THE UNEMPLOYMENT HYSTERESIS ANALYSIS FOR TURKEY

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ABSTRACT

TESTING FOR THE UNEMPLOYMENT HYSTERESIS IN TURKEY

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This study tests for hysteresis of unemployment for Turkey over the period of January 2005 – May 2013. Allowing for the business cycle asymmetry of unemployment, with steep increases during recessions, followed by more gradual declines during expansions, we employ the threshold autoregressive (TAR) type unit root test of Caner and Hansen (2001). The empirical findings reveal that the nonlinear unit root test provides strong evidence in favour of the natural rate hypothesis while the standard linear unit root tests fails to do so.

Keywords: Unemployment rate, natural unemployment rate, hysteresis hypothesis, threshold autoregressive (TAR) model

ÖZ

TÜRKİYE İÇİN İŞSİZLİK HİSTERİSİ ANALİZİ

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Bu çalışma Ocak 2005 – Mayıs 2013 dönemi için Türkiye'deki işsizlik histerisini test etmektedir. İşsizliğin konjontürel dalgalanma asimetrisine, durgunluk dönemindeki hızlı artışlar ve bunu takiben genişleme döneminde daha aşamalı azalma ile izin verilerek, Caner ve Hansen'in (2001) eşik otoregresif modeli kullanılmıştır. Amprik sonuçlar standart lineer birim kök testleri başarısız olurken nonlineer birim kök testinin doğal işsizlik oranı lehine önemli deliller sağladığını ortaya koymuştur.

Anahtar Kelimeler: İşsizlik oranı, doğal işsizlik oranı, hiseri hipotezi, eşik otoregresif (TAR) model

To My Family

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey Fuller
ESTAR	Exponential Smooth Transition Autoregressive
LSTAR	Logistic Smooth Transition Autoregressive
PP	Phillips-Perron
TAR	Threshold Autoregressive
STAR	Smooth Transition Autoregressive

CHAPTER 1

INTRODUCTION

Over the last century, the unemployment rate, one of the most important social and economic indicators for economies, has been discussed considerably within different perspectives. Among these discussions, nonlinearity of unemployment rate caused by business cycles effects becomes prominent. Especially after oil shocks in 1970s, the growing body of research, such as Neftçi (1984), Rothman (1988), Luukkonen and Teräsvirta (1991), Burgess (1992), Andolfatto (1997), Bodman (1998), Peel and Speight (1998, 2000), Koop and Potter (1999), Skalin and Teräsvirta (2000), Caporale and Gil-Alana (2007) and Cancelo (2007) concentrate on the fact that the unemployment rate exhibits an asymmetric behavior due to business cycle effect. It can be said that the periodic structure of business cycles suggests that significant asymmetries are present over different phases of the cycle (Bodman, 1998). In particular, while the unemployment rate increases sharply in recession period, it decreases gradually in expansion period. That means the unemployment rate displays a nonlinear pattern when business cycles effects are considered.

The above-mentioned nonlinearity of unemployment rate is one direction of the unemployment rate discussions and the stationarity is another main discussion subject on unemployment rate. Within the stationarity context, in the last two decades, two main theories, natural rate and hysteresis hypotheses come to the forefront. The natural rate hypothesis support the stationarity process for the unemployment rate, while the hysteresis hypothesis emphasizes a persistency of shocks.

Early studies examining the stationarity of unemployment rate use the standard unit roots tests, which do not allow for nonlinearity. However, with the nonlinearity approach taken into consideration as a result of business cycle effect, the recent literature mainly focuses on the unit root tests allowing for nonlinearity in OECD countries such as Gustavsson and Österholm (2006), Wei (2007), Lin et al. (2008), Lee (2010), Chang and Lee (2011) and Chou and Zhang (2012).

In Turkey, there are several studies conducted to analyze the hysteresis and natural rate hypotheses.[1] All of these studies, except Güloğlu and İspir (2011), find the empirical support for the existence of unemployment hysteresis in Turkey using standard unit root tests and structural break tests. However, during the process of stationarity test, they do not consider the nonlinearity simultaneously. Therefore, we aim to examine the unemployment rate stationarity in Turkey by taking the possibility of nonlinearities in the unemployment rate into account. Within this framework, this study analyses the empirical validity of the natural rate hypothesis for Turkish unemployment rate over the sample period of January 2005 – May 2013. And, in accordance with the purpose of considering nonlinearity as well, we employ the threshold autoregressive (TAR) unit root test, one of the nonlinear unit root tests proposed by Caner and Hansen (2001), which mainly provides a chance to study with the joint consideration of nonstationarity and nonlinearity. As a result, main contribution of this study is that utilizing the TAR-type unit root test developed by Caner and Hansen (2001) gives an opportunity to discuss the hysteresis hypothesis for Turkey by analyzing the nonlinearity and nonstationarity simultaneously, which has not been studied for Turkish unemployment rate so far.

Our empirical findings reveal that the standard Augmented Dickey Fuller (ADF) and Phillips-Peron (PP) unit root tests fail to reject the unit root null hypothesis. Although the standard unit root tests point to the existence of hysteresis hypothesis for the sample period in Turkey, the TAR-type unit root test of Caner and Hansen

[1] Küçükkale (2001), Pazarlıoğlu and Çevik (2005, 2007), Barışık and Çevik (2008), Güloğlu and İspir (2011), Koçyiğit, Tüfekçi and Bayat (2011) and Gözgör (2012)

(2001) supports the natural unemployment rate in Turkey for the same period by taking nonlinearity simultaneously into account.

This study is organized as follows; Chapter 1 briefly introduces the study, Chapter 2 reviews the theoretical and empirical literature of the hysteresis hypothesis and the natural rate of unemployment, Chapter 3 presents the data, Chapter 4 describes the Caner and Hansen's (2001) TAR model, Chapter 5 discusses the empirical results with preliminary analysis and finally Chapter 6 concludes the study.

CHAPTER 2

LITERATURE REVIEW

In twentieth century; since, the unemployment rate affects the economy from different aspects; it has been one of the most challenging research topics in economy. Therefore, it has been discussed considerably within different perspectives over the last century. Especially, after 1970's due to the first oil shock effect, unemployment rates increase all over the world and this cause an increase the number of studies trying to understand how the unemployment rate behaves. Among these studies, especially two different theories, the natural rate and hysteresis hypotheses, came into prominence.

