.g., for the KPSS-based tests we will have KL_1, KL_2, KL_3, KL_1^{-1}, KL_2^{-1}, KL_3^{-1}, KL_4, KL_5 and KL_6.

b. Regression-Based Tests

The null hypothesis, now, is that the series is I(1). The alternative hypotheses are the same as above. We may express the model as

(10a) $$y_t = \beta' d_t + u_t$$

(10b) $$u_t = \alpha u_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta u_{t-i} + \varepsilon_t$$

Then, for the shift from I(0) to I(1) we have

(11) $$\begin{aligned} H_0 &: \alpha = 1, && t = 1,\ldots,T \\ H_{01} &: |\alpha| < 1, && t = 1,\ldots,[\tau T] \\ & \alpha = 1, && t = [\tau T]+1,\ldots,T \end{aligned}$$

In testing for a shift from I(1) to I(0), there are two ways we may formulate the hypothesis and this will reflect itself in the implementation of the test statistics. In the first case, which corresponds to the way BLS view the problem, we have

(12) $$\begin{aligned} H_0 &: \alpha = 1, && t = 1,\ldots,T \\ H_{01} &: \alpha = 1, && t = 1,\ldots,[\tau T] \\ & |\alpha| < 1, && t = [\tau T]+1,\ldots,T \end{aligned}$$

In the second case, as implemented by LKSN and Leybourne et al (2006), the time ordering of the data is reversed; i.e, we now consider, instead of y_t, t =1,...,T, $z_t = y_{T-t+1}$, replace y_t by z_t in (10a) and test

$$\begin{aligned} & H_0 : \alpha = 1, && t = 1,\ldots,T \\ & H_{01} : |\alpha| < 1, && t = T,\ldots,T-[\tau T] \\ & \qquad \alpha = 1, && t = T-[\tau T]-1,\ldots,1 \end{aligned} \tag{13}$$

The strategy followed in testing these hypotheses is to determine the subperiod for which y_t is I(0). Thus, to test for H_{01}, the equation in (10a) is estimated for an initial sample of size $[\tau_0 T]$, and the residuals $\hat{u}_t$ are used to form the equation

$$\Delta\hat{u}_t = \rho\hat{u}_{t-1} + \sum_{i=1}^{p-1}\gamma_i \Delta\hat{u}_{t-i} + \varepsilon_t \tag{14}$$

where $\rho = \alpha - 1$ and $\rho = 0$ is tested. This procedure is repeated recursively, i.e., in each step, the initial sample $[\tau_0 T]$ is increased by 1 and the t-ratio for ρ, $t_\rho(\tau)$ is obtained. The test statistic is taken to be the minimum of these t-ratios. If the minimum value exceeds the appropriate critical value, then the switch point will be the τ-value that corresponds to this minimum. In other words, a separate criterion, like $\Lambda(\tau)$ of (8), is not required to determine the switch point.

Now, in testing H_{10}, based on the formulation in (12), reverse-recursion is applied to (14) in the sense that it is estimated recursively for $t = T-[\tau T]+1,...,T$. The first subsample in this procedure will be the last $[\tau_0 T]$ observations and the sample will be increased by one observation but will move towards the beginning of the period. Again $t_\rho(\tau)$ is calculated at each step and its minimum will be our test statistic; the switch point will again be given by this minimum.

If, however, the formulation of H_{10} in (13) is used, then the procedure described in testing for H_{01} will be applied to the z_t series. Now the minimum $t_\rho(\tau)$ from

$$\Delta\tilde{u}_t = \rho\tilde{u}_{t-1} + \sum_{i=1}^{p-1}\gamma_i \Delta\tilde{u}_{t-i} + \varepsilon_t \tag{15}$$

where $\tilde{u}_t = z_t - \tilde{\beta}' d_t$, will be the test statistic.

