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UNEMPLOYMENT HYSTERESIS IN TURKEY: EVIDENCE FROM NONLINEAR UNIT ROOT TESTS WITH FOURIER FUNCTION[1]

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Abstract: The purpose of the article is to give brief information about the development process of time series analysis and to test the validity of the unemployment hysteresis in Turkey for female and male graduates for the years from 1988 to 2013. For this purpose, Kapetanios et al. [2003], Sollis [2009] and Kruse [2011] nonlinear unit root tests are applied based on the smooth transition autoregressive (STAR) model. Besides, nonlinear unit root tests proposed by Christopoulos et al. [2010] and Guris [2018] are employed to model the structural breaks through Fourier approach and to model the nonlinearity through a STAR model.

Keywords: nonlinear unit root tests, Fourier approach, STAR model, unemployment hysteresis

JEL classification: E24, C22, C12

INTRODUCTION

Analysing the effects of the shocks on macroeconomic variables has been the main problem for both researchers and policy developers. It is because having a permanent or temporary effect on the variables has crucial importance in terms of

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policies to be implemented. In the literature, unit root test procedures have been utilized to see the effects of the shocks on macroeconomic variables. Unit root test procedures have been developed first in linear time series analysis by Fuller [1976], Dickey and Fuller [1979, 1981], and Nelson and Plosser [1982]. Following those tests, many other tests such as Phillips and Perron [1988], Kwiatkowski et al. [1992], Elliot et al. [1996], Ng-Perron [2001] constitute the basis of unit root literature. However, Perron [1989] points out that test results will be the non-rejection of the null hypothesis and biased when the existing structural breaks are ignored in the unit root tests. Subsequent to the contribution of Perron [1989], unit root tests with single and double breaks, such as Zivot and Andrews [1992], Perron and Vogelsang [1992], Lumsdaine and Papell [1997], Clemente et al. [1998], Lee and Strazicich [2003], Carrion-i Silvestre and Sanso [2007], Narayan and Popp [2010], Lee and Strazicich [2013], have been proposed in the literature. Nevertheless, nonlinear time series analysis has been remarkable attention as a result of the acceleration of technological and scientific progression to overcome the encountered problems in linear time series analysis.

In this study, we apply Kapetanios et al. [2003] (also known as KSS test), Sollis [2009] and Kruse [2011] nonlinear unit root tests based on the smooth transition autoregressive methodology after testing the linearity of the series with Harvey and Leybourne [2007] and Harvey et al. [2008]. On the other hand, Becker [2006] highlights that there is no possibility to know the form of breaks in reality. Thus new approaches have been suggested to literature in the light of the Becker [2006]'s paper. In recent years, the Fourier approach has been mostly used in modelling structural breaks in unit root tests. Christopoulos and Leon-Ledesma [2010] have proposed a new test procedure that models the structural breaks through the Fourier approach and models the nonlinearity through the smooth transition autoregressive (STAR) model. Guris [2018] has developed a new test based upon the test proposed by Christopoulos and Leon-Ledesma [2010]. In the new test, Guris [2018] considers the Kruse [2011] test to model the nonlinear adjustment and considers the Fourier approach to model the structural breaks. In this test, it is found that the power of the test is greater than Kruse [2011] and KSS [2003] tests, especially for the small sample.

The objectives of the study are first to evaluate the mentioned nonlinear unit root tests and, in the application part, as a second objective, to test the effects of the transitory shocks on unemployment rates of female and male graduates in Turkey in 1988-2013. Unemployment which leads to economic and social problems in a country is one of the main problems in Turkey along with the other major problems such as poverty and income inequality. The effect of the transitory shocks on unemployment is examined via Natural Unemployment Rate (NAIRU) and Unemployment Hysteresis Hypothesis. If transitory shocks in the economy have not permanent effect on the unemployment rate, Unemployment Hysteresis Hypothesis developed by Blanchard and Summers [1986] will not be valid. Identifying the impact of the transitory shocks on unemployment is a critical issue

to develop the policies to finding solutions for this problem. Our contribution here is that, as far as we know, this study is the first study which applies different nonlinear unit root tests along with the new test proposed by Guris [2018] to test the unemployment hysteresis hypothesis for female and male graduates in Turkey.