The former theory, known as the natural rate of unemployment, was proposed by Friedman (1968) and Phelps (1967, 1968). The hypothesis of natural rate of unemployment characterizing unemployment rate dynamics as a mean reverting process is based on the equilibrium of unemployment rate (Lee and Chang, 2008). According to both Friedman and Phelps, the unemployment rate follows a stationary process and therefore the shock that occurs in labor market has a temporary effect on the unemployment rate. So, in this theory, the main idea is that the unemployment rate is converging to its equilibrium rate in the long run after shock. A consequence of this situation is that in the long run, unemployment tends to a steady state or to an equilibrium value, which is called "natural rate" of unemployment (Christopoulos and Leon-Ledesma, 2007).

The second theory is called as the hysteresis hypothesis. The hysteresis idea in unemployment was firstly put forward by Blanchard and Summers, in 1986. The word of hysteresis refers the situation where equilibrium is "path dependent"

(Blanchard and Summers, 1986). That means hysteresis reflects the effect of history of actual unemployment rate to its equilibrium rate. In other words, the natural rate is influenced by the path of actual unemployment (Ball, 2009). Therefore, the term hysteresis denotes a situation where transitory shocks may have permanent effects on the unemployment rate (Roed, 1997). So, the idea of hysteresis includes the persistence effects of shocks. The presence of persistence means that shocks to unemployment rates have long durations (Mitchell, 1993).

According to Blanchard and Summers (1986), the hysteresis hypothesis is embodied in two directions; membership theories and duration theories. In membership theory, called insider – outsider theory, explores the idea that wage setting is generally determined by firms' incumbent workers rather than by the unemployed. Because of the fixed costs of hiring new worker and the walkout threat of insiders, firms hire workers from other firms. Since, this situation does not represent an increase in current employed person, the persistence of unemployment rate occurs. Hence, it can be seen that the unionization has positive effect on persistence among economies that lack a centralized structure of labor bargaining (Barro, 1988).

The second direction in Blanchard and Summers' hysteresis theory is the duration theories, which are based on the distinction between short term and long term unemployed, and explore the idea that the long term unemployed exerts the pressure on wage setting. Since the atrophy of skills and discouragement of the long term unemployed, they have less influence on wage settings than short term unemployed.

Hence, hysteresis and natural rate theories are respectively associated with non-stationarity and stationarity of unemployment rate; studies have been focused on the unit root tests to discriminate between these competing theories.[2] In other words, the basic approach of testing these two main competing theories is actually testing for

[2] Hysteresis hypothesis indicates that the unemployment rate has a unit root, so it follows the I(1) process, while the natural rate hypothesis follows the I(0) process.

the stationarity of unemployment rate. To test for stationarity, the empirical literature utilizes different type of unit root tests. First group (majority) of studies applies the standard univariate unit root tests, such as Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), Phillips and Perron (PP) and, Kwaitowski, Phillips, Schmidt and Shin (KPSS) tests. To examine the stationarity of the unemployment rate, Blanchard and Summers (1986), Brunello (1990), Neudorfer et al. (1990) and Jaeger and Parkinson (1991) employ the conventional unit root tests in their studies. Despite diversity of country characteristics and unemployment experience, these studies find empirical evidences in favor of hysteresis in Europe and Japan. Only Blanchard and Summers (1986) report stationarity for the United States.

One common criticism of the ADF and PP tests is that they have low power against local alternatives in small samples (Song and Wu, 1997). Additionally, the conventional unit root test does not allow for possible structural breaks. Therefore to increase the power of tests, second group of studies consider the structural breaks in the time path of unemployment rate. Mitchell (1993), Roed (1996), Arestis and Mariscal (2000), Papell et al. (2000), Clemente et al. (2005), Lee and Chang (2008) and Gustavsson and Österholm (2010) utilize the unit root test considering the structural breaks such as Zivot-Andrews (ZA) test, Lagrange Multiplier (LM) univariate unit root test. While considering the structural breaks, some of the results are similar with the standard unit root test and moreover, for some countries, there are more serious results in favor of hysteresis.[3] On the other hand, majority differs from former empirical findings and provides significant evidence that the unemployment rate presents stationarity when the structural breaks are considered.[4] These results also show that the unit root tests allowing for structural breaks have

[3]Gustavsson and Österholm (2010) find stronger evidence for hysteresis in Austria, Finland, Iceland, Israel, Italy, Japan and Sweden.

[4]Arestis and Mariscal (2000), Papell et al. (2000) and Lee and Chang (2008) examine the hysteresis hypothesis for some OECD countries and even they cannot reject the unit root for all countries, they reject the unit root for mostly countries as well. So, second group of tests have the greater ability than standard unit root tests to reject a unit root null for some OECD countries when they consider the breaks.

more power than the conventional unit root tests to reject the unit root null hypothesis.

Before considering the nonlinearity, the last group of studies examines the hysteresis hypothesis within a panel data framework. Song and Wu (1997, 1998), Leon-Ledesma (2000), Johansen (2002), Smyth (2003), Camarero and Tamarit (2004), Chang et al. (2005), Camarero et al. (2006), Christopoulos and Leon-Ledesma (2007), Mohan et al (2007), Lee et al. (2010), Cheng et al. (2011), Ener and Arıca (2011) and Gözgör (2013) employ panel unit root tests. These studies, however, do not provide an inconclusive result for the integration order of the unemployment rate.

In the literature discussed above, empirical studies are generally based on the assumption of linearity of unemployment rate. In fact, the empirical supports for the nonlinearity of unemployment are presented by Neftçi (1984), Rothman (1988), Sichel (1989), Luukkonen and Teräsvirta (1991), Burgess (1992), Andolfatto (1997), Bodman (1998), Peel and Speight (1998, 2000), Koop and Potter (1999), Skalin and Teräsvirta (2000), Caporale and Gil-Alana (2007) and Cancelo (2007). As a result, the unemployment can display nonlinear behavior due to business cycles or some idiosyncratic factors specific to the labor market (Cancelo, 2007). According to these empirical literatures, since the existence of business cycle creates an asymmetry in the unemployment rate behavior, the economy behaves differently during expansion and recession periods. In other words, while the unemployment rate increases sharply in recessions, then it decreases slowly in the expansion periods.