The contributions of LKSN and those by BLS, Taylor (2005b) and Leybourne et al (2006), differ in the way (10a) is estimated. The latter group of contributions estimate this equation by OLS so that the t-ratios mentioned above are nothing but recursively obtained ADF statistics. Thus, if we denote the t-ratios obtained from the forward recursive estimation of (14) by $t_\rho^F(\tau)$, from reverse recursive estimation by $t_\rho^R(\tau)$, and from the forward recursive estimation (15) based on backward data by $t_\rho^B(\tau)$, then we may formally define our three statistics as

(16) $$\min ADF^F = \min_{\tau\in[\tau_0,1]} t_\rho^F(\tau)$$

(17) $$\min ADF^R = \min_{\tau\in[\tau_0,1]} t_\rho^R(\tau)$$

(18) $$\min ADF^B = \min_{\tau\in[\tau_0,1]} t_\rho^B(\tau)$$

On the other hand, LKSN estimate (10a) by Generalized Least Squares (GLS), in the spirit of Elliott et al (1996). In fact, they obtain recursive DFGLS statistics and use their minimum values as their test statistics. They, however, only consider the forward recursive estimation of (10a) and (14) and the forward recursive estimation of $z_t = \beta' d_t + u_t$ and (15). Hence, their statistics may formally be expressed as

(19) $$\min DFGLS^F = \min_{\tau\in[\tau_0,1]} t_\rho^F(\tau)$$

(20) $$\min DFGLS^B = \min_{\tau\in[\tau_0,1]} t_\rho^B(\tau)$$

The GLS estimation of (10a) is carried out by assuming that $u_t = \delta u_{t-1} + \varepsilon_t$ and that δ is less than unity but takes on the values in a neighborhood defined by $\delta = 1 + (c/T)$. The choice of c, $\bar{c}$, yields the value of δ, $\bar{\delta}$, used in the GLS estimation of β. This value differs for the models this procedure is applied to. For example, for the full sample test of a unit root where $d_t = (1,t)'$, $\bar{c}$ is taken to be -13.5. In the present application $\bar{c}$ is found to be -25.

When we finally turn to testing $H_{01} \cup H_{10}$ we find that LKSN and Taylor (2005b) differ from Leybourne et all (2006). LKSN suggest using

(21) $$DFGLS_{\min} = \min\left\{\min DFGLS^{F}, \min DFGLS^{B}\right\}$$

while Taylor (2005b) suggests

(22) $$ADF_{\min}^{FR} = \min\left\{\min ADF^{F}, \min ADF^{R}\right\}$$

$$ADF_{\min}^{FB} = \min\left\{\min ADF^{F}, \min ADF^{B}\right\}$$

On the other hand, Leybourne et al (2006) suggest the statistic

(23) $$R = \left|\frac{\min ADF^{F}}{\min ADF^{R}}\right|$$

and note that it may not only be used to test $H_{01} \cup H_{10}$, but $H_{01}$and H_{10} separately.

3. The Data

The data have been obtained from the electronic data base of the Turkish Statistical Institute. They consist of three monthly series on the Consumer Price Index and on the Wholesale Price Index. The CPI series have 1978-79, 1987 and 1994 as base years while the WPI series have 1981, 1987 and 1994 as base years. The monthly inflation rates are obtained by taking the first differences of the natural logarithms of these series. Hence, we shall denote the resultant series by CPIINF7879, CPIINF87, CPIINF94, WPIINF81, WPIINF87 and WPIINF94. CPIINF7879 and WPIINF81 cover the period 1982.02-2005.12, while CPIINF87 and WPIINF87 cover the period 1988.02-2005.12. The CPIINF94 and WPIINF94 series, on the other hand, cover the period 1994.02-2006.12 since data until 2006.12 are available for the two price indexes involved.

