



TESTING FOR NON-LINEAR TREND REVERSION IN THE ESTAR AND AESTAR PROCESSES, WHETHER GDP AND CPI SERIES IN TURKEY ARE STATIONARY OR NOT?



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ABSTRACT

In this paper, we test the GDP and CPI series of Turkey under the alternative hypothesis based on non-linear framework by allowing trend reversion. Herewith, there are some evidences in favor of non-linear trend stationary for GDP and CPI series conversely to most of the previous studies' results. These findings imply that Turkey's main macroeconomic variables show non-linear behavior and have structural break. Based on these findings, regarding the GDP and CPI series, it can also be stated that the macroeconomic politics implemented by the governments are efficient just for the short-run but not for the long run.

Key words: Non-linear unit root, ESTAR Process, KSS test, AESTAR Process.

Jel Classification: C22; E31.

ESTAR VE AESTAR SÜREÇLERİNDE TERSİNE DÖNEN DOĞRUSAL OLMAYAN EĞİLİMİN TEST EDİLMESİ; TÜRKİYEDE GDP VE CPI SERİLERİ DURAĞAN MI? DEĞİL Mİ?

ÖZ

Bu makalede Türkiye'nin GSYİH ve TÜFE serileri trend etrafında doğrusal olmayan temellere dayanan alternatif hipotez testleri kullanılarak test edilmektedir. Bu çalışmada, son zamanlarda elde edilen çoğu çalışma sonuçlarının tersine GSYİH ve TÜFE serilerinde doğrusal olmayan trend durağanlık lehine kanıtlar elde edilmektedir. Bu bulgular, Türkiye'nin temel makro ekonomik değişkenlerinin yapısal kırılmalara sahip olduğunu ve doğrusal olmayan davranışlar gösterdiğini ortaya koymaktadır. Bu bulgulardan hareketle, hükümetlerce uygulanan makro ekonomik politikaların GSYİH ve TÜFE serileri açısından sadece kısa dönem için etkin ancak uzun dönemler için gayri etkin olduğu da ifade edilebilir.

Anahtar kelimeler: Doğrusal olmayan birim kök, ESTAR Süreci, KSS Testi, AESTAR Süreci.

Jel Sınıflaması: C22; E31.

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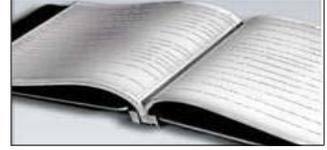
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1. Introduction

It is widely believed that the macroeconomic time series are best characterized as unit root processes (Nelson and Plosser, 1982) stemming from the idea that the macroeconomic time series are influenced by the economic policies implemented by the governments or the governments implement various economic policies in order to influence the macroeconomic magnitudes toward their aims. As pointed out by Nelson and Plosser (1982), the modeling of some main macroeconomic variables has important implications for macroeconomic policy modeling, testing and forecasting whether it is a trend stationary or a difference stationary process. The status of the macroeconomic time series being in a trend stationary or a difference stationary denotes that they have structural features. When the macroeconomic time series are stationary, it denotes that the macroeconomic variables are influenced for only short-run by the changes in economic policies and these altered policies could not be successful. Therefore, not only for empirical researchers but also for politicians, the studies on this subject are crucial. Based on this view, the time series of some macroeconomic variables such as; real output, consumption, investment, savings, money aggregates, prices, wages and net export, which are tried to be effected by the governments in order to obtain the sustainable macroeconomic stability have got much more attention within the literature.

Within the literature, between the unit root tests, which are on the linear time series basis, the Dickey-Fuller type unit root tests are the commonly used techniques (Beechey and Österholm, 2008). However, Froot and Rogoff (1995) and Taylor (2001) point it out that, when the alternative is an autoregressive parameter near unity, which must be seen as the empirically relevant case when testing macroeconomic variables, the power of Dickey-Fuller-type tests is known to be low. In this context, some authors noted that the Augmented Dickey-Fuller (ADF) test lacks power against its alternatives, the other stationary test models as in the underlying model that is exponential smooth-transition autoregressive (ESTAR) rather than standard linear autoregressive (Sercu et.al, 1995: Micheal et.al, 1997 (ESTAR model comes from STAR models). If the model rejects linearity test under the null hypothesis which is suggested by Luukonen et. al (1988), then one can use STAR models. Thus, linearity test is applied to both of the variables and both of them reject the linearity test under the null hypothesis 10% level.), Liew



et. al, 2004; Cuestas and Garratt, 2008; Chang et.al, 2009; Cuestas and Harrison, 2010; King and Dobson, 2011). These researchers, thereby, used unit-root test, which are on the non-linear time series technique basis when investigating whether the macroeconomic time series that they are interested in are stationary or not.