The rest of the study is organized as follows: The method is examined in the second section. Empirical data are defined in the third section. Results are given in the fourth section and finally, the summary of the study is presented in the fifth section.

METHOD

In the nonlinear time series analysis, unit root tests have been attracted attention in recent years. In the literature, there is seen that linear time series analysis is mostly used by many researchers due to the ease of application and interpretation. However, new methods have begun to emerge simultaneously with the technological and scientific developments to overcome the following problems. The encountered problems in the linear unit root tests can be listed as follows:

- A priori knowledge is needed for the date, number, and functional form of breaks.
- Dummy variables are employed to account for breaks which assumed to be instantaneous.
- If the data show a nonlinear aspect, linear unit root tests will face a power problem. Furthermore, unit root test results will be the non-rejection of the null hypothesis and biased with that problem.

At that point, nonlinear time series models have been started to develop and many unit root tests have been proposed into the literature. In the traditional linear unit root tests, structural breaks are modelled by dummy variables in which instantaneous changes are assumed. However, structural breaks can occur in a smooth structure at a time of period. Hence STAR models introduced by Chan and Tong [1986] are developed by Terasvirta [1994]. In this second approach considered the existence of the nonlinear dynamics, the transition between regimes is formed through a transition function which models the nonlinear adjustment thanks to the exponential smooth transition autoregressive (ESTAR) process or logistic smooth transition autoregressive (LSTAR) process [Terasvirta 1994]. The first nonlinear unit root test proposed by KSS [2003] is considered as a nonlinear version of the Augmented Dickey-Fuller (ADF) test. The purpose of the test is to put forth a testing procedure to specify the presence of nonstationary against a nonlinear ESTAR process, which is globally stationary.

The KSS test procedure considered the ESTAR model can be shown as follows:

$$\Delta y_t = \phi y_{t-1}.\left[1 - e^{-\theta(y_{t-1}-C)^2}\right] + \varepsilon_t, \quad (1)$$

where $\varepsilon_t \sim iid(0, \sigma^2)$. In Equation 1, c is assumed to be zero and the following equation is created.

$$\Delta y_t = \phi y_{t-1}.\left[1 - e^{-\theta(y_{t-1})^2}\right] + \varepsilon_t. \quad (2)$$

In Equation 2, the unit root null hypothesis, $H_0: \theta = 0$, is tested against nonlinear ESTAR process, $H_1: \theta > 0$. However, Equation 3 based on the Taylor series approximation is suggested since testing the null hypothesis directly is not feasible in Equation 2 [Kapetanios et al. 2003].

$$\Delta y_t = \delta y_{t-1}^3 + \sum p_j \Delta y_{t-j} + \varepsilon_t. \quad (3)$$

In Equation 3, the null hypothesis supposed to be rewritten as $H_0: \delta = 0$ and the alternative hypothesis can be rewritten as $H_1: \delta > 0$.

In the Kapetanios et al. [2003]'s paper, critical values of the t-statistics are given for three cases referred to the model with the raw data, the de-meaned data and the de-trended data. Following the KSS test, Sollis [2009] has proposed a new unit root test to test the unit root null hypothesis from the extended version of the KSS test. Symmetric or asymmetric stationary ESTAR nonlinearity is defined under the alternative hypothesis from this extended test, unlike the KSS test. The extended ESTAR process is as follows:

$$\Delta y_t = \phi_1 y_{t-1}^3 + \phi_2 y_{t-1}^4 + \sum_{i=1}^{k} k_i \Delta y_{t-i} + \eta_i. \quad (4)$$

In Equation 4, in the case of the rejection of the unit root hypothesis, $H_0: \phi_1 = \phi_2 = 0$, the symmetric hypothesis, $H_0: \phi_2 = 0$, will be tested against the asymmetric alternative hypothesis, $H_1: \phi_2 \neq 0$.