4. Empirical Results

We applied the persistence shift tests discussed in Section 2 to these six inflation series. We present the results in four tables. But, due to the large number of tests statistics used and the fact that each one has a different distribution, instead of presenting the critical values at the end of each table, we gathered them in Table 1. Also, the critical values presented in Table 1 are the asymptotic critical values, not the values that were also available

Table 1
Critical Values of Tests

		KL_1	KL_2	KL_3	KL_1^{-1}	KL_2^{-1}	KL_3^{-1}	KL_4	KL_5	KL_6
Model 1	*0.10*	13.87	3.55	3.45	13.65	3.50	3.39	18.07	4.63	5.12
	0.05	18.33	4.67	5.22	18.08	4.59	5.11	22.95	5.90	7.24
	0.01	30.26	7.74	10.51	29.91	7.72	10.41	35.98	9.35	13.22
Model 2	*0.10*	7.00	2.36	1.50	7.00	2.36	1.50	6.61	2.88	1.95
	0.05	8.68	2.89	1.97	8.64	2.88	1.96	10.38	3.42	2.49
	0.01	12.92	4.20	3.38	13.00	4.19	3.40	14.94	4.84	4.14
		KS_1	KS_2	KS_3	KS_1^{-1}	KS_2^{-1}	KS_3^{-1}	KS_4	KS_5	KS_6
Model 1	*0.10*	2.81	1.53	0.79	2.80	1.52	0.79	3.14	1.71	0.89
	0.05	3.16	1.71	0.89	3.15	1.71	0.89	3.48	1.89	0.99
	0.01	2.12	1.12	1.12	3.91	2.11	1.11	4.25	2.29	1.21
Model 2	*0.10*	2.26	1.37	0.70	2.25	1.37	0.70	2.46	1.49	0.77
	0.05	2.48	1.50	0.77	2.47	1.49	0.76	2.67	1.61	0.83
	0.01	2.94	1.76	0.91	2.94	1.76	0.90	3.14	1.88	0.97
		RS_1	RS_2	RS_3	RS_1^{-1}	RS_2^{-1}	RS_3^{-1}	RS_4	RS_5	RS_6
Model 1	*0.10*	2.12	1.36	0.70	2.12	1.38	0.70	2.32	1.50	0.77
	0.05	2.32	1.50	0.77	2.33	1.50	0.77	2.51	1.62	0.83
	0.01	2.76	1.77	0.90	2.76	1.77	0.90	2.95	1.87	0.96
Model 2	*0.10*	2.15	1.35	0.69	2.14	1.35	0.69	2.33	1.46	0.75
	0.05	2.34	1.46	0.75	2.33	1.46	0.75	2.52	1.57	0.80
	0.01	2.76	1.70	0.87	2.77	1.70	0.87	2.94	1.80	0.92

		$\min ADF^F$	$\min ADF^R$	$\min ADF^B$	$ADF^{FR}_{\min}$	$ADF^{FB}_{\min}$	R_{LT}	R_{UT}
Model 1	*0.10*	-3.32	-3.91	-3.31	-3.97	-3.55	0.67	1.49
	0.05	-3.58	-4.17	-3.59	-4.22	-3.81	0.59	1.68
	0.01	-4.09	-4.68	-4.11	-4.70	-4.32	0.47	2.13
Model 2	*0.10*	-3.93	-4.40	-3.94	-4.47	-4.15	0.73	1.37
	0.05	-4.19	-4.65	-4.21	-4.71	-4.40	0.67	1.50
	0.01	-4.71	-5.12	-4.70	-5.17	-4.89	0.56	1.80

		$\min DFGLS^{F,B}$	$DFGLS_{\min}$
Model 1	*0.10*	-2.40	-2.69
	0.05	-2.70	-2.95
Model 2	*0.10*	-3.27	-3.54
	0.05	-3.55	-3.78

Notes:

1. Model 1 contains and intercept and Model 2 contains both an intercept and a linear trend term.
2. The critical values for the KL_i and KL_i^{-1} statistics are from Taylor (2005a), Table 1.
3. The critical values for the KS_i and KS_i^{-1} statistics are from Taylor (2005a), Table 2.
4. The critical values for the RS_i and RS_i^{-1} statistics are from Taylor (2005a), Table 3.
5. The critical values for the $\min ADF^F$ and $\min ADF^B$ statistics are from Leybourne et al (2006), Table 1b, for *R* from Table 1a, while those for $\min ADF^R$, $ADF^{FR}_{\min}$ and $ADF^{FB}_{\min}$ are from Taylor (2005b), Table III.
6. The critical values for $\min DFGLS^{F,B}$ and $DFGLS_{\min}$ are from LKSN, Table 1.
7. R_{LT} and R_{UT} refer to lower-tail and upper-tail critical values, respectively.