In an ESTAR model, the speed of mean or trend reversion to the equilibrium is not constant; rather, the process can display unit-root behavior in the region close to its equilibrium but strong reversion when the process is far from its mean or trend. Beechey and Österholm (2008) and Shelley and Wallace (2011) believe that an ESTAR process is a plausible characterization of price and output dynamics. Following these authors, we are to believe that an ESTAR process is plausible characterization of Turkey's GDP and CPI. As it is known that Turkey had implicit inflation targeting strategy, based on CPI, during the period of 2002-2005, and had explicit inflation targeting strategy beginning by 2006 and stands still. If CPI is stationary in Turkey, it can be predicted that the inflation targeting strategy could be successful. Thus, finding out the situation of the CPI, whether it is stationary or not, is very important for the politicians. This subject has been examined by some authors for some countries other than Turkey, and one of them, Gregoriou and Kontonikas (2009) showed that inflation targeting regime has non-linear unit root in the 5 OECD countries (UK, Canada, Sweden, Australia, New Zealand) and two non-OECD countries (Israel and Chile). All of these countries adopted inflation targeting regime based on CPI in early 1990s. Gregoriou and Kontonikas suggest that if the CPI series are stationary then inflation targeting regime can be successful. Amato and Gerlach (2002) are of the other researchers who are interested in and studied the Inflation Targeting Strategy for emerging markets and transition economies. By their study concerning the emerging markets, Amato and Gerlach (2002) pointed out that targeting the CPI series is required in order to get the inflation-targeting regime succeeded. Besides, by the study of Shelley and Wallace (2011) related with US, it has come up with that the length of the sampling has an important role for the success of inflation targeting regime.

Through the non-linear unit root tests, Cuestas and Harrison (2010) proved the persistency of inflation in most of the middle and eastern European countries. Thereto, Arize and Malindretos (2012) represents that the inflation rates are not stationary in African countries by



applying likewise non-linear unit root tests. In parallel with those situations, considering that the Turkish economy incurred and was influenced by high inflation rates for many years and had many financial crises, such as; in 1994, in 1998, in 2001, which led to fluctuations regarding its GDP and other macroeconomic variables in its history, the matter of Turkey's GDP is stationary or not is worth to be investigated as well.

Concerningly and widely believed that there cannot be seen any stationary behavior just following such financial crises in an economy and its GDP also will be non-stationary normally. However, with respect to the importance of the subject, it should be tested that whether the fluctuations caused by the economic crises put perpetual effects on macroeconomic variables or not. Consequently, as the GDP series, when they are stationary, show that the economic crises effects remain limited just for the short-run and it is crucial to pay more attention to the denotation.

2. Method

This paper is composed consisting of five sections. 1. section is formed by “Instruction”. As the second, one “Method” covers the general construction of the paper. The following section “3.Data” describes the data sets. Section 4 presents the econometric methodology and its' results. Section 5 is the “Conclusion”. The “References” part comes after as the last one.

3. Data

Our dataset comprises of Turkey's GDP and CPI series. The real GDP dataset has been received from www.ggdc.net and it covers the annual period 1923-2006 (84 obs.). The CPI dataset has been received from www.oecd.org and it covers the monthly period 2002:1-2010:1 (97 obs.). As it could not be managed to reach the overlapping datasets related with both of those series of GDP and CPI for the periods observed, thereby, the data intervals do not match each other herein the study. However, it is thought that the differences between intervals might not cause to any inconvenience as it is focused on stationary tests of basic macroeconomic variables by the study. If the relations between these series are our concern for investigation, the said difference is to be problematic. Nevertheless, herein, as there is not such an aim, this situation is worth to be disregarded. Consequently, both of those series are transformed into natural logarithm and the following figures are illustrated by covering both of them.