F-test statistics and critical values for the zero mean, non-zero mean and deterministic trend cases are specified in the Sollis [2009]'s paper to test the hypothesis.

Kruse [2011] has proposed a new test to test the unit root hypothesis, $H_0: \phi_1 = \phi_2 = 0$, against a globally stationary ESTAR process, $H_1: \phi_1 < 0,\ \phi_2 \neq 0$. The following model is considered as a development version of the KSS test.

$$\Delta y_t = \phi_1 y_{t-1}^3 + \phi_2 y_{t-1}^2 + \sum_{i=1}^{k} \rho_i \Delta y_{t-i} + u_t. \quad (5)$$

Kruse [2011] implements the methods of Abadir and Distaso [2007] to derive a modified Wald test. However, in the nonlinear unit root tests, there is considered that the form of the breaks is known although there is not possible to know the form of breaks, break date and numbers in reality [Becker et al. 2004, 2006]. In this respect, the Fourier approach is one of the approaches to answer the question of how the structural breaks should be modelled. Advantages of the Fourier approach can be listed as follows:

- The ability to accurately capture unknown structural fractures since the usage of the dummy is not adequate to capture the breaks.
- Suitable for unknown structural break dates.

- Suitable for unknown number of breaks.

Fourier approach can be described as follows:

$$y_t = \delta_0 + \delta_1 \sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \cos\left(\frac{2\pi kt}{T}\right) + v_t, \quad (6)$$

k – optimal frequency,

t – trend,

T – sample size.

Christopoulos and Leon-Ledesma [2010] have proposed a new unit root test procedure by combining the Fourier approach and nonlinearity. In the first stage, Fourier form is applied to capture the structural breaks and in the second stage, KSS test is applied for the nonlinearity. Besides, in this study, we use the Fourier Kruse test proposed by Guris [2018]. In this new test, nonlinearity is modelled by the ESTAR model as proposed in the Kruse [2011] test (Equation 5) and structural breaks are modelled by Fourier function (Equation 6).

EMPIRICAL DATA

The data we used in the study is obtained by Turkish Statistical Institute (TUIK) for the period 1988-2013[2]. The unemployment data are divided into two groups as female and male graduates. Unemployed can be defined as people who are without work within the reference period but seeking employment for the last 3 months and who are available to work in 2 weeks[3]. Unemployment rate refers to the ratio of the unemployed population into the labour force.

Descriptive statistics presented in Table 1 can be summarized as follows:

- The mean of the unemployment rate of female graduates is 12.7% while the mean of the unemployment rate is 7.1% for male graduates.
- The median of the unemployment rate of female graduates is 12.6% although the median of the unemployment rate of male graduates is 7.0%.
- The maximum unemployment rate of female graduates is 17.6% while the maximum rate of male graduates is 9.8%.
- The minimum unemployment rate of female graduates is 8.1% while the rate is 5.3% for male graduates.
- The standard deviation is 2.8% for female graduates while the standard deviation is 1.3% for male graduates.

[2] The period is chosen depending on the availability of the dataset.

[3] The definition was revised in 2014 by TUIK as people who are seeking employment for the last 2 months instead of 3 months but the data we employ here is for the years before 2014.