Table 2
Ratio Tests for Inflation Series Based on the Consumer Price Indeces

CPIINF7879									
	KL_1	KL_2	KL_3	KL_1^{-1}	KL_2^{-1}	KL_3^{-1}	KL_4	KL_5	KL_6
Model 1	35.616***	2.875	12.649***	15.413*	2.690	4.037*	35.616**	2.875	12.649***
Model 2	16.253***	2.753*	4.447***	16.184***	2.669*	4.338***	16.253***	2.753*	4.447***
	KS_1	KS_2	KS_3	KS_1^{-1}	KS_2^{-1}	KS_3^{-1}	KS_4	KS_5	KS_6
Model 1	5.495***	1.846**	1.151***	4.344***	1.544*	0.376	5.495***	1.846*	1.151***
Model 2	3.268***	1.464*	0.809**	3.168***	1.541**	0.471	3.268***	1.541*	0.809*
	RS_1	RS_2	RS_3	RS_1^{-1}	RS_2^{-1}	RS_3^{-1}	RS_4	RS_5	RS_6
Model 1	4.344***	1.729**	0.989***	1.544	0.749	0.391	4.344***	1.729**	0.989***
Model 2	3.168***	1.541**	0.854**	2.049	0.875	0.467	3.168***	1.541**	0.854**
	$\Lambda_{\max}$		**date**		$\Lambda_{\min}$		**Date**		
Model 1	3.196		2001.02		0.604		1986.10		
Model 2	3.202		2001.03		0.538		1986.10		
CPIINF87									
	KL_1	KL_2	KL_3	KL_1^{-1}	KL_2^{-1}	KL_3^{-1}	KL_4	KL_5	KL_6
Model 1	323.51***	5.093**	156.89***	15.419*	2.591	4.063*	323.51***	5.093*	156.89***
Model 2	17.498***	2.797*	4.811***	15.230***	2.682*	4.116***	17.498***	2.797	4.811***
	KS_1	KS_2	KS_3	KS_1^{-1}	KS_2^{-1}	KS_3^{-1}	KS_4	KS_5	KS_6
Model 1	3.973***	1.769**	1.019**	1.834	0.808	0.431	3.973**	1.769*	1.019**
Model 2	3.004***	1.134	0.632	2.681**	1.169	0.601	3.004**	1.169	0.632
	RS_1	RS_2	RS_3	RS_1^{-1}	RS_2^{-1}	RS_3^{-1}	RS_4	RS_5	RS_6
Model 1	2.822*	1.571**	0.856**	1.607	0.814	0.426	2.822*	1.571**	0.856**
Model 2	3.557***	1.169	0.672	3.078***	1.156	0.632	3.557***	1.169	0.672
	$\Lambda_{\max}$		**Date**		$\Lambda_{\min}$		**Date**		
Model 1	1.639		2001.02		0.365		1994.05		
Model 2	0.923		2001.03		0.199		1994.08		
CPIINF94									
	KL_1	KL_2	KL_3	KL_1^{-1}	KL_2^{-1}	KL_3^{-1}	KL_4	KL_5	KL_6
Model 1	16.784*	2.839	4.703*	16.188*	2.708	4.433*	16.784	2.839	4.703*
Model 2	16.788***	2.750*	4.691***	15.570***	2.626*	4.168***	16.788***	2.750*	4.691***
	KS_1	KS_2	KS_3	KS_1^{-1}	KS_2^{-1}	KS_3^{-1}	KS_4	KS_5	KS_6
Model 1	2.804	1.456	0.867	32.243***	4.790***	11.693***	32.243***	4.790***	11.693***
Model 2	1.194	0.583	0.299	6.624***	2.235***	1.473***	6.624***	2.235***	1.473***
	RS_1	RS_2	RS_3	RS_1^{-1}	RS_2^{-1}	RS_3^{-1}	RS_4	RS_5	RS_6
Model 1	2.804*	1.385*	0.815**	19.478***	3.605***	6.280**	19.478***	3.605***	6.280**
Model 2	1.165	0.617	0.317	6.787***	2.187***	1.494***	6.787***	2.187***	1.494***
	$\Lambda_{\max}$		**Date**		$\Lambda_{\min}$		**Date**		
Model 1	0.595		2001.02		0.100		1996.08		
Model 2	0.968		2004.08		0.050		1996.08		