As mentioned above, a cyclical asymmetry creates nonlinearity; therefore it cannot be represented by linear models. Within this framework, in the last three decades, several models have been suggested to capture possible nonlinearities. In applied literature, threshold autoregressive (TAR) models put forward by Tong (1983) and smooth transition autoregressive (STAR) models presented by Teräsvirta (1994) outstand among other nonlinear models. TAR model can be described as a set of different linear AR model changing according to value of the threshold variable relative to fixed threshold. That means although process of each regime is linear, regime switching creates a nonlinearity for whole process. And, if the discontinuity of the threshold is replaced by a smooth transition function, the TAR model can be generalized to the smooth transition autoregressive (STAR) model (Hansen, 1997). So, in STAR model, there is a smooth transition function instead of the fixed threshold. According to the choices for the transition function, there are two types of STAR model: the logistic STAR (LSTAR) and the exponential STAR (ESTAR) models. The main difference between LSTAR and ESTAR models is based on the dynamics of periods. In LSTAR model, dynamics of expansion and contraction periods are different. However, an ESTAR model has three periods including expansion and contraction periods having similar dynamics structure and a middle ground having different dynamic as well. Hence, recent researchers such as, Rothman (1991), Hansen (1997), Montgomery et al. (1998), Koop and Potter (1999), Skalin and Teräsvirta (2000), Caner and Hansen (2001) and McHugh et al. (2002), Dueker et al. (2010) examine the unemployment rate using TAR, STAR, LSTAR and ESTAR nonlinear models to capture its nonlinearity.

It is well known that the standard unit root tests, such as the ADF and PP tests might have a low power when the unemployment rate displays a nonlinear behavior (Lee, 2010). To capture the possible nonlinearity, in applied literature, nonlinear type of unit root tests are developed by Enders and Granger (1998) and Caner and Hansen (2001) for TAR model and by Kapetanios et al. (2003) for ESTAR model. Therefore, the recent literature analyzing the hysteresis hypothesis is mainly focused on these unit root tests, which allow for nonlinearity. Within this framework, Gustavsson and Österholm (2006), Wei (2007), Lin et al. (2008), Ghosh and Dutt (2008), Lee (2010), Chang and Lee (2011) and Chou and Zhang (2012) employ the nonlinear unit root tests discussed above and nonlinear panel unit root tests to examine the hysteresis hypothesis in unemployment. These papers mostly provide evidence for the stationarity for sample countries' unemployment. According to these results, it can be said that the unit root tests allowing for nonlinearity have more power to reject the null hypothesis than the standard unit root tests.

In Turkey, the first study related to the hysteresis hypothesis and natural unemployment rate is provided by Küçükkale (2001). Küçükkale examines the hysteresis hypothesis by using the Kalman-Filter technique, which commonly uses to estimate the time varying regressions efficiently, with the annual data for the period of 1950 - 1995. Then, Pazarlıoğlu and Çevik (2005, 2007) analyze the Ratchet effect[5] on Turkey's unemployment rate by using Ratchet model in two studies for the periods of 1984 - 2004 and 1923 - 2005. In both papers, they find an upward Ratchet effect in the unemployment rate, so the hysteresis hypothesis is accepted for the sample periods.

Another analysis for Turkey is provided by Barışık and Çevik (2008). Barışık and Çevik employ the standard unit root tests, structural break tests (Zivot Andrews (ZA) and Bai-Peron) and long memory model for the period of 1923 - 2006 and find the hysteresis effect on Turkey's unemployment rate like previous analyses. In 2009, Yılancı examines the unemployment hysteresis for Turkey over the period of 1923 - 2007 by using Perron, ZA, Lumsdaine-Papell and LM unit root tests, which allow for structural breaks, and the hysteresis hypothesis is found as well. In 2011, the hysteresis hypothesis is examined by Güloğlu and İspir (2011) using the panel unit root tests for the period of 1988 - 2008 and by Koçyiğit, Tüfekçi and Bayat (2011) using the STAR model for the period of 1923 - 2010. Finally, Gözgör (2012) examines the hysteresis in regional unemployment rates for the period 2004 – 2012 by using panel unit root tests. Except Güloğlu and İspir[6] (2011), all of these studies done for Turkey's unemployment rate conclude with the empirical support for the unemployment hysteresis in Turkey.

[5]Ratchet effect is described as one side effect. In case of the unemployment rate, changes can occur in both sides in the short run. But in the long run if there is a one-side increase or decrease in the unemployment rate, this can be considered the Ratchet effect on the unemployment rate (Pazarlıoğlu and Çevik, 2005, 2007).

[6]According to Güloğlu and İspir (2011), the time series and panel unit root test which do not considering the structural breaks, reject the natural rate hypothesis while the panel unit root test considering structural breaks confirms the natural rate of unemployment in Turkey for the sample period.

This study aims to investigate the empirical validity of the natural rate hypothesis for Turkish unemployment rate over the period of January 2005 – May 2013. Similar to the most recent studies in the literature, to capture the nonlinearity of unemployment rate, we utilize the TAR-type unit root test of Caner and Hansen (2001). Also, it should be stated that STAR type of unit root tests are not selected in our analyzing. Because, the ESTAR model cannot completely capture the nonlinear dynamics of unemployment since expansion and contraction periods in ESTAR models have same dynamics and on the other hand, the LSTAR type of unit root test is in progress. Therefore, the TAR type unit root test is selected for testing. Additionally, the main advantage of this approach is that it enables a unit root testing procedure, which allows simultaneous examination of nonlinearity and nonstationarity. Moreover, it is known that the power of the test is substantially higher than the standard ADF test in the presence of nonlinearity (Ghosh and Dutt, 2008). Within this framework, our study differs from the existing studies for Turkey that we account not only for nonstationarity but also possible nonlinearity in the unemployment rate.

CHAPTER 3

DATA

To analyze the hysteresis hypothesis in Turkey, this study utilizes monthly seasonally adjusted data of Turkey's unemployment rate, which considers both males and females over the age of 15. The monthly series covering the period of January 2005 - May 2013 are obtained from the Turkish Statistical Institute (TSI) database. Since monthly unemployment data of Turkey is available only after January 2005, 2005 is selected as the starting date.