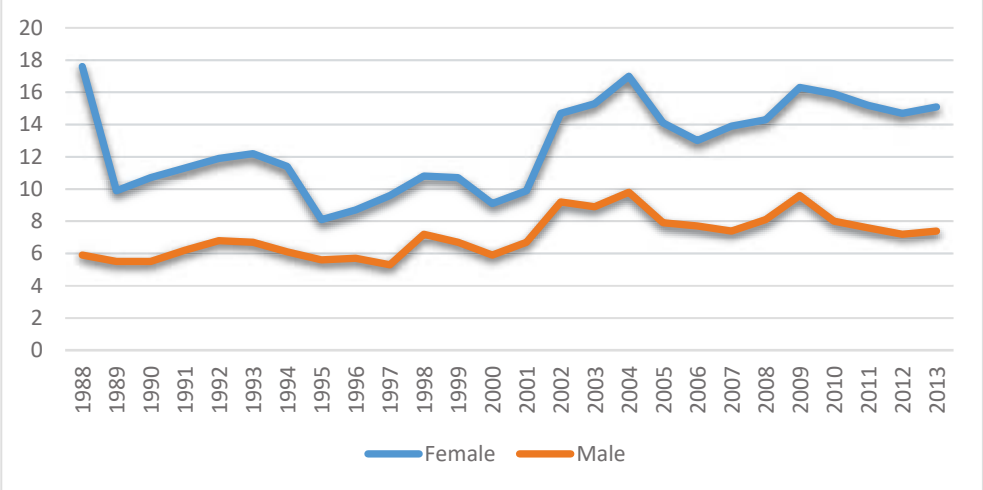
Table 1. Descriptive statistics of unemployment rates of female and male graduates

Variables	Mean	Median	Maximum	Minimum	Std. Dev.
Female	12.7	12.6	17.6	8.1	2.8
Male	7.1	7.0	9.8	5.3	1.3

Source: own calculations

Unemployment rates for female and male graduates are represented in Figure 1 with the blue- and orange-colored line, respectively. According to Figure 1, the highest unemployment rate for female is seen in 1988 with 17.6% while the highest rate for male is seen in 2004 with 9.8%. The second highest rate is obtained in 2004 for female with 17.0% and in 2010 for male with 9.6%. The lowest unemployment rate for female graduates is observed in 1995 with 8.1% while the lowest rate for male graduates is observed in 1997 with 5.3%.

Figure 1. Unemployment rates of female and male graduates (%)



Source: own preparation

RESULTS

In the first step of the analysis, we run the Harvey et al. [2008] and Harvey and Leybourne [2007] tests to test the linearity of the series. In Table 2, we see the results of the tests. According to Harvey et al. [2008] test results, the null hypothesis of linearity is rejected for female at the level of 1% and the male at the level of 5%. Harvey and Leybourne [2007] test results display that the linearity is rejected for both series at the level of 5%.

Table 2. Linearity test results

	Harvey et al. (2008)	Harvey and Leybourne (2007)		
Variables		%1	%5	%10
Female	16.25	10.62	10.47	10.39
Male	6.42	12.91	12.77	12.68

Note: The critical value for Harvey et al. (2008) test is 9.21 at the level of 1%; 5.99 at the level of 5%; 4.60 at the level of 10%. The critical value for Harvey and Leybourne (2007) test is 13.27 at the level of 1%; 9.48 at the level of 5%; 7.77 at the level of 10%.

Source: own calculations

In Table 3, we reject the unit root null hypothesis at the 1% level of significance for female and the 5% level of significance for male. The rejection of the null hypothesis reports that series are stationary which means hysteresis hypothesis is not valid for female and male graduates.

Table 3. KSS [2003] unit root test results

Variables	Lags	Akaike Criterion	KSS Test Stat	Tau Critical Values	
Female	0	3.971	-4.023***	%1	-3.48
Male	0	2.545	-2.951**	%5	-2.93
				%10	-2.66

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively. Minimum Akaike criterion is chosen during the estimation process in the model automatically.

Source: own calculations

In Table 4, we reject the null hypothesis at the 10% level of significance only for male graduates. For female, the non-rejection of the null hypothesis means that the hysteresis hypothesis is valid according to Sollis [2009] test results.