Notes:
1. Model 1 contains and intercept and Model 2 contains both an intercept and a linear trend term
2. Refer to Table 1 for the critical values.
3. * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level

for sample sizes that approximated the actual sample sizes used in the applications. This provides uniformity for the critical values used; avoiding the different approximations one encounters in tables prepared for different test statistics. The results in all the tables are

presented for the intercept-only case, which we call Model 1, and for the intercept and trend case, which we call Model 2.

The ratio test results for the CPI-based inflation series are given in Table 2. The null hypothesis of no shift in persistence is rejected by KL_1 and also by KL_1^{-1} and KL_3^{-1} for CPIINF7879 in Model 1, while all KL_i and KL_i^{-1} reject the null in Model 2, for both one-sided and two-sided alternatives. We find that the KS_i and KS_i^{-1} results are quite similar. All KS_i reject for both models, while only KS_1^{-1} and KS_2^{-1} reject for both models. Finally, all RS_i reject for Model 1 while only RS_1 and RS_1^{-1} reject for Model 2. The shift points given by $\Lambda_{\max}$ are 2001.02 for Model 1 and 2001.03 for Model 2, while the same shift date is given by $\Lambda_{\min}$ for both models; namely, 1986.10. Thus, the evidence from these tests strongly favour a shift from I(0) to I(1) around the first quarter of 2001.

The results for CPIINF87 are not much different. We find that the KL_i reject the null for both models while KL_1^{-1} and KL_3^{-1} reject for Model 1 and all KL_i^{-1} reject for Model 2. The KS - KS^{-1} and RS - RS^{-1} results are identical. The KS_i and RS_i reject for Model 1 while KS_1, RS_1, KS_1^{-1} and RS_1^{-1} reject for Model 2. The I(0)-to-I(1) shift points are, again, 2001.02 and 2001.03 and, the I(1)-to-I(0) are, now, 1994.05 and 1994.08. Again, evidence favouring a I(0)-to-I(1) shift dominate and for the same dates as before, but there is now also increasing evidence of I(1)-to-I(0) shifts, particularly for Model 2.

When we finally turn to the results for CPIINF94, we tend to find that the I(1)-to-I(0) shift appears to be favoured more than in the previous two cases. This is observed more in the KS_i^{-1} and RS_i^{-1} results rather than in the KL_i^{-1} results. In fact, the KS_i^{-1} reject for both models, while there are some weakly significant results for RS_i in the case of Model 1. $\Lambda_{\max}$ indicates, as the shift date, 2001.02 for Model 1 and 2004.08 for Model 2, while $\Lambda_{\min}$ indicates 1996.08 for both models.

Table 3 contains the regression-based test results for the CPI-based inflation series. For CPIINF7879, we find that $\min ADF^F$ and $\min ADF^R$ reject, and R rejects in the I(0)-to-I(1) direction for Model 1, while all three "min" tests reject for Model 2. $\min DFGLS^F$ rejects for Model 1, while both $\min DFGLS^F$ and $\min DFGLS^B$ reject for Model 2. The shift dates vary a lot. 1997.10 and 1995.04 are found for the I(0)-to-I(1) shift in Models 1, and

2, respectively, while the I(1)-to-I(0) dates are 200.11 and 1983.02 for Model 1 and 1993.02 and 2002.01 for Model 2.