A plot of the series is provided in Figure 1. Although a visual inspection of the plot does not reveal clear evidence for stationarity of the Turkish unemployment rate, it is obvious that with the effect of the recent economic crisis, in the beginning of second half of 2008, the unemployment rate starts to increase and reaches to the record level 15.0% on April 2009. Then, its reversion to the prior level is possible on February 2011. This fluctuation indicates that the unemployment rate increases sharply in recessions and then slowly decline to its prior level in expansions. In other words, the decrease in unemployment rate is not rapid as its increases. This can be considered as a reason of the nonlinearity, which may be caused by the business cycle effect. And, afterwards it decreases to the minimum level 8.9% on June 2012, for the period of January 2005 – May 2013.

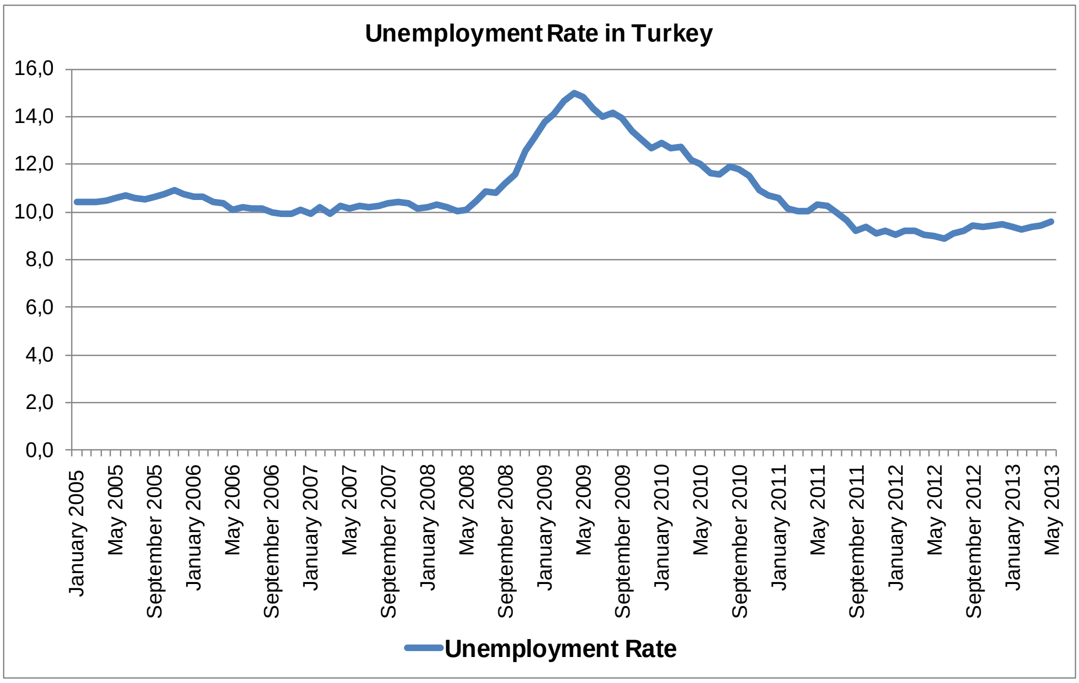

Figure 1: Unemployment rate over the period 2005:1 to 2013:05. (Source: Turkish Statistical Institute, Data: Males and females over the age of 15)

CHAPTER 4

METHODOLOGY

In this study, we investigate the unemployment hysteresis in Turkey by using the TAR-type unit root test of Caner and Hansen (2001).

In general, TAR model developed by Tong (1978) has been a significant effect on economic literature. Tong (1983, 1990), Chan (1991, 1993), Chan and Tsay (1998) and Hansen (1996, 1997, 2000) are among the papers to contribute the TAR model as well. But in all of these papers, the important maintained assumption is that the data is stationary and has no unit root (Caner and Hansen, 2001). So, they test for the nonlinearity under the assumption of stationarity. Therefore, it is not possible to discriminate nonstationarity from nonlinearity. Within this framework, Caner and Hansen's paper (2001) is the first paper to distinguish nonstationarity from nonlinearity. For this reason, Caner and Hansen (2001) suggest the Wald tests for the threshold effect (for nonlinearity) and Wald and t tests for unit roots (for nonstationarity).

The model introduced by Caner and Hansen (2001) is a TAR process defined as:

$$\Delta y_t = \boldsymbol{\theta}_1' \boldsymbol{x}_{t-1} I_{\{Z_{t-1}<\lambda\}} + \boldsymbol{\theta}_2' \boldsymbol{x}_{t-1} I_{\{Z_{t-1}\geq\lambda\}} + e_t \,, \tag{1}$$

t = 1,…,T, where y_t is the unemployment rate and $\boldsymbol{x_{t-1} = (y_{t-1} r_t' \Delta y_{t-1} \ldots \Delta y_{t-k})'}$, $I_{\{\,\}}$ is the indicator function, e_t is the iid disturbance term, $Z_{t-1} = y_t - y_{t-m}$ (for some $m \geq 1$)

is the threshold variable with m representing the delay order. $\boldsymbol{r_t}$ is a vector of deterministic components including an intercept and possibly linear time trend.[7] λ represents the unknown threshold value and defined within the interval of $\lambda \in \Lambda = [\lambda_1, \lambda_2]$ where λ_1 and λ_2 are selected according to $P(Z_t \leq \lambda_1) = \pi_1 > 0$ and $P(Z_t \leq \lambda_2) = \pi_2 < 1$ .Since, π_1 and π_2 treat symmetrically, $\pi_2 = 1 - \pi_1$, there is no regime has less than π_1% of the total sample.

The components $\boldsymbol{\theta_1}$ and $\boldsymbol{\theta_2}$ can be shown as follows:

$$\boldsymbol{\theta_1} = \begin{pmatrix} \rho_1 \\ \boldsymbol{\beta_1} \\ \boldsymbol{\alpha_1} \end{pmatrix}, \ \boldsymbol{\theta_2} = \begin{pmatrix} \rho_2 \\ \boldsymbol{\beta_2} \\ \boldsymbol{\alpha_2} \end{pmatrix} \tag{2}$$

where ρ_1 and ρ_2 are scalar, $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ have the same dimension with $\boldsymbol{r_t}$, and $\boldsymbol{\alpha_1}$ and $\boldsymbol{\alpha}_2$ are k-vectors. Additionally, (ρ_1, ρ_2) are the slope coefficients on y_{t-1}, $(\boldsymbol{\beta_1}, \boldsymbol{\beta_2})$ are the slopes on the deterministic components and $(\boldsymbol{\alpha_1}, \boldsymbol{\alpha_2})$ are the coefficients of $(\boldsymbol{\Delta y_{t\text{-}1}} \ldots \boldsymbol{\Delta y_{t\text{-}k}})$ in the two regimes.