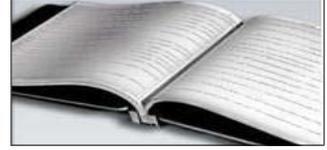
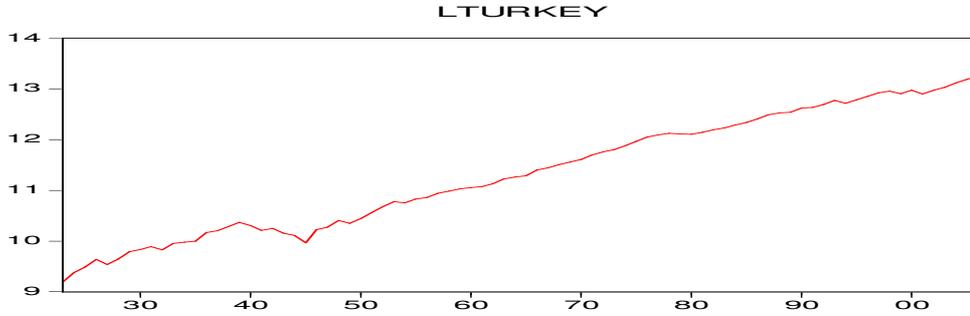
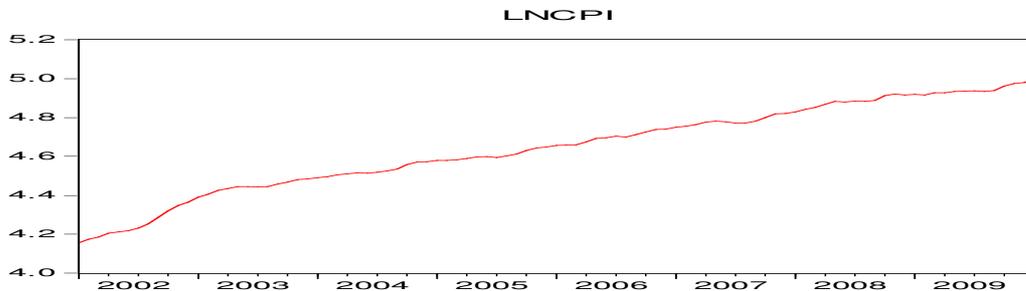


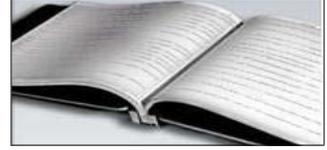
Figure 1. Turkey's GDPs between 1923 and 2006.



When the 1. Figure is dissected, it can be monitored that GDP series display fluctuations that spread out along with the 2nd World War, the crisis of 1958, troubled years as of the petroleum shocks, the crisis of 1980, the gulf crisis of 1991-92, the financial crises of 1994 and 2001. The direction of these fluctuations is downward and they caused contraction and unemployment in the economy. Even though the governments had taken some measures and had applied them persistently in order to overcome the economical negative effects of these fluctuations, it is captured by the behaviors of these measures that they failed to be successful in the long run. However, it can also be inferred from 1st Figure that, they were effective on GDP series in the short-run and draw the series toward the stationary position path. However, as this inference is intuitive, it should be empirically evidenced as well and if the evidencing is done by the tests based on non- linear unit root test techniques that are more critical than conventional unit root test techniques, it can bring more importance and credibility to such a study.

Figure 2. Turkey's CPI between 2002:1 and 2010:1.





Considering the CPI series on the 2nd Figure, it is clearly seen that there is a highly stable behavior especially just after the application of Implicit Inflation Targeting Regime. By the way, this structure has an importance with respect to the fluctuations in an economy, showing whether they are indigenous or exogenous, and they do not have any perpetual effects on CPI, but have only temporary impact on them.

As it can be seen on these figures, both of those series have linear trend and the researchers wonder the tendencies of them and try to find out whether both of them are trend stationary or not because, within the investigated period, any sliding concerning the trend of macroeconomic series may cause to an inference of that there are long-run impacts of the economic policies implemented before.

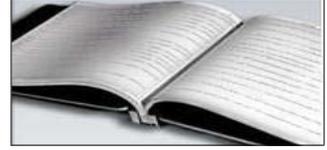
4. Econometric Methodology and Application

In this section, the econometric methodology places and the results of them are presented. Kapetanios et. al. (2003) (KSS) suggest a new unit root test in the non-linear framework, which is based on an ESTAR process.

$$\Delta y_t = \gamma y_{t-1} [1 - \exp(-\theta y_{t-1}^2)] + u_t \quad (1)$$

where y_t is the de-trended series of interest, which defined $y_t = \tilde{y} - \mu - \beta t$ and u_t is an i.i.d. error term with zero mean and constant variance. Besides, “ y_t ” may also be non-zero mean or de-meant series here. But, when the error term has zero mean and constant variance, applying KSS test might be inconvenient (Shelley and Wallace, 2011). Meanwhile, $\theta \geq 0$ is known the transition parameter of the ESTAR process that governs the speed of transition. The null hypothesis of this test procedure is $H_0 : \theta = 0$ against the alternative $H_1 : \theta > 0$. Because γ is not identified under the null, testing this null hypothesis is not feasible. Thus, KSS reparametrize equation (1) based on the first order Taylor series approximation obtains:

$$\Delta y_t = \delta y_{t-1}^3 + \sum_{i=1}^k \beta_i \Delta y_{t-i} + u_t \quad (2)$$



where the term $\sum_{i=1}^k \beta_i \Delta y_{t-i}$ is the augmented term and “k” is the lag length, which based on AIC or SC.