Table 3
Regression-Based Tests for Inflation Series Based on the Consumer Price Indeces

CPIINF7879

	min ADF^F	p	min ADF^R	p	min ADF^B	p	$ADF^{FR}_{\min}$	$ADF^{FB}_{\min}$	R
Model 1	-4.735*** (1987.10)	2	-4.399*** (2000.11)	10	-2.645 (1983.02)	10	-4.735***	-4.735***	1.790**
Model 2	-7.319*** (1995.04)	2	-5.371*** (1993.02)	6	-5.461*** (2001.01	1	-7.319***	-7.319***	1.340

	min $DFGLS^F$	p	min $DFGLS^B$	p	$DFGLS_{\min}$
Model 1	-4.575*** (1987.10)	2	-1.994 (1982.09)	10	-4.575***
Model 2	-7.360*** (1995.04)	2	-4.444*** (2000.03)	1	-7.360***

CPIINF87

	min ADF^F	p	min ADF^R	p	min ADF^B	p	$ADF^{FR}_{\min}$	$ADF^{FB}_{\min}$	R
Model 1	-6.187*** (1995.05)	1	-4.525** (2000.11)	10	-2.755 (2002.03)	13	-6.187***	-6.187***	2.246***
Model 2	-6.577*** (1996.04)	3	-5.013** (2001.11)	7	-6.850*** (1994.03)	1	-6.577***	-6.850***	0.960

	min $DFGLS^F$	p	min $DFGLS^B$	p	$DFGLS_{\min}$
Model 1	-4.453** (1993.11)	7	-2.644* (2003.03)	13	-4.532**
Model 2	-6.593** (1996.05)	3	-5.466*** (1998.01)	1	-6.593**

CPIINF94

	min ADF^F	p	min ADF^R	p	min ADF^B	p	$ADF^{FR}_{\min}$	$ADF^{FB}_{\min}$	R
Model 1	-6.437*** (1996.09)	7	-6.042*** (2003.07)	9	-4.816*** (2004.03)	9	-6.437***	-6.437***	1.337
Model 2	-6.099*** (1996.09)	9	-6.042*** (2003.07)	9	-5.217*** (1999.04)	6	-6.099***	-6.099***	1.169

	min $DFGLS^F$	p	min $DFGLS^B$	p	$DFGLS_{\min}$
Model 1	-1.505 (2001.04)	12	-4.819*** (2004.04)	12	-4.819**
Model 2	-3.339* (2003.05)	12	-4.761*** (1995.02)	6	-4.761**

Notes:
1. Model 1 contains and intercept and Model 2 contains both an intercept and a linear trend term
2. Refer to Table 1 for the critical values.
3. * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level

We note that the results for CPIINF87 are quite similar. The results regarding the $\min ADF$ tests and R are exactly the same as above while both $\min DFGLS$ tests reject for both models. The shift dates also vary all over the place. 1995.05 comes close to the shift date above for I(0)-to-I(1) while 2000.11 is repeated for both models.

The results for CPIINF94 are not the same as the ratio test results. Even though there are strong rejections in the case of $\min ADF^R$ and $\min ADF^B$ tests for both models, they are

overshadowed by the $\min ADF^F$ results. $\min DFGLS$ results, however, do favour a I(1)-to-I(0) shift. The shift dates, in this case, are 2004.04 for Model 1 and 1995.02 for Model 2.

Table 4
Ratio Tests for Inflation Series Based on the Wholesale Price Indeces

WPIINF81

	KL_1	KL_2	KL_3	KL_1^{-1}	KL_2^{-1}	KL_3^{-1}	KL_4	KL_5	KL_6
Model 1	34.275***	2.867	11.979***	15.344*	2.597	4.028*	34.275**	2.867	11.979**
Model 2	16.105***	2.732*	4.385***	16.234***	2.661*	4.3288**	16.234***	2.732	4.385***
	KS_1	KS_2	KS_3	KS_1^{-1}	KS_2^{-1}	KS_3^{-1}	KS_4	KS_5	KS_6
Model 1	6.027***	2.027**	1.283***	1.118	0.646	0.333	6.027***	2.027**	1.283***
Model 2	3.053***	1.600*	0.854**	1.948	0.740	0.384	3.053**	1.600*	0.854**
	RS_1	RS_2	RS_3	RS_1^{-1}	RS_2^{-1}	RS_3^{-1}	RS_4	RS_5	RS_6
Model 1	3.686***	1.780***	0.976***	1.233	0.684	0.353	3.686***	1.780**	0.976***
Model 2	3.177***	1.600**	0.858**	2.049	0.761	0.399	3.177***	1.600**	0.858**