Estimation of the model starts with specification of the unknown threshold value, λ. To do that, first, the Equation (1) is estimated by the ordinary least squares (OLS), for each $\lambda \in \Lambda$:

$$\Delta y_t = \hat{\boldsymbol{\theta}}_{\boldsymbol{1}}' \boldsymbol{x_{t\text{-}1}} I_{\{Z_{t-1} < \lambda\}} + \hat{\boldsymbol{\theta}}_{\boldsymbol{2}}' \boldsymbol{x_{t\text{-}1}} I_{\{Z_{t-1} \geq \lambda\}} + \hat{e}_t \ , \tag{3}$$

---

[7] If the series y_t is nontrended, $\boldsymbol{r_t} = 1$, while if the series is highly trended then $\boldsymbol{r_t} = (\boldsymbol{1\ t})'$.

Then, the OLS estimate of σ^2 is obtained for each λ as follows:

$$\hat{\sigma}^2(\lambda) = T^{-1}\sum_{1}^{T}\hat{e}_t(\lambda^2)\,, \tag{4}$$

And, the least squares (LS) estimates of the threshold, $\hat{\lambda}$ is found by minimizing $\hat{\sigma}^2(\lambda)$:

$$\hat{\lambda} = arg\,\min_{\lambda\in\Lambda}\hat{\sigma}^2(\lambda)\,, \tag{5}$$

Then, the LS estimates of other parameters are found by plugging in the point estimate $\hat{\lambda}$, $\hat{\theta}_1 = \hat{\theta}_1(\hat{\lambda})$ and $\hat{\theta}_2 = \hat{\theta}_2(\hat{\lambda})$. And, the estimated model can be written as follows:

$$\Delta y_t = \hat{\boldsymbol{\theta}}_{\boldsymbol{1}}'\,\boldsymbol{x}_{\boldsymbol{t-1}}I_{\left\{Z_{t-1}<\hat{\lambda}\right\}} + \hat{\boldsymbol{\theta}}_{\boldsymbol{2}}'\,\boldsymbol{x}_{\boldsymbol{t-1}}I_{\left\{Z_{t-1}\geq\hat{\lambda}\right\}} + \hat{e}_t\,, \tag{6}$$

As mentioned above, the most important contribution of Caner and Hansen's TAR model to the literature is to discriminate nonstationarity from nonlinearity. In this context, Caner and Hansen (2001) use the Wald tests for the threshold effect (for nonlinearity) and Wald and t tests for unit roots (for nonstationarity).

4.1. Testing for the Threshold Effect

It is obvious that nonlinearity disappears under the joint null hypothesis:

$$H_0 : \theta_1 = \theta_2 , \tag{7}$$

The following sup Wald test is used in order to test null of linearity in favor of threshold model:

$$\sup_{\lambda \in \Lambda} W_t(\lambda) = \sup_{\lambda \in \Lambda} T \left(\frac{\hat{\sigma}_0^{\,2}}{\hat{\sigma}^{\,2}} - 1 \right), \tag{8}$$

Where $\hat{\sigma}_0^{\,2}$ is the OLS estimator of the residual variance of the null linear model and $\hat{\sigma}^{\,2}$ is the OLS estimator of the residual variance of the model (6).

Caner and Hansen (2001) indicate that the Wald test defined in (8) has a nonstandard asymptotic null distribution due to possible nonstationarity and existence of nuisance parameter problem. Note that the threshold value, λ is unidentified under the null of linearity. Therefore, the asymptotic distribution of the test statistic is non-pivotal and depends on the nuisance parameters. Indeed, the dependence is so complicated that critical values cannot be directly obtained. In order to account for this problem, Caner and Hansen (2001) propose two bootstrap procedures to approximate the asymptotic distribution of the Wald statistic, one is based on the restriction of a unit root (constrained bootstrap method), and the other depends on the unrestricted estimates (unconstrained bootstrap method). Generally the true order of integration is unknown, so in order to calculate *p*-values, they suggest using both two bootstrap methods, one appropriate for the stationary case and the other appropriate for the unit root case. And the results are determined with the more conservative (the larger) *p*-value.

4.2. Testing for the Unit Root

Since the parameters ρ_1 and ρ_2 control the stationarity of the process y_t, the null hypothesis of a unit root can be written as:

$$H_0 : \rho_1 = \rho_2 = 0 \ , \qquad (9)$$

Under the null hypothesis, the unemployment rate follows an I(1) structure, implying empirical validity of the hysteresis hypothesis. The first and natural alternative of H_0 is

$$H_1 : \rho_1 < 0 \text{ and } \rho_2 < 0 \qquad (11)$$

And, the second alternative of H_0 is

$$H_2 = \begin{cases} \rho_1 < 0 \text{ and } \rho_2 = 0 \\ \qquad \text{or} \\ \rho_1 = 0 \text{ and } \rho_2 < 0 \end{cases} , \qquad (10)$$

While the first alternative hypothesis H_1 indicates stationarity for both regimes, the second one H_2 allows the unemployment rate being non-stationary but not a pure unit root process. More specifically, under H_2, the unemployment rate behaves like a unit root process in one regime, while it behaves like a stationary process in the other regime.

To test and discriminate these cases, Caner and Hansen (2001) propose a different test statistics. The test proposed for H_0 against the unrestricted alternative of $\rho_1 \neq 0$ or $\rho_2 \neq 0$ is

$$R_{2T} = t_1^2 + t_2^2 \ , \tag{11}$$

where t_1 and t_2 are the t ratios for $\hat{\rho}_1$ and $\hat{\rho}_2$ from the OLS regression (6). If the null hypothesis cannot be rejected, then y_t follows the I(1) process so, it has a unit root. However, Caner and Hansen (2001) claim that since the alternatives H_1 and H_2 are one-sided this two-sided Wald statistic (R_{2T}) may have less power than a one sided version and then, they propose the following one-sided Wald statistic (R_{1T})

$$R_{1T} = t_1^2 I_{\left\{\hat{\rho}_1 < 0\right\}} + t_2^2 I_{\left\{\hat{\rho}_2 < 0\right\}}, \tag{12}$$

which is employed to test H_0 against the one-sided alternative $\rho_1 < 0$ or $\rho_2 < 0$. R_{1T} and R_{2T} have power against alternative hypothesis, but they cannot discriminate the stationarity among the regimes, so Caner and Hansen (2001) suggest the individual t statistics, t_1 and t_2. If only one of $-t_1$ or $-t_2$ is statistically significant, this will be consistent with the partial unit root case H_2.[8] Meanwhile, these individual test statistics are able to distinguish between H_0, H_1 and H_2 (in other words between the pure unit root, partial unit root and stationary cases). Since, according to Caner and Hansen (2001), R_{1T} has more power than R_{2T}, the results of R_{1T}, t_1 and t_2 statistics is only reported to examine hysteresis in this study.