Table 4. Sollis [2009] unit root test results

	Lags	Akaike Criterion	Sollis Test Stat	Critical Values	
Female	1	3.765	2.991	%1	6.89
Male	0	2.616	4.328*	%5	4.88
				%10	4.00

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively. Minimum Akaike criterion is chosen during the estimation process in the model automatically.

Source: own calculations

As shown in Table 5, null hypothesis of the unit root is rejected at the 1% level of significance for female and at 10% significance for male. The rejection of

the unit root refers that series are stationary and thus, hysteresis hypothesis is not valid for both female and male graduates.

Table 5. Kruse [2011] unit root test results

	Lags	Kruse Test Stat	Critical Values	
Female	0	19.313***	%1	13.75
Male	0	9.549*	%5	10.17
			%10	8.60

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively.

Source: own calculations

Christopoulos and Leon-Ledesma [2010] test results in Table 6 show that the null hypothesis of unit root is rejected at the 5% level of significance only for female. However, the null hypothesis of unit root is not rejected for male which means that the hysteresis hypothesis is valid for male.

Table 6. Christopoulos and Leon-Ledesma [2010] unit root test results

	Lags	Test Stat	Critical Values k=1	
Female	0	-3.943**	%1	-4.14
Male	0	-2.908	%5	-3.59
			%10	-3.26

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively.

Source: own calculations

In Table 7, Güriş [2018] test results indicate that the null hypothesis of unit root is rejected at the 5% level of significance for both female and male graduates. Hysteresis hypothesis is not valid considering the test results given in Table 7.

Table 7. Güriş [2018] unit root test results

	Lags	Test Stat	Critical Values k=1	
Female	1	19.094**	%1	20.32
Male	1	17.364**	%5	14.72
			%10	12.32

Note: The signs of ***,** and * refer that the unit root hypothesis is rejected at the level of 1%, 5% and 10%, respectively.

Source: own calculations

KSS [2003], Kruse [2011], Christopoulos and Leon-Ledesma [2010] and Güriş [2018] test results report that the unit root hypothesis is not valid for female graduates for the period of 1988-2013. In addition, the null hypothesis is rejected for male graduates as a result of the KSS [2003], Sollis [2009], Kruse [2011] and Güriş [2018] tests.

SUMMARY

In the nonlinear time series analysis, unit root tests have been popular to identify the effects of the shocks on macroeconomic variables which show a nonlinear property. In this study, we applied three different unit root tests, KSS [2003], Sollis [2009] and Kruse [2011] based on the STAR model. However, as a result of the acceleration of technological or/and scientific development, new approaches are needed to resolve the problems we face in our analyses. The Fourier approach is seen as one of the alternative ways by scientists since it gives powerful results compared to traditional unit root tests. In other words, in the traditional unit root tests, the real problem occurs when we try to identify the time, number and form of the break since in reality, it is not possible to identify them. For this reason, we employed two different nonlinear unit root tests with Fourier approach, Christopoulos and Leon-Ledesma [2010] and Güriş [2018], in order to improve the reliability of the results.

In the application part, nonlinear unit root tests utilized to test the hysteresis hypothesis for female and male graduates in Turkey. The data for unemployment rates of female and male graduates conducted by TUIK are used for that purpose. The data remark that the highest gap in unemployment rates of female and male graduates is seen in 1988 while the lowest gap is observed in 1995 when the unemployment rate of female graduates is very close to the unemployment rate of male. Applied tests, KSS [2003], Sollis [2009], Kruse [2011], Christopoulos and Leon-Ledesma [2010] and Güriş [2018], report that unemployment hysteresis hypothesis is not valid for female and male graduates. It means that the shocks in the economy have a temporary effect on unemployment rates. Besides, it is expected that unemployment rates will be back to its mean in the long run after showing an increasing trend. For future work, it is important to work with extended data taken different education categories into account. Additionally, it is also important to include different countries into the study to make a comparison.

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