	$\Lambda_{\max}$	**date**	$\Lambda_{\min}$	**date**
Model 1	4.366	2001.02	0.585	1986.10
Model 2	2.605	2001.02	0.536	1986.10

WPIINF87

	KL_1	KL_2	KL_3	KL_1^{-1}	KL_2^{-1}	KL_3^{-1}	KL_4	KL_5	KL_6
Model 1	94.502***	3.327	42.383***	15.206*	2.586	3.996*	94.502***	3.327	42.383***
Model 2	18.269***	2.801*	4.982***	15.771***	2.658*	4.290***	18.269***	2.801*	4.982***
	KS_1	KS_2	KS_3	KS_1^{-1}	KS_2^{-1}	KS_3^{-1}	KS_4	KS_5	KS_6
Model 1	7.125***	2.303***	1.721***	2.554	0.988	0.565	7.125***	2.303***	1.721***
Model 2	4.585***	1.400*	0.884**	2.541**	1.091	0.595	4.585***	1.400	0.884**
	RS_1	RS_2	RS_3	RS_1^{-1}	RS_2^{-1}	RS_3^{-1}	RS_4	RS_5	RS_6
Model 1	4.363***	2.023***	1.254***	1.693	0.847	0.458	4.363***	2.023***	1.254***
Model 2	4.258***	1.337	0.828**	2.778***	1.040	0.628	4.258***	1.337	0.828**

	$\Lambda_{\max}$	**Date**	$\Lambda_{\min}$	**date**
Model 1	2.713	2001.02	0.292	1994.05
Model 2	1.590	2001.02	0.204	1994.07

WPIINF94

	KL_1	KL_2	KL_3	KL_1^{-1}	KL_2^{-1}	KL_3^{-1}	KL_4	KL_5	KL_6
Model 1	16.783*	2.786	4.692*	16.023*	2.685	4.391*	16.783*	2.786	4.692
Model 2	16.788***	2.744*	4.691***	15.539***	2.615*	4.151***	16.788***	2.744	4.691***
	KS_1	KS_2	KS_3	KS_1^{-1}	KS_2^{-1}	KS_3^{-1}	KS_4	KS_5	KS_6
Model 1	1.984	1.198	0.661	9.265***	2.216***	2.333***	9.265***	2.216***	2.333***
Model 2	1.022	0.554	0.280	3.617***	1.956***	1.029***	3.617***	1.956***	1.029***
	RS_1	RS_2	RS_3	RS_1^{-1}	RS_2^{-1}	RS_3^{-1}	RS_4	RS_5	RS_6
Model 1	1.982	1.175	0.648	5.816***	1.794***	1.401***	5.816***	1.794***	1.401***
Model 2	1.213	0.636	0.325	3.683***	1.808***	0.976***	3.683***	1.808***	0.976***

	$\Lambda_{\max}$	**Date**	$\Lambda_{\min}$	**date**
Model 1	0.817	2001.02	0.078	1996.08
Model 2	0.431	2001.02	0.043	1996.08

Notes:
4. Model 1 contains and intercept and Model 2 contains both an intercept and a linear trend term
5. Refer to Table 1 for the critical values.
6. * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level

Tables 4 and 5 contain the results pertaining to the WPI-based series. The pictures that emerge from both tables are quite similar to the CPI-based inflation results. The ratio tests in

Table 5
Regression-Based Tests for Inflation Series Based on the Wholesale Price Indeces

WPIINF81

	min ADF^F	p	min ADF^R	p	min ADF^B	p	$ADF^{FR}_{\min}$	$ADF^{FB}_{\min}$	R
Model 1	-3.930** (2003.01)	8	-3.588*** (2000.10)	13	-3.683** (1983.02)	8	-3.930	-3.930*	1.067
Model 2	-7.363*** (1996.12)	2	-10.266*** (1993.02)	1	-5.198*** (1997.02)	1	-10.266***	-7.363***	1.417*

	min $DFGLS^F$	p	min $DFGLS^B$	p	$DFGLS_{\min}$
Model 1	-3.921** (2003.01)	8	-2.440 (1983.01)	10	-3.921***
Model 2	-4.159*** (2002.01)	8	-5.134*** (1997.02)	1	-5.134***