[8]To retain the convention that the test rejects for large values of the statistic, Caner and Hansen (2001) consider the negative of the t statistics, $-t_1$ and $-t_2$.

CHAPTER 5

EMPRICAL RESULTS

5.1 Preliminary Analysis

As a preliminary analysis, we employ the most commonly used standard unit root tests, the ADF and PP tests. The ADF and PP tests results together with the corresponding critical values are represented in Table 1. According to these results, we find that the ADF and PP tests both cannot reject the null hypothesis of a unit root at the 5% significance level, so they point to the hysteresis hypothesis for the related period in Turkey.

Table 1: Augmented Dickey Fuller and Phillips - Perron Test Results

	Test Statistic	1% level	5% level	10% level
ADF	-1.635311	-3.501445	-2.892536	-2.583371
PP	-1.451726	-3.497029	-2.890623	-2.582353

Notes: The lag order for the ADF unit root test (lag = 6) has been chosen using the general specific method. The bandwidth for the PP test is determined using the Newey-West automatic bandwidth selection procedure for a Bartlett Kernel.

As it has been mentioned earlier, the standard unit root tests such as ADF and PP tests have low power in case of the nonlinearity and additionally, the TAR model is more favorable to analyze the unemployment rate since, the TAR model can capture dynamics of unemployment rate more than STAR models if considering different dynamics of expansion and recession periods. For these reasons, we employ the

Caner and Hansen's (2001) TAR model to capture and examine properly the nonlinear behavior of the Turkey's unemployment for the related period.

5.2 Caner and Hansen's TAR Model Application

As mentioned before, the aim of this study is to test the existence of unemployment hysteresis in Turkey over the monthly period of January 2005 – May 2013. First, we employ the standard ADF and PP tests as reported in Chapter 3 and, the results reveal that none of these tests can reject the unit root null hypothesis at the 5% significance level. Hence, they point to the hysteresis hypothesis, similar to the previous studies conducted for Turkey, mentioned in Chapter 2. As it is known that standard unit root tests implicitly assume linearity and have low power to detect potential nonlinear stationarity, these results may not be reliable. Therefore, we continue with the TAR-type unit root test of Caner and Hansen (2001), discussed in Chapter 4.

In TAR application, the first issue we need to clarify is whether the unemployment rate follows a nonlinear pattern or not. To test for nonlinearity, the Wald test W_t is employed in accordance with Caner and Hansen's paper (2001) and the test statistics together with the bootstrap critical values are reported in Table 2. According to the results, the null hypothesis of linearity is rejected in favor of TAR-type nonlinearity for all delay parameters, except for $m=1$ and $m=10$. That means the unemployment rate process has two regimes while 70 observations fall first regime, 18 observations fall second regime.

Table 2: Bootstrap Threshold Test (Unconstrained Model)

Delay Order (m)	W_t	10% CV	5% CV	1% CV	Bootstrap p-Value
1	33.292395	34.311010	37.495571	45.397738	0.115000
2	46.332843	34.279854	37.381677	44.276672	0.006000
3	39.485841	33.727585	38.152825	45.115897	0.039000
4	38.954287	33.980498	37.613346	46.463225	0.033000
5	40.080726	34.032638	37.006701	44.422084	0.022000
6	42.739390	33.084563	36.671304	44.205394	0.012000
7	43.886411	34.122042	37.322338	43.050628	0.009000
8	46.505824	33.895504	37.042203	42.764722	0.003000
9	49.242689	33.627729	37.998150	44.244866	0.003000
10	33.780874	33.829274	36.672047	43.775840	0.101000
11	47.481303	33.488011	37.333936	44.824598	0.006000
12	49.785948	33.184987	36.940468	44.406403	0.006000

Notes: Bootstrap p-values calculated from 1,000 replications. 70 observations in first regime and 18 observations in second regime.

Since *m* is generally unknown a priori, Caner and Hansen (2001) suggest selecting *m* endogenously according to W_t statistic. The least squares (LS) estimate of *m* is the value that minimizes the residual variance. Since the Wald test W_t is a monotonic function of the residual variance, selecting the *m* minimizing the residual variance is the same with choosing the m maximizing the W_t. As seen in Table 2, W_t statistic is maximized when $\hat{m}=12$. However, in the economic analysis, selecting $\hat{m}=12$ is not considered as a meaningful indicator, due to the late response of the unemployment rate; in other words, choosing the delay order as 12 may not be possible in economic terms because of the effect of prior 12-month unemployment rate to the current unemployment rate may not be considered economically logical. So, while the LS point estimate for the delay parameter is $\hat{m}=12$, $\hat{m}=12$ is selected which is the 5th biggest value in Wald tests W_t and has the same bootstrap *p*-value with the $m = 12$ case. Similarly, Caner and Hansen (2001) prefer smaller delay parameters in their study as well.[9]

Once nonlinearity is ensured, we continue with testing for stationarity of the unemployment rate. The threshold unit root test statistics, R_{1T}, t_1 and t_2, calculated for $\hat{m} = 12$ are reported in Table 3.[10] As discussed in Chapter 4, since the asymptotic null distribution is nonstandard and depends on the nuisance parameter, the bootstrap *p*-values are taken into consideration. According to the R_{1T} statistic, the null of a unit root is rejected against a two-regime stationary threshold model at the 1% significance level with the bootstrap *p*-value of 0.005. Although this provides empirical support for the validity of the natural rate hypothesis, it is also important to reveal the dynamics of the unemployment rate within each regime. To do that, we utilize t_1 and t_2 test statistics. It is observed that while the bootstrap *p*-value for t_1 is 0.001, it is 0.199 for t_2. This reveals that the unemployment rate follows a unit root process in Regime 2 and behaves like a stationary process in Regime 1. As a result, while the standard ADF and PP tests support the hysteresis effect on the unemployment rate for the sample period in Turkey, the TAR-type unit root test suggested by Caner and Hansen (2001) fail to reject the stationarity of unemployment rate for same period.