When examining a series with potential trend reversion, the test series y_t is constructed as the set of residuals from a preliminary OLS regression of the unadjusted time series \tilde{y}_t on a constant and linear time trend. In equation (2), the null hypothesis to be tested is $H_0 : \delta = 0$ against the alternative $H_1 : \delta < 0$. The null hypothesis of a unit root is rejected for small enough values of the test statistic; critical values can be found in Kapetanios et al. (2003).

Following KSS (2003), Sollis (2009) proposed a new unit root test against the alternative of symmetric or asymmetric ESTAR (AESTAR) nonlinearity. This test employs both an exponential function and a logistic function (Sollis, 2009). Following Sollis (2009), one can use equation (3) to test nonlinearities.

$$\Delta y_t = \delta_1 y_{t-1}^3 + \delta_2 y_{t-1}^4 + \sum_{i=1}^k \beta_i \Delta y_{t-i} + u_t \quad (3)$$

In this expression the null hypothesis becomes,

$$H_0 : \delta_1 = \delta_2 = 0 \quad (4)$$

in the auxiliary model (3). One can use this model for non-zero mean, de-meanded series or deterministic trend cases.

The most important feature of AESTAR model proposed is that if the unit root hypothesis has been rejected against the alternative of stationary symmetric or asymmetric ESTAR nonlinearity, the null hypothesis of symmetric ESTAR nonlinearity can then be tested against the alternative of asymmetric ESTAR nonlinearity using the auxiliary model (3) by testing $H_0 : \delta_2 = 0$ against $H_1 : \delta_2 \neq 0$ with a standard F-test. For the critical values, one can use Sollis’s table.

We use the annually level of real GDP for Turkey from 1923 to 2006 and the monthly level of the CPI (all items) from January 2002 to January 2010. Both series are transformed into natural logarithms for the analysis. Lag length for the ADF, ADF-GLS, KSS and AESTAR tests are determined by the AIC. The results are reported in table 1.



Table1. Unit-root tests for trend stationarity of Turkey's GDP and CPI

	CPI	GDP
ADF	-1.9951	-0.9074
ADF-GLS	1.8742	3.5338
KSS	-4.2134***	-5.1705***
AESTAR	9.8317***	13.8552***
Sample	2002:9-2010:1	1923-2006

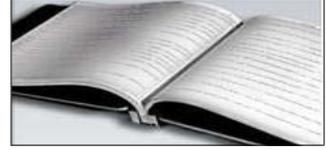
Note: *** Denotes significant result at the 1% level. These results show that Turkey's CPI and GDP series are trend stationary at the 1% level according to KSS test and AESTAR test.

These results imply that when we use for both variables traditional unit root tests we do not reject null hypothesis, but reject non-linear unit root under the null.

5. Conclusion

In this study, Turkey's GDP and CPI series are tested in non-linear framework allowing trend reversion under the alternative hypothesis. As seen in table 1, the conventional unit-root tests provide no evidence of trend stationary, failing to reject the unit-root null at conventional significance levels. But, the KSS test and the Sollis's test reject the null of the unit root in both of those series at the 1% level. Thus, this result favors the globally stationary ESTAR and AESTAR process for both of them. This test results have two important implications; firstly, if the basic macroeconomic variables are trend stationary, it implies that the implemented macroeconomic policies have impact on those variables just in the short run. Moreover, it indicates that these variables have non-linear dynamics as well. Therefore, when analyzing such macroeconomic variables concerning stationary, beware of the unit root tests based on linear techniques is essential. As per the findings of trend-stationary, the output implied by real GDP should be decomposed by using a time-trend regression into a trend component and a stationary cyclical component. Furthermore, the forecast-error variance will be bounded even in the limits and GDP will not shift by the political regime.

Secondly, as per the findings, the CPI is stationary and that is so meaningful because the price stability is the most important indication by which whether the macroeconomic stability is achieved or not. By the way, it might be complimentary to state herein that the price stability

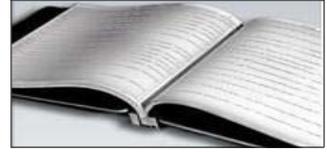


came into question and it was highlighted as of the conjunctures of the collapse of Bretton Woods Systems, the petroleum crisis within 1970s and the liberalization of capital flows. On the other hand, as it is more commonly assumed in the monetary-policy literature, trend-stationary CPI is consistent with price-level targeting but not with the inflation targeting. This distinction is crucial for evaluating central banks' behaviors and stabilization. Under an inflation-targeting regime, long-run expectations about the price level are poorly anchored, as the price level would be generated by a unit-root process with drift. But, in contrast with it, the Price-level targeting can anchor expectations regarding the price level. The rejection of the KSS and AESTAR nulls suggests that some modeling choices for applied Monetary-Policy research may need to be reconsidered.

Finally, as a result of the investigation, through the study, it is inferred that the fiscal and monetary stabilization policies would only have temporary effects on the real output levels and CPI in Turkey.

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