WPIINF87

	min ADF^F	p	min ADF^R	p	min ADF^B	p	$ADF^{FR}_{\min}$	$ADF^{FB}_{\min}$	R
Model 1	-6.431*** (2000.04)	2	-4.317** (2002.03)	6	-4.759 (1988.02)	4	-6.431***	-6.431**	1.351
Model 2	-6.427*** (2000.03)	2	-11.381*** (1993.02)	1	-6.850*** (1994.03)	1	-11.381***	-6.850***	0.938

	min $DFGLS^F$	p	min $DFGLS^B$	p	$DFGLS_{\min}$
Model 1	-4.532** (1993.11)	7	-3.762** (1988.05)	4	-4.532**
Model 2	-4.913** (2004.10)	4	-6.614** (1994.04)	12	-6.614**

WPIINF94

	min ADF^F	p	min ADF^R	p	min ADF^B	p	$ADF^{FR}_{\min}$	$ADF^{FB}_{\min}$	R
Model 1	-13.044*** (1996.08)	13	-5.986*** (2002.02)	6	-5.001*** (2004.03)	2	-13.044***	-13.044***	2.608***
Model 2	-4.744*** (1993.03)	9	-5.921*** (2000.02)	6	-4.883*** (2004.03)	6	-5.921***	-4.883***	0.972

	min $DFGLS^F$	p	min $DFGLS^B$	p	$DFGLS_{\min}$
Model 1	-4.329*** (2002.03)	1	-4.634*** (2004.02)	1	-4.634***
Model 2	-4.478*** (2001.06)	1	-4.761*** (1995.02)	6	-4.761***

Notes:
4. Model 1 contains and intercept and Model 2 contains both an intercept and a linear trend term
5. Refer to Table 1 for the critical values.
6. * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level

Table 4 again favour I(0)-to-I(1) shifts for WPIINF81 and WPIINF87 with the shift date being 2001.02 in both cases. For WPIINF94 we find that KL_1 and KL_3 are highly significant compared to KL_1^{-1} and KL_3^{-1} for Model 1, while all tests are significant for Model 2 with the KL_i having a slight edge over the KL_i^{-1} tests. But both KS_i^{-1} and RS_i^{-1} tests are significant for both models and the shift date is the same; 1996.08.

The regression-based test results show slight differences. Dominance of I(1)-to-I(0) shifts are observed for $\min ADF^R$ in the case of WPIINF81 for Model 2 and this holds for both $\min ADF^R$ and $\min ADF^B$ in the case of WPIINF87. This dominance of the I(1)-to-I(0) shift continues for WPIINF94 but $\min DFGLS^F$ is also highly significant for both models. The shift points for the I(1)-to-I(0) shifts are either 2002.02 or 2004.03.

5. Conclusions

We have applied a series of tests to Turkish monthly inflation rates based on both the CPI and the WPI. This involved three series for each case, covering different lengths of time. We may list our conclusions as follows.

1. The ratio tests, as applied to series covering longer time periods, 1978-79 and 1987-based, to be precise, a shift from I(0) to I(1), with shift date around the first quarter of 2001. The regression-based test corraborate these results to a great extent.

2. For the 1994-based series, however, we find that I(1)-to-I(0) shifts are indicated more often, especially by the regression based tests and at around similar dates.

3. If one has no apriori expectation about the direction that the shift will take place, i.e., if the alternative hypothesis is $H_{01} \cup H_{10}$, then one may conclude that the majority of the evidence points to Turkish inflation rates moving from being I(0) to I(1) and one may be satisfied by this conclusion.

4. But, if one takes notice of the fact that a policy of inflation targeting was put into operation after 2001 and this led to an appriciable decline in the rate of inflation, then significant results when the alternative hypothesis is H_{10} was to be expected. Such results were mainly obtained for the 1994-based series.

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