Table 3: Bootstrap and Asymptotic *p*-Values (Unconstrained Model)

m = 2	Bootstrap *p*-Value	Asymptotic *p*-Value	W_t	t Statistic	10% CV	5% CV	1% CV
R_{1T}	0.005000	0.002558	20.000131		10.386310	12.680024	17.801933
t_1	0.001000	0.007289		3.934158	2.553817	2.981378	3.546935
t_2	0.199000	0.404692		2.126625	2.572361	2.953497	3.833241

Notes: Bootstrap *p*-values calculated from 1,000 replications.

[9] In Caner and Hansen's paper (2001), while the LS point estimate for the delay parameter is $\hat{m} = 12$, they choose the delay parameter as $\hat{m} = 9$ which yields a near identical value for the residual sum of squares and hence the test statistic W_t.

[10] Since the R_{2T} test results are nearly identical to the R_{1T} test results and has less power than R_{1T}, we do not report the R_{2T} test results.

According to the results, it is found that the point estimate of the threshold value $\hat{\lambda}$ is 0.47. Given the appropriate delay order is 2, we have two regimes depending on whether the threshold variable $Z_{t-1} = y_{t-1} - y_{t-3}$ lies below or above the threshold value. More specifically, the first regime occurs when $Z_{t-1} < 0.47$, which indicates a period where the unemployment rate changes less than 0.47 over a two-month period. The second regime occurs when $Z_{t-1} > 0.47$, which indicates a period where the unemployment rate changes more than 0.47 over a two-month period. Furthermore, it is seen that while the first regime covers approximately 20% of the observations, 80% of the observations fall into the second regime.

To analyze the estimated threshold model more closely, the LS parameter estimates and the Wald tests for the pairwise equality of individual coefficients with the corresponding *p*-values are given in Table 4. As seen in Table 4, the parameter estimates differ between the two regimes. When the tests for equality of individual coefficients are examined, the bootstrap *p*-values are found significant for Δy_{t-2}, Δy_{t-5} and Δy_{t-7}. This situation indicates the nonlinearities in the coefficients on Δy_{t-2}, Δy_{t-5} and Δy_{t-7}, in other words while these three coefficients emphasize the switches between regimes, the other coefficients are either less important or invariant between regimes.

Table 4: Least Squares Estimates Unconstrained Threshold Model

	Estimates $\hat{m}=2$, $\hat{\lambda}=0.47$			
	$Z_{t-1} < \hat{\lambda}$		$Z_{t-1} \geq \hat{\lambda}$	
Regressor	**Estimate**	**s.e.**	**Estimate**	**s.e.**
Constant	0.746914	0.205875	9.021154	4.230457
y_{t-1}	-0.077234	0.019632	-0.954194	0.448690
Δy_{t-1}	0.158308	0.122479	1.248363	0.829674
Δy_{t-2}	0.098329	0.121655	3.233430	1.209088
Δy_{t-3}	-0.555097	0.119381	1.285975	0.892942
Δy_{t-4}	0.294792	0.142117	2.124795	0.974082
Δy_{t-5}	0.173303	0.145574	3.148948	1.019855
Δy_{t-6}	-0.344766	0.146522	-1.395584	0.950241
Δy_{t-7}	0.241729	0.147709	-2.732093	1.118996
Δy_{t-8}	0.070179	0.145418	0.088269	0.657657
Δy_{t-9}	-0.024433	0.140604	-1.321269	0.577008
Δy_{t-10}	0.168951	0.120358	0.247580	1.144352
Δy_{t-11}	-0.154248	0.118829	3.838122	2.042914
Δy_{t-12}	0.082415	0.109184	0.327592	0.484353

	Equality of Individual Coefficients	
	Wald Statistics	Bootstrap p-Value
Constant	3.816405	0.238000
y_{t-1}	3.812738	0.216000
Δy_{t-1}	1.689347	0.398000
Δy_{t-2}	6.655993	0.067000
Δy_{t-3}	4.176392	0.128000
Δy_{t-4}	3.455932	0.202000
Δy_{t-5}	8.343059	0.026000
Δy_{t-6}	1.194491	0.459000
Δy_{t-7}	6.941778	0.046000
Δy_{t-8}	0.000721	0.986000
Δy_{t-9}	4.768204	0.119000
Δy_{t-10}	0.004670	0.957000
Δy_{t-11}	3.806225	0.165000
Δy_{t-12}	0.243843	0.752000

Therefore, Δy_{t-2}, Δy_{t-5} and Δy_{t-7} are selected as constraints. With imposing these constraints, we re-estimate the model and estimation results of the constrained model are provided in Table 5. According to the results, only coefficients of Δy_{t-2}, Δy_{t-5} and Δy_{t-7} shift between regimes and the others remain the same.

Table 5: Least Squares Estimates Constrained Threshold Model

	Estimates $\hat{m} = 2$, $\hat{\lambda} = 0.47$			
	$Z_{t-1} < \hat{\lambda}$		$Z_{t-1} \geq \hat{\lambda}$	
Regressor	**Estimate**	**s.e.**	**Estimate**	**s.e.**
Constant	0.800970	0.415323	0.587802	0.221898
y_{t-1}	-0.058247	0.035803	-0.060123	0.021037
Δy_{t-2}	0.268559	0.283981	0.637386	0.128737
Δy_{t-5}	0.261582	0.201597	0.374973	0.163971
Δy_{t-7}	0.472467	0.169113	0.030077	0.167656
		Estimate	**s.e.**	
Δy_{t-1}		0.701230	0.129345	
Δy_{t-3}		-0.620739	0.123359	
Δy_{t-4}		0.404298	0.133688	
Δy_{t-6}		-0.483461	0.153379	
Δy_{t-8}		0.103888	0.145090	
Δy_{t-9}		-0.084310	0.142697	
Δy_{t-10}		0.077080	0.124996	
Δy_{t-11}		-0.120697	0.123252	
Δy_{t-12}		0.127643	0.110146	

Additionally, it must be noticed that all the above results are obtained by setting the trimming value of 0.15 so that $[\pi_1, \pi_2] = [0.15, 0.85]$. In order to check robustness of the results to the choice of the trimming value, we also employ a trimming of 0.10 and obtain quite similar results.

As a result, the estimation of the TAR-type unit root test suggested by Caner and Hansen (2001) reveals that the Turkish unemployment rate has a nonlinear stationary process for the monthly period of January 2005 – May 2013. Within the framework of all discussions and results given above, a plot of series, yielded as the result of unconstrained (when $m = 2$) TAR model application, is given in Figure 2. From the general overview of Figure 2, as mentioned above, the two regimes structure of Turkey's unemployment rate in favor of TAR type nonlinear model over the period can be seen. The visual inspection of the plot shows that the second regime in Turkish unemployment rate occurs within the years of 2008 and 2010. In order to analyze this switching between regimes, it can be said that the last global financial crises in 2008 create a temporary structural change in Turkish unemployment rate and the unemployment rate follows a different pattern. Thus, there is a clear visual suggestion of the steepness form of asymmetry including that the inclines are steep relative to the declines. And after the crises effect, the unemployment rate return to its former value by gradually decreasing.

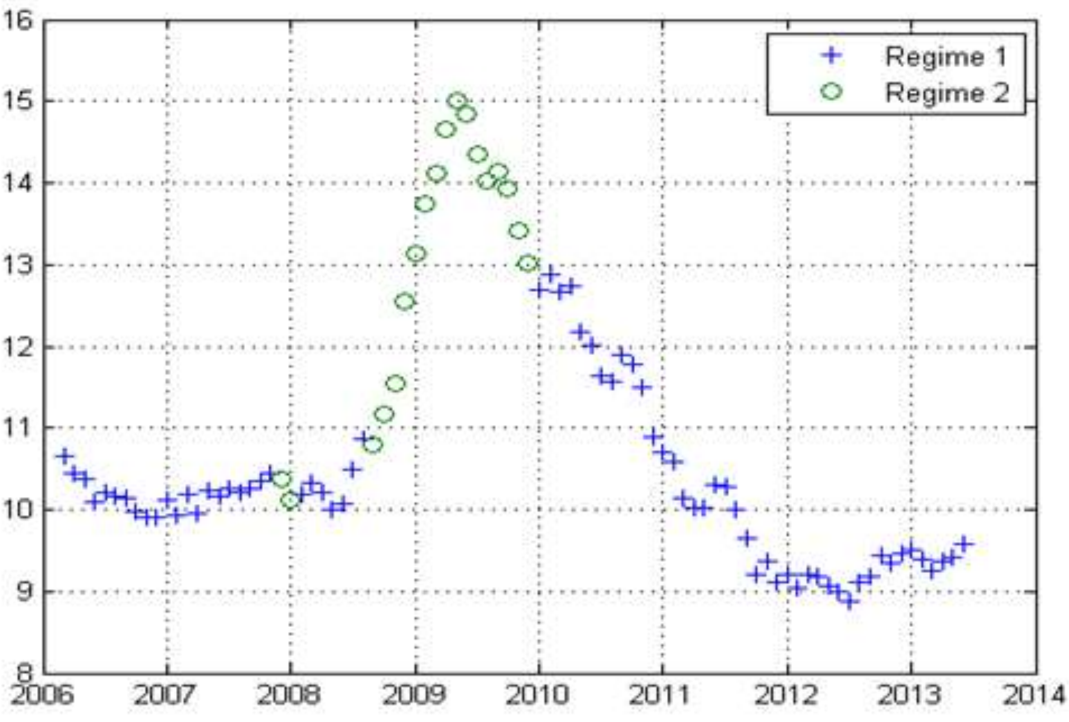

Figure 2: Turkey Unemployment Rate, Classified by Threshold Regime (Obtained from The Unconstrained Model ($m = 2$))

CHAPTER 6

CONCLUSION

In this study we investigate the existence of hysteresis effect on Turkish unemployment rate over the period of January 2005 – May 2013. While the hysteresis hypothesis emphasizes the nonstationarity of unemployment rate considering effect of shocks as permanent, the natural rate hypothesis indicates the changes in unemployment rate as temporary. In this study, while testing these hypotheses, our aim is to account for not only possible nonstationarity but also possible nonlinearity arising from business cycles.

The preliminary results reveal that the unemployment rate in Turkey for the related period has a unit root, so the hysteresis hypothesis is valid for Turkish unemployment rate. However, these results do not consider the nonlinearity of unemployment rate. In fact, according to the recent literature, the unemployment rate has a nonlinear structure due to business cycles or some idiosyncratic factors specific to the labor market effect. That means the unemployment rate do not behave similar in expansion and recession periods; while the unemployment rate increases sharply in recessions, then it decreases slowly in expansion periods. Moreover, this nonlinearity of unemployment rate causes that the standard unit root tests have low power in existence of nonlinearity.

Within this nonlinearity framework, several nonlinear models such as TAR, ESTAR and LSTAR models uncover the crucial role of the nonlinearities in our hysteresis analysis, as it is mentioned before. But, the ESTAR and LSTAR models do not fit for the purpose of our analysis. Because, the ESTAR model cannot completely capture the nonlinear dynamics of unemployment rate and the LSTAR type of unit root test is still in progress. Therefore, the TAR-type unit root test suggested by Caner and Hansen (2001) is selected for our analysis. In addition, the main advantage of this test is that it enables a unit root testing procedure, which allows simultaneous examination of nonlinearity and nonstationarity. As a result of TAR-type unit root test, we find that the natural rate of unemployment is evident for Turkey in the sample period; and the unemployment rate process in Turkey can be considered as a stationary nonlinear process. Additionally, it is also need to mention that our study related to the unemployment hysteresis differs from the existing studies for Turkey due to simultaneous analysis for nonlinearity and nonstationarity.

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APPENDIX A

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	
Sosyal Bilimler Enstitüsü	x
Uygulamalı Matematik Enstitüsü	
Enformatik Enstitüsü	
Deniz Bilimleri Enstitüsü	

YAZARIN

Soyadı : Akçay
Adı : Sıla
Bölümü : İktisat

TEZİN ADI (İngilizce) : Testing for The Unemployment Hysteresis in Turkey

TEZİN TÜRÜ : Yüksek Lisans [x] Doktora [ ]

1.	Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir.	x
2.	Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir.	
3.	Tezimden bir bir (1) yıl süreyle fotokopi alınamaz.	

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: