

T.C.
MARMARA ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İKTİSAT (İNG) ANABİLİM DALI
İKTİSAT (İNG) BİLİM DALI

**TESTING FOR ASYMMETRY IN OKUN’S LAW: EVIDENCE
FROM TURKEY**

Yüksek Lisans Tezi

GÖKHAN UMUT

İstanbul, 2013

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Danışmanı: PROF. DR. ALİ SUUT DOĞRUEL

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To my father, Yakup

To my mother, Şerife

To my brother, Serkan

GENERAL KNOWLEDGE

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ABSTRACT

Turkey has several economic developments since 2001 in which Transition Program for Strengthening the Economy has been started to apply. Especially, growth rate of Turkey is undoubtedly notable after this time. However, even though there are several developments in the economy, some drawbacks have been emerged in the same period. High pattern of unemployment in spite of high economic growth is one of these problems. In this sense, persistent high unemployment rate has been observed since 2001. The aim of this paper is to analyze the relationship between economic growth and unemployment between the period of 2001:Q2-2012:Q4 in Turkey. To that end, a threshold autoregressive model is applied in order to detect whether this relationship has a nonlinear pattern. In this context, the procedure of Hansen (1996, 2000) is employed in order to see if there is an asymmetric relationship between these two variables. According to the results, there is an asymmetry in Okun's law in Turkey for the period between 2001-2012. In addition, it is concluded that the asymmetry in Okun's law may result from the changes in labour force participation rate.

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ÖZET

Türkiye, güçlü ekonomiye geçiş programının uygulandığı tarih olan 2001 yılından bu yana bir takım ekonomik gelişmeler kaydetmiştir. Özellikle, bu tarihten sonra elde edilen ekonomik büyüme göze çarpmaktadır. Bununla birlikte, bir takım ekonomik gelişmeler elde edilmesine rağmen, ekonomide bazı problemler ortaya çıkmıştır. Yüksek ve kalıcı işsizlik bu problemlerden bir tanesidir. Bu dönemdeki kalıcı işsizlik oranı göze çarpmaktadır. Bu çalışmanın amacı, 2001:Q1-2012:Q4 dönemleri arasında, Türkiye’deki ekonomik büyüme ile işsizlik arasındaki ilişkiyi analiz etmektir. Bu anlamda, iki değişken arasındaki doğrusal olmayan ilişkiyi ortaya çıkarabilmek için eşik otoregresif modeli kullanılmıştır. Diğer bir ifadeyle, değişkenler arasında asimetric bir ilişkinin var olup olmadığı Hansen (1996, 2000)’in geliştirdiği yöntem ile analiz edilmiştir. Sonuçlara göre, Türkiye’de Okun yasasında asimetric bir ilişki söz konusudur. Buna ek olarak, asimetrisinin sebebinin, işgücüne katılım oranındaki değişimler olabileceği sonucuna varılmıştır.

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ABBREVIATIONS

ADF	: Augmented Dickey- Fuller Unit Root Test
AR	: Autoregressive
EMU	: European Monetary Union Countries
GDP	: Gross Domestic Product
GNP	: Gross National Product
HP	: Hodrick-Prescott Filter
HS	: Hansen-Seo Procedure
KSS	: Kapetanios, Shin and Snell Unit Root Test
LM Test	: Lagrange Multiplier Test
MTAR	: Momentum Threshold Autoregressive Model
OECD	: Organization of Economic Co-operation and Development
OLS	: Ordinary Least Squares Method
PP	: Philips and Perron Unit Root Tests
RSM	: Regime Switching Models
TAR	: Threshold Autoregressive Models
TURKSTAT	: Turkish Statistical Institute
TFP	: Total Factor Productivity
UK	: United Kingdom
USA	: United States

CHAPTER 1: INTRODUCTION

During 1990s, Turkish economy had suffered from various problems such as unsustainable public sector debt, structural problems in financial sectors and low growth rate. Because these problems have caused economic instability, Transition Program for Strengthening the Economy (*Güçlü Ekonomiye Geçiş Programı*) has started to be applied since 2001. The program has emphasized two major problems of Turkish economy: unsustainable public sector debt and fragility in the financial sector. In this sense, two aims have been determined in order to solve these problems. The first goal was to provide a strong public sector that would have low public interest. The second was to stabilize the financial sector. In addition, the role of government has changed from an active position in the market to a just regulatory one after 2001.

As a result of this program, some economic developments have been observed from 2001 onwards. The most notable development occurred undoubtedly in the economic growth. Turkish economy grew approximately by 7%, between the period of 2002-2007 and 5.2%, which are higher than economic growth in 1990s, over the periods 2002-2012. The main factor of the economic growth after 2001 was increment in either total factor productivity or labor productivity. In this sense, Total Factor Productivity (TFP) has contributed to the economic growth by 25.9% in 2002-2011. On the other hand, the problem of high unemployment increased in the same period in spite of high economic growth. While the unemployment rate was 7.7% in 1992-2001, it was 10.3% between the periods 2002-2012.

When taking into consideration the conditions of economic growth and unemployment together in the case of Turkey, a question might be raised: Could increase in output growth provide decrease in unemployment. In this regard, it will be showed in this thesis that the concept of “jobless growth” is the issue which has experienced in Turkish economy since 2001.

As is known, economic growth and unemployment nexus is generally argued as revealed by Okun’s paper (1962). He assumes that there is a symmetric relationship between these variables. He employs three models which are the difference model, the gap model and the fitted trended and elasticity model in order to analyze this relationship statistically for the US economy. According to his results, an increase of 3% in the growth rate of real gross national product results in a 1% decrease in the unemployment rate. There are several studies that test the Okun’s law empirically for the case of different countries. Hamada and Kurosaka (1984), Kaufman (1988), Blanchard (1989), Prachowny (1993), Weber (1997) and Freeman (2000) are just some of them.

Even though Okun postulates a linear specification for analyzing this relationship; in recent years, economists have attracted attention to the possibilities of asymmetry (a nonlinear nexus) in the relationship between output growth and unemployment. Asymmetry in Okun’s law means that the response of unemployment to the output growth is obviously different when economy is contracting from the one when economy is expanding (Silvapulle *et. al.*, 2004, p.355). In other words, downswings and upswings in output have different absolute effect on unemployment. Palley (1993), Harris and Silverstone (2001), Viren (2001), Mayes and Viren (2002) and Silvapulle *et. al.* (2004) are some of the studies that analyze the asymmetry in Okun’s law.

Regarding the contradiction of high output growth and unemployment rate in Turkey since 2001, it has been argued whether a structural change could be observed in Turkey when Okun's law is applied. In this context, while some papers assess that the Okun's law is valid for Turkish economy, even if the Okun's coefficient is smaller in comparison with Okun's original findings, some studies conclude that Okun's law is asymmetric for Turkey.

In order to specify the asymmetric effects of output growth changes on the unemployment, it is gathered the quarterly data for Turkey from 2001:Q2 to 2012:Q4 in this study. Since the gap model as Okun utilizes is used, Hodrick-Prescott filtered method is employed in order to extract the cyclical components of output growth and unemployment. This study will contribute to the literature in two aspects. Firstly, this paper investigates the asymmetry in the relationship between output growth and unemployment for Turkish economy. Secondly, this paper examines the reason of asymmetry in Okun's law for Turkey. To that end, labour force participation is included to the model in order to test whether the asymmetry in Okun's law results from changes in labour force participation as inspired by the work of Palley (1993).

The content of this thesis is as follows: the second chapter explains the Okun's law and presents the models that Okun utilizes. In addition, as the asymmetry concept in Okun's law is discussed, the literature review for asymmetry in Okun's law is also presented in this chapter. The third chapter explicates the relationship between economic growth and unemployment for Turkey descriptively for the period 2001-2012. The forth chapter elaborates the methodology of Threshold Autoregressive (TAR) Model, the characteristics of data, standard unit root tests and nonlinear unit root test in the level, and finally, it presents

the estimation results according to both linear and nonlinear models. The thesis will conclude with the fifth chapter.

CHAPTER 2: OKUN’S LAW AND ASYMMETRY

2.1. Okun’s Law

Connection between economic growth and unemployment has attracted attention of economists due to its importance on macroeconomic stabilization. Under the assumption that an economy is at its long-run production level, unemployment should be its natural level called “natural rate of unemployment” which also refers to frictional or structural unemployment. In this sense, economists have been paying attention to the question of how unemployment deviates from its natural rate when production increases or decreases from its long-term production level. In fact, the inverse relationship between economic growth and unemployment has been known by economists for a long time. However, Arthur Okun statistically showed this relation and empirically proved the nexus between unemployment and potential output depending upon the change in productivity, labor force participation and hours worked (Holmes and Silverstone, 2006, p.293). He came up with a negative linkage among the variables, in his original paper entitled as “Potential GNP: Its Measurement and Significance” which analyzes this relationship by using quarterly data to the example of the United States of America over the period of 1947-1960. That is why the relationship between economic growth and unemployment has been termed as Okun’s law after Okun first formalized it statistically. More clearly, Okun’s law is a statistical indicator which postulates a negatively relationship between unemployment and real output. Therefore, Okun’s law implies the linkup between the level of activity in the good markets and the level of activity in

the labor market over the business cycle (Silvapulle, Moosa and Silvapulle, 2004, p.354). Put it another way, Okun's basic hypothesis while propounding his idea is that to produce more goods and services entail more labor within an economy. Thereby, unemployment rate is a convenient indicator which shows the amount of labor used in the economy (Knotek, 2007, p.74).

When agreed-upon interpretation of Okun's law is taken into account, there are two main reasons causing the unemployment in an economy: deficiency of aggregate demand and idle resources (Mihçı and Atılgan, 2010, p.34). The first one might be understood by means of old Keynesian perspective. Owing to changes in aggregate demand, output plans of the firms shift on the purpose of reaching the equilibrium output production level. This will affect the labor demand and, accordingly, unemployment rate. Similarly, idle resources lead to enormous social costs in the context of unemployment.

The standard specification of Okun's law can be presented as:

$$[1] \quad (Y - Y^*)_t = \alpha + \beta(U - U^*)_t + \varepsilon_t, \quad \beta < 0$$

where Y is the logarithm of observed real output, U is the logarithm of observed unemployment rate, Y^* and U^* are the potential output and natural rate of unemployment, respectively, and ε_t is a random error term. According to Okun's results, a one-percentage point change in the unemployment rate above four percent natural unemployment rate leads to

a decrement in output at an approximately three-percentage rate¹. Underlying the reason why a one percentage change in unemployment causes a change in output more than proportionate rate is that changes in unemployment are associated with the changes in labor force participation, labour hours and capital utilization (Harris and Silverstone, 2001, p.2). In other words, Okun assumes in his analysis that while the unemployment rate changes to a certain extent, other factors which affect economic growth through labor such as capacity utilization, work hours and productivity alter simultaneously as well. In this sense, unemployment is a good proxy variable as Okun states:

While I shall discuss the steps individually below, the basic technique I am reporting consists of a leap from the unemployment rate to potential output rather than a series of steps involving the several underlying factors. (...) the leap requires the assumption that, whatever the influences of slack economic activity on average hours, labor force participation, and manhour productivity, the magnitudes of all these effects are related to the unemployment rate. With this assumption, the unemployment rate can be viewed as a proxy variable for all the ways in which output is affected by idle resources (Okun, 1962, p.2).

After the recognition of Okun's law as a rule of thumb for interpreting the tie between economic growth and unemployment, a lot of studies have been emerged which implemented Okun's theory to several countries in order to test the validity of the law. A great majority of these works have reached a conclusion that the characteristics of the law have been valid for various countries and periods, although coefficient has been changing depending on the features of countries' labor market structure. Notwithstanding, Prachowny (1993) claimed that Okun's contribution has not been well understood yet. The reason

¹ There was an agreement among the economists that four percent unemployment is a target rate under the labor market conditions. Okun also assumes the four percentage unemployment rate target, when he calculated the potential GNP in his paper.

underlying this circumstance is that while most current applications accept the *ceteris paribus* assumption, Okun's law is based on *mutatis mutandis* as stated in Prachowny (1993).²

The significance of Okun's law is multi-dimensional. First of all, aggregate supply curve can be derived by incorporating Okun's law with the Philips curve. Put it differently, the combination of Philips curve and Okun's law provides the aggregate supply curve. Secondly, this rule of thumb is important for some economic implications in macro economy. For instance, policy-makers should know the necessity of economic growth in order to reduce unemployment rate. Besides, the validity of disinflation policy depends on the sacrifice ratio that means the responsiveness of unemployment to the output growth rate (Sögner and Stiassny, 2002, p.1775). Thirdly, this relationship has been stable and reliable. Finally, Okun's law does not have a complex structure such that it has simplified the links between the output and unemployment (Gordon, 1984, p.539).

Okun (1962) uses three methods in order to comprehend this relationship; these are the difference model, the gap model and the fitted trend and elasticity model.

2.1.1. The Difference Model

The difference model reflects the variables in first differences in a regression model. When it is considered specific to Okun's law, this method explicates the variables which are unemployment (u_t) and output (y_t) in first differences as follow:

² The concept of *Mutatis mutandis* implies that changes in output rate stem from the combined effect of changes in the labour force, employment, hours worked per worker and productivity.

$$[2] \quad \Delta u_t = \beta_0 + \beta_1 \Delta y_t + \varepsilon_t \quad t = 1, 2, \dots, T \quad ; \quad \beta_1 < 0$$

where the parameter β_0 is an intercept term obtaining the mean growth rate, β_1 is often known as the Okun's coefficient, Δ is a difference operator, and ε_t is a white-noise error term. As is demonstrated in equation [2], this relationship captures the simultaneous correlation between movement in unemployment and output growth. In other words, the difference model that Okun analyzes expresses how output growth changes contemporaneously with the fluctuations in unemployment rate. Okun's coefficient is expected to be negative considering economic theory. With a further explanation, a negative coefficient of output growth is associated with an increasing in unemployment rate, and a rise in output growth causes to fall unemployment rate to a certain extent. $[-\beta_0 / \beta_1]$ indicates the “*necessary rate of output growth*” to resume a given unemployment rate. Namely, the rate shows how rapidly the economy could need to grow to provide a stable rate of unemployment (Knotek, 2007, p.75). If realized output growth rate is above the rate of $[-\beta_0 / \beta_1]$, unemployment rate decreases, whereas unemployment increases in case of a decline in the realized output growth rate below the rate.

Okun (1962) estimated the regression by using first difference method over the period 1947:Q2-1960:Q4. Reported estimation results are as;³

³ U and Y represent changes in unemployment rate and output growth rate, respectively. Both series include quarterly and seasonally adjusted data. What's more, Okun did not use annualized rates of output growth.

$$[3] \quad \Delta u_t = 0.3 - 0.30 \Delta y_t$$

$$(0,4) \quad (0,4)$$

$$R^2=0,58 \quad \text{and Durbin-Watson Stat}= 1,6$$

where Δu_t is the change in the unemployment rate and Δy_t is change in real output. According to the estimation results, the rate of unemployment will increase by 0.3 point from one quarter to the next one when real GNP does not change. Each extra one percentage point increment in output leads to decline unemployment at 0.3% points. Put another way, assuming previous quarters are given, a one percentage increase in unemployment rate causes 3.3% decrease in output growth in an economy.⁴

The difference model specification has a main downside. Attfield and Silverstone (1997) draw attention that if unemployment and output series are not only individually integrated as $I(1)$ but also are together cointegrated, hence, equation [2] is misspecified. They also indicate that the Okun's coefficient estimation for the U.S. is over 2 when a cointegrated relationship is considered (Lee, 2000, p.334).

2.1.2. The Gap Model

According to the gap model approach that Okun propounds, the level of unemployment is based on the gap among the actual output and potential output. In the same vein, Okun's law relates to the concept of the gap between actual unemployment and natural

⁴ Okun estimates the coefficient on unemployment as 3.3%. However, Barreto and Howland (1993) assert that Okun's procedure is incorrect. They reestimate by using Okun's data set and find the coefficient as 1.95% for the difference model.

rate of unemployment; and the gap between actual and equilibrium output. The relationship can be written as:

$$[4] \quad (u_t - u_t^*) = \beta_0 + \beta_1(y_t - y_t^*) + \varepsilon_t \quad , \beta_1 < 0$$

$$[5] \quad u^c = \beta_0 + \beta_1 y^c + \varepsilon_t \quad , \beta_1 < 0$$

where u_t symbolizes the actual rate of unemployment and u_t^* represents the natural rate of unemployment. By the same token, y_t denotes the actual level of output and y_t^* is the potential or trend level of output. The variable β_0 might be thought as the unemployment rate under the full employment conditions. Okun estimated the relationship between output gap and unemployment gap, in a sense, the tie among the output rate and unemployment level, using the gap model. In this framework, $u_t - u_t^* = u_t^c$ refers to the cyclical rate of unemployment (unemployment gap), and $y_t - y_t^* = y_t^c$ represents the cyclical output rate (output gap). There are three criteria to test the validity of potential paths such like:

- i) Goodness of Fit
- ii) There is no trend in the residuals
- iii) There is a consensus on idea which potential GNP should equal to actual GNP when unemployment rate is equal to 4%.

Contrary to aforementioned difference model, required information about unemployment and output trends are not directly observable in the gap model. Surprisingly, there is no consensus on appropriate technique in generating these trend series.⁵

For the gap equation, Okun uses linear trends to obtain the natural rate of unemployment and the potential output level even though more recent studies identify that applying deterministic trends may result in misleading implications (Lee, 2000, p.334). He intended to determine how much the economy could produce output in an economy under the full employment conditions.⁶ The basic feature of full employment level in an economy as Okun's thought is to provide as much as production under the certain unemployment rate without increasing so much inflation.

As is mentioned above, idle resources cause a high rate of unemployment with respect to Okun. In such a case, it is expected that the actual rate of output may be below its potential level. The reverse scenario is also valid. Namely, a low rate of unemployment would occur when the actual level of output is above potential rate. Therefore, Okun (1962) estimated the regression by using the gap model between the period of 1953:Q1-1960:Q4. The regression result is as follows:

⁵ In fact, Lee (2000) indicates that estimated Okun's coefficient is sensitive to method that is used for detecting the cyclical component of the variables.

⁶ It should be noted that the major aim of Okun is to calculate potential output of United States of America under the condition of full employment. In this framework, the full employment target should be understood as achieving for maximum production without inflationary pressure. In other words, it balances more output and price stability in an economy.

$$[6] \quad (u_t - u_t^*) = 3.67 - 0.35(y_t - y_t^*)$$

(0.14) (0.03)

$R^2 = 0.82$ and Durbin-Watson Stat=0.49

where $(u_t - u_t^*)$ represents the unemployment gap and $(y - y^*)$ denotes the output gap. According to the results, when unemployment rate increases at a one percentage, output decreases at 2.8% of potential output.⁷ Additionally, it is obvious that estimated unemployment rate would be equal to 3.67 percent under the condition that output gap is equal to zero, expressly; it is akin to natural rate of unemployment, 4%.

2.1.3. Fitted Trend and Elasticity Method

As mentioned above, the difference model uses the changes in unemployment and in GNP. The gap model depends upon the levels. Fitted trend and elasticity method obtains the unemployment-output coefficient from the level data without including a trend to the model. The model exhibits the tie between unemployment and output as follows:

- a) The rate of actual output to potential output has a constant elasticity relationship in the relevant range and the “employment rate” ($N=100-U$) is as a proportion of its potential level:

⁷ Okun estimates the coefficient on unemployment as 2.8%. However, Barreto and Howland (1993) find Okun’s coefficient as 2.35% for the gap model.

$$[7] \quad N / N_f = (A / P)^a$$

where A and P denotes the actual and potential output, respectively, and N represents employment rate and N_f is its potential level.

b) Constant growth rate (r) of potential output is starting from P_0 at any time t:

$$[8] \quad P_t = P_0 e^{rt}$$

Substitute equation [8] into (7):

$$[9] \quad N_t = (A_t^a N_f) / (P_0^a e^{art})$$

Take the logarithm of equation (9):

$$[10] \quad \ln N_t = a \ln A_t + \ln N_f - a \ln P_0 - (ar)t$$

Rearrange the equation (10):

$$[11] \quad \ln N_t = \ln(N_f / P_0^a) + a \ln A_t - (ar)t$$

The logarithm of the employment as a dependent variable is based on a time trend and the logarithm of actual real GNP as an independent variable. The coefficient of actual output's logarithm is the "output elasticity of the employment rate"; the coefficient of time is an estimation of the potential growth rate and the intercept term is a benchmark (P_0) for any given potential rate of employment (N_f).

Okun's (1962) estimation by using fitted trend and elasticity method for the periods 1953:Q1-1960:Q4 is noted below:

$$[12] \quad \ln N_t = 212 + 0.40 \ln A_t - 0.32t$$

(27) (0.04) (0.03)

$$R^2 = 0.84, \text{ Durbin-Watson Stat} = 0.54 \text{ and } R_{(\ln N_t)(\ln A_t)(t)} = 0.74$$

When the regression equation is applied for varying sample, elasticity coefficient is estimated 0.35 to 0.40. Each one percentage increment in unemployment rate leads to decrement in output at a rate lightly less than a 3 percentage with respect to the results.⁸

⁸ Okun estimates the coefficient on unemployment as 2.8% and 2.5%. Barreto and Howland (1993) find the Okun's coefficient as 1.83% for the fitted trend and elasticity model.

Ultimately, the result that arises from mentioned-above techniques is the 3 –to- 1 link among the unemployment rate and output. Uniform estimation result emerged from different techniques can be summarized as below;

$$[13] \quad P = A [1 + 0.032 (U-4)]$$

Potential output will be equal to actual output on condition that the unemployment rate is four percent. A one percentage increase in unemployment above four percentages will lead to decrease in output at 3.2 percentages level. However, Okun's relation does not mean to be estimated aside from this range. There is no reason to presume the 3.2 percent coefficient to be valid when unemployment rate is 1 or 15 percent of the labor force (Okun, 1962, p.3).

2.1. Asymmetry in Okun's Law

Okun (1962) remarks the significance of studying cyclical measures "*such as advance over previous peak levels or advance over recession trough levels*" (Okun, 1962, p.1). In such case, it should be assumed that each peak is uniform in order to measure how far away the actual rate is from the target rate according to Okun (Okun, 1962, p.1). In other words, a symmetric relation among the variables is assumed by a great majority of specifications. In this sense, many papers regarding uniformity in each peak assumption have been studied after acceptance of Okun's hypothesis as a rule of thumb.

However, recently, economists have been drawing attention to the possibility of asymmetry in the Okun's law. An explanation of asymmetry is that downswings and upswings in output have different absolute effect on unemployment. To put it another way, response of the unemployment to growth in output is different when economy is contracting and expanding (Silvapulle, Moosa and Silvapulle, 2004, p.355). In fact, the asymmetry is not a foreign concept in economics literature. Most economists are pertinent to asymmetry in business cycles. Especially, Keynes (1936), who claims that downturns might be sharper than upturns in an economy, provides an explanation why output effect on unemployment differs according to economic conditions (Viren, 2001, p.254).

Harris and Silverstone (2001) come up with four reasons why testing for asymmetry in the output-unemployment relationship is crucial. Firstly, asymmetry in Okun's law has a distinctive role among the alternative theories of joint labour and good markets. Secondly, asymmetry in Okun's law stands for an asymmetry in Philips curve at the same time, and reverse scenario is also valid. Thirdly, knowledge about asymmetry in the relationship between unemployment and output may be useful for both structural policies (e.g. labour market reforms) and stabilization policies (e.g. appropriate monetary policy responses). Fourthly, when asymmetry is ignored though it is present, forecasting error could be arise. In addition to all of these, ignoring the asymmetry while it is present leads to poor forecasts and erroneous inference in hypothesis testing. Null hypothesis that there is a long-run relationship among output and unemployment might be rejected on the condition of ignoring asymmetry, and this leads to faulty policies (Silvapulle *et. al.*, 2004, p.356). Courtney (1991) concludes his working by using an aggregate production function approach that "*imposing symmetry in the Okun's law regression leads to serious underestimates of unemployment rate increases in*

contractions and overestimates of decreases in the unemployment rate during expansions”
(Courtney (1991), as cited in Harris and Silverstone, 2001, p.1).

Viren (2001) also emphasizes the theoretical and policy-related importance of testing asymmetry suggested by Harris and Silverstone (2001). First of all, searching out the asymmetry in the unemployment-output relationship is noteworthy for the effectiveness of unemployment policy. Secondly, non-linearity in Okun’s law would suggest that the conditions of other macroeconomic variables such as Philips Curve is important. Finally, detecting asymmetry would have important due to its implication for aggregation. More clearly, Viren discusses that implication of aggregation is significant in the context of EMU countries which differ considerably in terms of their cyclical situation (Viren 2001, p. 253).

Another explanation for asymmetry might be explained as unemployment responds more strongly to output growth on the contraction than on the expansion. This assumption is related to psychology of employers who are prone to be pessimistic when bad news happens. Assume that there is no restriction on hiring and laying off employees, when economy experiences a downturn, firms respond to this shock by firing worker very quickly. However, when the economy goes into upturns, employers could not be willing to hire more workers due to fear of the possibility that economic recovery might not continue long time. Under these circumstances, unemployment responds very quickly to output on the downswing than on the upswing (Silvapulle *et. al.*, 2004, p.357).

On the other hand, there are two reverse scenarios pointing out that unemployment responds faster to output growth on the upswings than the downswings. In the first case, rigidity of labor market would lead to asymmetry in unemployment-output relationship. If

there are some restrictions on firing but not on hiring, when economy goes into downswing, the response of unemployment will be slow. When the economy recovers, employers will be willing to hire more workers. Therefore, the response of unemployment to output growth will be fast because restrictions on hiring workers are not too strong. The second case is based on the situation that firms invest in their staff for training. In such a case, employers would not be willing to lay off workers on the downturn. They would want to hire more workers because of the training process, when economy recovers (Silvapulle *et. al.*, 2004, p.357).

Economists have tried to understand the reasons underlying the asymmetry in unemployment-output relationship. Courtney's explanation for asymmetry is related to factor substitution during cycles (involving non-constant relationships among hours, labour force participation and capital), fluctuations in multi-factor productivity, and changes in the distribution of sectoral growth rates (Courtney (1991), as cited in Harris and Silverstone, 2001). According to Palley (1993), asymmetry hinges on changes in sectoral growth rates and in labour force participation. From the labor demand side, the magnitude of Okun's coefficient is linked to the employment policies of firms and depends upon the labor force participation decisions of households from the labor supply side (Palley, 1993, p.151). In this sense, considering labor supply side, the tie between the output growth and labour supply is related to the cyclical sensitivity of labour force participation. Increment in output growth results in increase in labour force participation; hence, as output growth rises, unemployment rate might fall by a small proportion. Contrary, a decline in the output growth rate causes to decrease in labour force participation; therefore, when output growth declines, the unemployment rate might not increase by a large proportion. Mayes and Viren (2002)'s explanation for the asymmetry is based on the behavior of the labour market. They discuss that downturns in the economy have more than proportionate downturn effects on

unemployment due to the mismatch among the sectors and regions (Mayes and Viren, 2002, p.8). Besides, Harris and Silverstone (2001) try to explain the asymmetry by using the concept of job creation and job destruction.

2.2. Literature Review on Asymmetry in Okun's Law

Asymmetry in Okun's law is an important topic that has been discussed by many economists all around the world. In this part, the remarkable results derived from these discussions will be summarized.

Palley (1993) deals with the effect of the change in the composition of the USA economy on Okun's law between for the period of 1948:Q3-1991:Q1. While doing this, he regards the asymmetric nature of USA business cycle. According to the results, the sensitivity of unemployment to upturns and downturns have increased in this period. In addition to this there has been an increment in negative sensitivity of unemployment to downturns. He puts forward that asymmetric behavior of Okun's law results from the change in the employment growth patterns and in behavior of female labor supply.

Cuaresma (2003) examines the asymmetric relationship between the cyclical component of unemployment rate and the GDP in the case of the USA between 1965:Q1-1999:Q1. In order to detect the cyclical component of the variables, he uses the Hodrick-Prescot filter and a bivariate structural time series model. The results affirm the existence of asymmetry in the USA economy. When the output gap is negative, the responsiveness of cyclical unemployment to output is higher. Besides, the behavior of unemployment changes significantly depending upon the different economic regimes.

Harris and Silverstone (2001) investigate the asymmetric relationship in Okun's law for seven OECD countries: Australia, Canada, Germany, Japan, New Zealand, the United Kingdom and the United States. Data series cover the period from 1978 to 1999 and the technique used in this study is based on the error correction term. The results show that short-run adjustment to disequilibrium changes according to if upturns or downturns in the business cycle are considered. Unemployment adjusts during a downturn in the business cycle, in all countries except Canada. The labour market seeks to tighten in upturns in those countries which attempt a response to disequilibrium.

Viren (2001) works on nonlinearity in the Okun's law for 20 OECD countries over the period of 1960-1997 by using a simple error-correction model of unemployment that is estimated with a threshold model estimator. He finds that the hypothesis of no threshold is rejected for all countries except Finland and Iceland. Therefore, it is inferred from the results that the output growth has a negative impact on unemployment while either output is above the long-run trend or unemployment is low. However, in depression, the extent output effect is smaller, even being close to zero.

Silvapulle *et. al.* (2004) examine the asymmetry in Okun's law for the United States using quarterly data between the periods 1947:Q1-1999:Q4. They employ the structure time series model of Harvey in order to decompose observed output and unemployment series into their components. Their results support that the short-run impacts of negative cyclical output on cyclical unemployment are different from those of positive ones. In this sense, they find that the response of unemployment to output is stronger while there is a negative output gap rather than a positive one.

Huang and Chang (2005) argue structural change by applying threshold approach in Okun's law to the case of Canada over the period 1960:Q1-2002:Q4. They use Hodrick-Prescott and Band-Pass Filtered Data in order to decompose the cyclical unemployment and output. In addition, they combine two significant methods which are Huang's (2003) structural break setup and Crespo-Cuaresma's (2003) threshold framework. According to the results, Okun's law exhibits nonlinear behavior and structural change. In this sense, applying classical linear estimation may give misleading results.

Holmes and Silverstone (2006) discuss the asymmetric relationship between real GDP and unemployment rate in the case of the USA between the periods 1963:Q1-2004:Q3 by using Markov switching approach. Their study is epochal compared to other ones that use Markov switching model, since they set forth an idea for asymmetry between the variables across regimes and within a regime. The results support that there is a significant inverse relationship between cyclical output and unemployment in expansionary regime.

Malley and Molona (2008) analyze the nonlinear relationship between economic growth and unemployment by using Kalman-filter approach between the period 1960:Q1-2001:Q4 for G7 countries: Canada, France, Germany, Italy, Japan, UK and US. They estimate a state-space local linear trend model in order to capture the threshold unemployment rate and reach that the threshold is statistically significant in all countries but just Germany is prone to being persistent in a high effort state. Moreover, labor productivity can also change in response to fluctuations in unemployment.

Fouquau (2008) investigates the asymmetry in Okun's law by applying the non-dynamic panel transition regression model introduced by Hansen (1999) for 20 OECD

countries over the period of 1970-2004. According to the results, there is an asymmetric relationship between cyclical unemployment and output gap regarding these countries.

Huang and Lin (2008) analyze the asymmetry in Okun's Law for USA for the period of 1948:Q1-2006:Q1 using novel smooth-time-varying parameter model developed by Koop and Tobias (2006). The results suggest that Okun's relationship indicates nonlinear behavior; in other words, Okun's coefficient varies over time. In spite of asymmetric relations, Okun's coefficient remains negative in all periods.

Arabacı and Arabacı (2010) examine the asymmetric relationship between unemployment and output in Turkey using data from 1999:Q1 to 2009:Q3. In order to analyze the asymmetric relationship, they use a Heaviside indicator function and utilize Hansen (2000)'s threshold regression approach. They employ two models used by Okun, namely difference model and gap model. In the gap model, they benefit from Hodrick-Prescott (HP) Filter to decompose the observed output and unemployment series into unobserved cyclical and trend component. They find a significant asymmetric relationship in both of two models. In the difference model, they calculate Okun coefficient as -1.62, in downturn, and -1.18, in upturn. In the gap model, Okun coefficient is -1.16 in upswings and -1.31 in downswings case. As is seen, in both models, the response of output changes to unemployment changes is higher in downturn of economy than one in upturn phase.

Tarı and Abasız (2010) scrutinize the asymmetry in Okun's law for Turkey between the period of 1968-2008 by using Two-Regime Threshold Vector Error Correction Model. Since the responses of variables in the model will be different from each other depending upon the economic conditions, they use the procedure of Hansen-Seo (HS). According to the

results, when error correction term is below the threshold value, response of economic growth to the unemployment occurs asymmetrically. Besides, they estimate Okun's coefficient as -0.48 and adjust the coefficient to -2.08 regarding the model specifications as is applied in Barreto and Howland (1993).

Ceylan and Şahin (2010) do research on whether unemployment and economic growth has an asymmetric relationship for Turkey between the period of 1950-2007. In order to capture the asymmetric relation, they benefit from TAR and Momentum TAR (M-TAR) model which provide to analyze long run relationship between the variables. The results prove that the nexus between economic growth and unemployment is asymmetric. In other words, the response of unemployment to the output growth differs across the regimes.

Barışık, Çevik and Çevik (2010) study the asymmetry in Okun's law for Turkish Economy between the period of 1988-2008 by using Markov-Switching Approach. According to the results, Okun coefficient differs according to whether the economy is in expansionary phase, or in contraction. On the one hand, in downturns, when actual output is above potential output, the unemployment rate is prone to decrease which is an expected results. On the other hand, in upturns, the relationship between output and unemployment does not seem statistically significant. These results reveal that Turkish economy has experienced a jobless growth in this period.

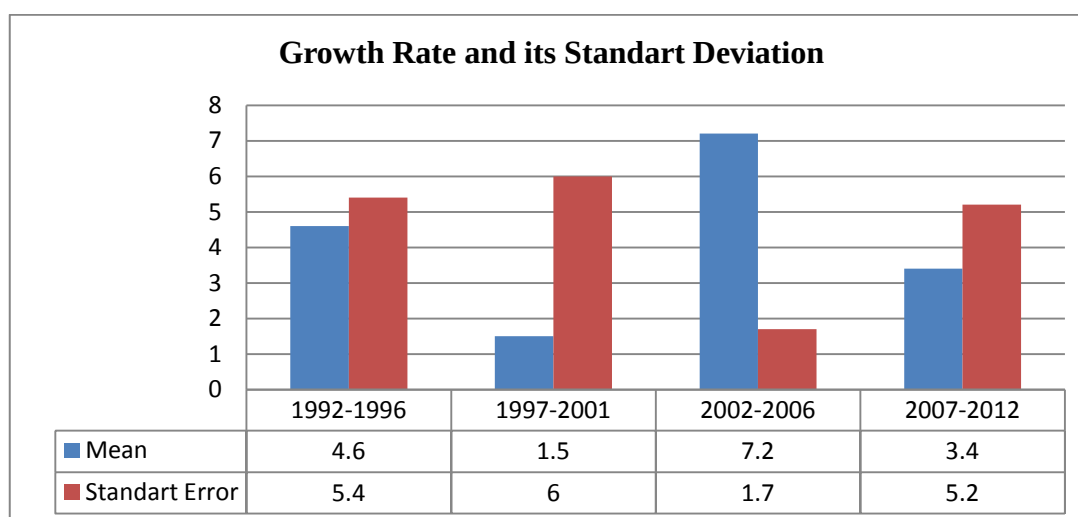
CHAPTER 3: ECONOMIC GROWTH AND UNEMPLOYMENT IN TURKEY AFTER 2001

Turkish economy has experienced a dramatic structural transformation since 2001. There are three typical characteristics of Turkish economy before 2001: unsustainable public sector debt, structural problems in financial sector, and low growth rate. On the other hand, current account deficit and unemployment were not significant problems for Turkish economy in the 1990s. Since existing problems have led to distortion in economic stability, the priorities of Turkish economy have changed with the transition program for strengthening the economy released by 2001. According to the program, Turkish economy had two crucial problems that were unsustainable public sector debt and fragility in the financial sector in 1990s (Central Bank of Turkish Republic 2001, p. 1). For the purpose of overcoming these problems, two goals have been determined. The first one is to provide a strong public sector which would have low public interest. The second is to stabilize the financial sector in Turkish economy (Umut, 2011, p. 112). Furthermore, the role of the government has changed from an active position in the market to a just regulatory one after 2001. Especially, by means of privatization, government's involvement to economic structure has been confined with only supervision and regulation so that the free-market mechanism would be strengthened (Pre-Accession Economic Programme, 2002, p.45).

It might be said that Turkish economy has achieved remarkable developments since 2001. Particularly, high pattern of growth rate in Turkish economy from 2001 onwards is non-ignorable. Turkish Economy grew approximately by 7% over the period of 2002-2007. This

high growth path of Turkish economy had prolonged until the financial crisis outburst in 2009. When considering the growth rates, it is possible to say that the growth performance of 2000s is remarkably higher than 1990s. In this sense, while the growth rate of Turkish economy was 3.4% between the period 1990-2001, this ratio was 5.2% on average over the periods 2002-2012.

**Figure 3.1: Economic Growth and its Standard Deviation in Turkey
(percentage, 1992-2012)**



Source: Author's own calculation based on Undersecretariat of Treasury

As is widely known, Turkish economy suffered from several economic crises occurred in 1991, 1994, 1999 and 2001 and end of 2008; and experienced negative economic growth in these years. In the period between 1992 and 1996, the mean of economic growth in Turkey was nearly 4.6%, whereas it was approximately 1.5% between the period 1997-2001. As for the period after 2001, the growth rate of Turkish economy was approximately by 7.2% between the years 2002-2006, and it was about 3.4% in 2007-2012 which was adversely affected by the economic crisis in 2008.

As high economic growth is a vital indicator for the countries, low volatility of the growth rate is also important in order to provide a sustainable growth path for the countries. In this regard, the growth rate of Turkish economy have shown volatile pattern in 1990s as well as in 2000s. While the average growth rate was about 4.6%, the volatility of the rate was 5.4 during the period from 1992 to 1996. In 1997-2001, the average growth rate of Turkey was 1.5%, while the volatility of the economic growth was about 6. The average growth rate was 7.2% that was the highest value in comparison with previous periods; volatility of the rate was 1.7, which was the lowest value compared with other periods as well, in 2002-2006. However, the average growth rate has declined to 3.4% and volatility of the growth has increased to 5.2 after 2007. In addition to erratic volatility among the periods, more strikingly, Turkey is even one of the countries where have the highest standard deviation in the GDP per capita growth rate for the period of 2008-2010 (Atiyas and Bakış, 2011, p.27).

Table 3.1: Developments in Gross Domestic Product and GDP Growth (2002-2011)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GDP (TL)	350476	454.781	559.033	648.932	758.391	843.178	950.534	952.559	1.103.750	1.281.454	1.416.817
GDP (\$)	230.494	304.901	390.387	481.497	526.429	648.754	742.094	616.703	734.929	734.929	616.703
GDP Growth	6.2	5.3	9.4	8.4	6.9	4.7	0.7	-4.7	8.9	8.5	2.2

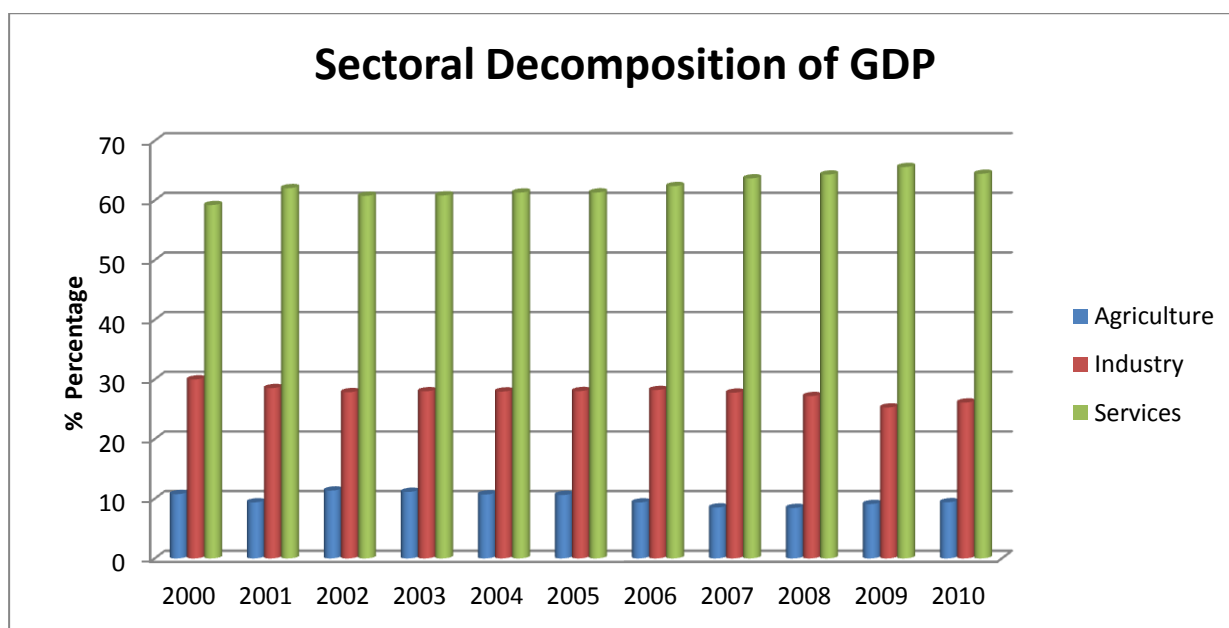
Source: TURKSTAT

Notes: GDP is based on current prices.

High and stable growth path of Turkish economy after 2002 have been sharply interrupted by world economic crisis at the end of 2008. In this regard, the economy grew almost at zero in 2008, and negatively in 2009. After the contraction that had started at the

last quarter of 2008, recovery has started in 2010. In this sense, economic growth was 8.9% in 2010, while it was about 8.5% in 2011. In 2012, growth rate of the economy declined rapidly to 2.2% that may support those who argue that there is a high volatility in Turkey. Owing to high growth path between the period of 2002-2007, GDP, which had decreased to 68 Million TL (constant price) at the end of 2001, exceeded 102 Billion TL (constant price) in 2008. At the same period, while the GDP with current prices was 240 billion TL in 2001, it increased to 950 billion TL at the end of 2008. After 2009, the GDP exceeded 1 trillion TL, and eventually reached to 1.416 trillion TL in 2012.

Figure 3.2: Sectoral Decomposition of GDP (percentage, 2000-2010)



Source: Author's own calculation based on UNCTAD

As to sectoral decomposition of the GDP, it should be stressed that the share of services sector in the GDP has been higher than the other sectors since 2001. Besides, the

share of industry sector in the GDP seems higher than agriculture sector, but less than services sector. It should be emphasized that the share of services sector in the GDP has been increasing year by year, while the share of industry and agriculture sector have been decreasing. To illustrate, the share of agriculture in GDP was 10.78% in 2000, it decreases to 10.62% in 2005 and to 9.40% in 2010. As for industry sector in GDP, its percentage was 30% in 2000, declined to 28.1% in 2005 and to 26.2% in 2010. On the other hand, service sector's portion was 59.3% in 2000, and increased to 61.34% in 2005 and to 64.47% in 2010.

One of the main components of economic growth in Turkey after 2001 is surely increasing productivity which includes both total factor productivity and labor productivity. During 1985-2000, the output growth was 4.3 % on average, total factor productivity (TFP) growth was just 0.2%. The leading factor in economic growth was increment in capital stock in this period (see Table 3.2 and 3.3). However, it is observed that the main factor of economic growth has changed after 2001, and total factor productivity has become the main factor of the economic growth since then. In this respect, TFP growth was 0.9 % in 2001-2011 and it was 1.4% in 2002-2011.

Table 3.2: Increases in Production Factors

Period	Output Growth	Capital Stock Growth	Employment Growth	TFP Growth
1985-2000	4.3	7.6	1.7	0.2
2001-2011	4.3	5.3	1.9	0.9
2002-2011	5.3	5.6	2.1	1.4
1985-2011	4.3	6.7	1.8	0.5

Source: Pre-Accession Economic Programme 2013-2015, p. 24

Table 3.3: Contribution to Growth by Factors of Production

Period	Capital Stock	Employment	TFP
1985-2000	71.3	23	5.7
2001-2011	53.4	26.4	20.2
2002-2011	50.4	23.7	25.9
1985-2011	64.0	24.4	11.6

Source: Pre-Accession Economic Programme 2013-2015, p. 24

The contribution of total factor productivity to economic growth is remarkably higher than the other factors after 2001. For instance, TFP contributed to the economic growth by 20.2% in 2001-2011, and by 25.9% in 2002-2011. These rates also show the impact of 2001 crisis on Total Factor Productivity-economic growth nexus. Furthermore, contribution of employment to the growth was by 26.4% in 2001-2011, and by 23.7 in 2002-2011. After the financial crisis in 2008, Turkish economy has grown by 8.9% and 8.5% in 2010 and 2011,

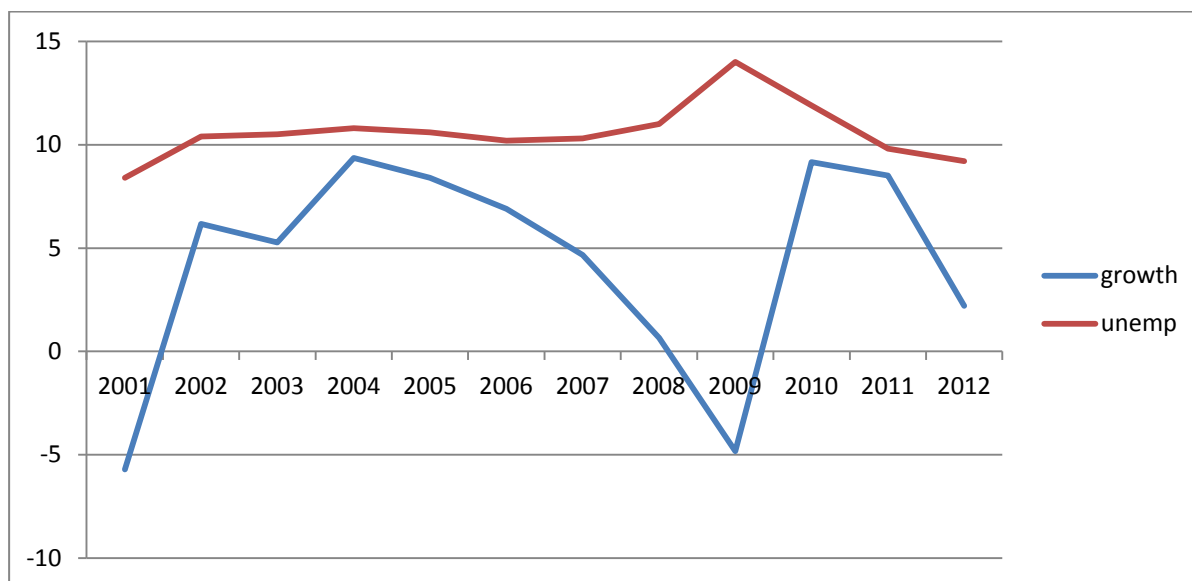
respectively. TFP growth was 0.2%, employment growth was 6.7% in 2011. Due to increase in employment, contribution of employment to economic growth was 46.4% in 2011. Contribution of capital stock and TFP were 51.7% and 1.9% respectively, at the same period (Pre-Accession Economic Programme 2013-2015, p. 24).

Higher economic growth can be also associated with the improvements in some macroeconomic variables after 2001. Especially, decreasing public debt and inflation lead relatively to ensure macroeconomic stability. To exemplify, public net debt stock has been decreasing as a share of national income and as an absolute value since 2001. The ratio of public net debt stock to GDP was 66.4% in 2001; it decreased to 41.7% in 2005 and to 17% in 2012. Besides, gross public debt stock has been declined below the average of European Union. Furthermore, higher inflation has not been a problem for the economy since 2001. It has been lower in this period relative to 1990s. For instance, while inflation rate was 62.4% in 1983-1994, it was 71.6% in 1995-2001 and 9.1% in 2002-2012.

Despite the fact that economic growth has been higher after 2000s compared to 1990s, the same affirmative performance has not been observed in Turkish labour market by virtue of supply side pressures such like dramatic growth of the working age population, widely distributed employment in small scale establishments, decreasing labour force participation and low employment rate (Şahin *et. al.*, 2013, p.5). Especially unemployment rate has been higher since 2001 in comparison with 1990s. For instance, average unemployment rate was 8.1% in 1992-1996 while it was 7.3% in 1997-2001. However, whereas average rate of unemployment in 2002-2006 was 10.5%, it was 11.1% in 2007-2012. More surprisingly, though Turkish economy has experienced higher growth rate after 2000, unemployment rate has been higher at the same period, as well. Especially, in 2002-2006,

unemployment rate was stubbornly higher in spite of the higher growth rate and lower volatility in economic growth.

Figure 3.3: Economic Growth and Unemployment (percentage, 2001-2012)



Source: TURKSTAT

As is seen from table 3.4, the unemployment rate has been fixed at 10% until 2007. Financial crisis at the end of 2008 has such a negative impact on employment. Hence, the rate increased to 11% in that year, whilst it dramatically rose to 14% in just one year later. As of 2010, the unemployment rate decreased to 11.9%, it declined to 9.8% in 2011 and to 9.2% in 2012. An important issue that should be emphasized is difference between male and female unemployment rate. Female unemployment rate have been higher than male unemployment rate since 2004. In this sense, female unemployment rate is 11.3 % in 2001-2012 while male unemployment rate is 10.6 % at the same period.

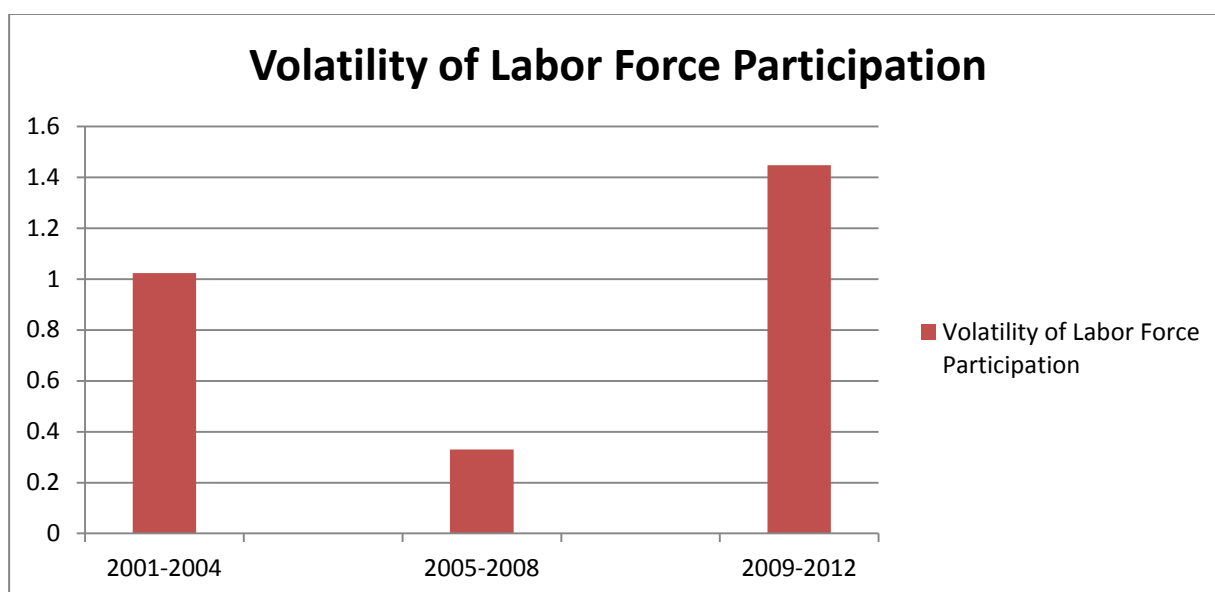
Table 3.4: Unemployment Rate and Labor Force Participation by Gender

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Unemployment Rate	<i>Total</i>	8.4	10.4	10.5	10.8	10.6	10.2	10.3	11	14	11.9	9.8	9.2
	<i>Female</i>	7.5	9.5	10.1	11	11.2	11.1	11	11.6	14.3	13	12.6	11.8
	<i>Male</i>	8.7	10.7	10.7	10.8	10.4	9.9	10	10.7	13.9	11.4	10.1	9.5
Labour Force Participation Rate	<i>Total</i>	49.6	51.9	50.6	49.9	50.2	50	50	50.7	51.8	52.8	49.8	50
	<i>Female</i>	27.1	29.4	28.1	25.3	25.4	25.8	25.8	26.8	28.5	30.3	28.7	29.5
	<i>Male</i>	72.5	74.5	73.3	74.7	75.1	74.4	74.4	74.8	75.3	75.5	71.7	71.1

Source: WORLD BANK, TURKSTAT

Labor force participation rate was 51.9% in 2002, and it has been fixed at approximately 50% in 2003-2008. It increased to 51.8% in 2009, but the rate reached to its highest level, by 52.8% in 2010. After this point, labor participation rate decreased to 49.8% in 2011 and to 50% in 2012. In addition, the volatility of labour force participation is undoubtedly remarkable. It may be said that labour force participation rate has a volatile pattern since 2001, just like economic growth. As is seen from the figure 3.4, the volatility of labour force participation was 1.02 between the period of 2001-2004, it decreased dramatically to 0.33 in 2005-2008 and increased to 1.44 in 2009-2012.

Figure 3.4: Volatility of Labor Force Participation

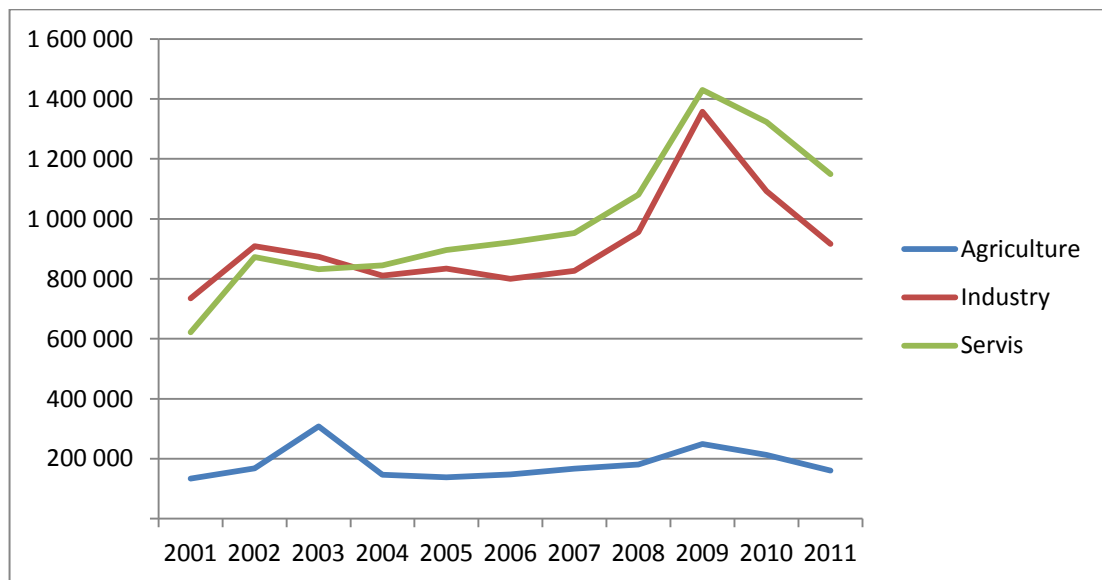


Source: Author's own calculation based on TURKSTAT

Huge gap between the male/female is noticeable in terms of the labour force participation. Female labor force participation rate has been strikingly lower than male labor force participation rate since 2001. Female labor force participation rate appears as 27.6 % in

2001-2012; whereas male labor force participation rate is 73.9 % at the same period. In addition to this, female participation rate is extremely low even in urban areas due to women's less participation to employment opportunities in urban areas (Taymaz, 2010, p.1). This can be attributed to the fact that females who migrate from rural areas to urban districts retreat from the labour force because of their low education levels, cultural values against their employment and unsuitable labour market conditions (Tansel, 2002, p.5).

Figure 3.5: Sectoral Unemployment (Thousand People, 15+)



Source: TURKSTAT

In addition to increase in the share of services sector in the GDP, unemployment in services sector has been also increasing since 2001 and the highest unemployment has occurred in service sector since 2003. In 2001, there were 622 thousand unemployed people in services sector. It increased to 922 thousand in 2006 and finally to 1 million 149 thousand unemployed in 2011. As for industry sector, there were 735 thousand unemployed people in 2001; it increased to 800 thousand unemployed in 2006 and to 916 thousand unemployed in

2011. In agriculture sector, there were 134 thousand unemployed in 2001; it increased to 148 thousand unemployed in 2006 and to 160 thousand unemployed in 2011.

As sources of the economic growth have changed since 2001 that is mentioned above, dynamics of unemployment have also differed after 2001 in comparison with 1990s. As is known, unemployment was not a serious problem in 1990s compared to 2000s in which high growth rates have been prolonging in spite of low employment rate. Unemployment rate was 7.7 percent between 1990-2001, whereas the rate was 9.23 percent between 2002-2012. There might have been two reasons of the low unemployment rate: Using agricultural sector as storage of employment and state economic enterprises (Umut, 2011, p. 120). On the other hand, since the structure of Turkish economy has changed with transition program for strengthening the economy since 2001, dynamics of unemployment have also altered. In this context, conditions that cause unemployment in Turkey can be affected by the factors driven by public sector, market and international conditions (Umut 2011, pp. 121). One important factor of the high unemployment after 2001 is related to changing the role of government. As it is dwelled on, role of the government in Turkey has changed since 2001 from active position in the market to supervisor. Due to this reason, state economic enterprises have not been used as a source of employment in Turkey, especially after 2001 (Umut, 2011, p.120). Agricultural sector is undoubtedly another field in which the employment structure has changed. In 1990s, 40 percent of total employment was in agriculture sector. After 2001, this ratio started to change dramatically year by year. Whereas number of employed people in agricultural sector was 9 million people in 1990s, it decreased to 7.5 million people between 2000-2004 and to 5.7 million people between 2005-2012. Besides, employed people in industrial and services sectors were 3.3 million and 6.9 million, respectively, between 1990-2000, while they increased to 4 million and 10.8 million between 2000-2012. Another factor

for stubborn unemployment is surely inflation targeting program which has been applied since 2001. In 1990s, one of the depressive problems in Turkish economy was very high inflation. Inflation rate was 62.7 percent in the period of 1983-1994; it was 71.6 percent between 1995-2001; however, 9.1 percent between 2002- 2012. When inflation targeting program combined with the goal of financial stability, Turkish economy was able to decrease the inflation rate and to reach to higher economic growth after 2001. On the other hand, this program has caused a pressure on the prices; therefore, employers preferred to fire many workers for the sake of reducing the production cost (Umut, 2011, 122). Another possible reason of ongoing unemployment in Turkey might be speculative capital flows. Even though interest rate has decreased year by year since 2001, it should be kept in mind that it is still higher compared to most of developing countries. Especially, credit interest rate remained constant at 16% in spite of the low inflation rate. Hence, Turkish Economy has experienced higher short-term capital inflow since 2001. As a result, while speculative capital inflow has led to growth in economy, it could not produce employment (Yeldan, 2010, p.11).

CHAPTER 4: EMPIRICAL ANALYSIS

4.1. Threshold Autoregressive Models

A great extent of empirical studies in economics hinges on a linear specification among the variables. In other words, many papers based on empirical studies mainly assume the linearity. However, some macroeconomic variables may exhibit nonlinear behavior on the basis of economic theory. For instance, interest rate tends to be more sensitive if an economy is either under the low-volatility regime or high-volatility regime. A similar movement might be observed in stock returns which differ depending upon low-volatility or high-volatility in financial market (Zapata and Gauthier, 2003, p.2). In such circumstances, nonlinear specification may give more consistent and efficient results *vis-à-vis* linear models. In order to detect these nonlinear behaviors, regime switching models (RSM) have been developed (Priestley, 1980 & 1988, and Granger and Terasvirta 1993). With a further explanation, the behavior of dependent variable depends upon the condition of the system. To exemplify, unemployment rate is prone to increase sharply in contraction term, however, it does not decline sharply to its long-run value in an economic expansion. In such a case, dynamic adjustment mechanism for unemployment depends upon if economy is either in a recession regime or in an expansionary regime. Therefore, some regime-switching models have been introduced to observe these types of regime shifts (Enders, 2010, p.439).

One popular nonlinear model that has been used in economics literature is the threshold autoregressive (TAR) model that was firstly introduced by Tong and Lim (1980) and Tong (1990). Thenceforth, TAR model has been a significant influence among the economist and it has found enormous application fields in the empirical economics literature (Hansen, 2011, p. 123). To illustrate, one common application of TAR model has been to analyze the business cycles, and specifically, aggregate output as measured by the GNP growth rates. In this framework, Beaudry and Koop (1993), Pesaran and Potter (1997) and Enders, Folk and Siklos (2007) are the pioneer studies which discuss the nonlinearity in output. Another major application of TAR model has been to test the nonlinearity of interest rate. In this sense, Pfann, Schotman and Tschernig (1996), Tsay (1998) and Hansen and Seo (2002) use the TAR model in order to detect the nonlinear behavior in interest rate. What's more, some papers have discussed that whether exchange rate has a nonlinear pattern or not. Krager and Kugler (1993), Balke and Wohar (1998), O'Connel (1998) and Chappel, Padmore, Mistry and Ellis (1998) are some of them. Besides, Koop and Potter (1999), Dijk, Franses and Paap (2002), Skalin and Teräsvirta (2002) are the examples that examine the nonlinearity of unemployment.

In order to understand TAR model, suppose that u_{Lt} and u_{St} are the long-run and short-run unemployment rate, respectively. Assume that the spread is defined as $k_t = u_{Lt} - u_{St}$ and adjust to the long run value $\bar{k}$. A simple first order autoregressive process [AR(1)] of the dynamic adjustment mechanism may be

$$[14] \quad k_t = a_0 + a_1 s_{t-1} + \varepsilon_t \quad \text{since} \quad 0 < a_1 < 1$$

Let $\bar{k}$ defines as the long run value $a_0 / (1 - a_1)$, so adjustment process converts into

$$[15] \quad k_t = \bar{k} + a_1(k_{t-1} - \bar{k}) + \varepsilon_t$$

The system can be said in long-run equilibrium if $k_t = \bar{k}$. In other cases, a_1 percent of the current period's deviation from the long-term value persists into the next period. Here, it is possible to say that unemployment rate exhibits a nonlinear adjustment pattern. The persistency of spread might differ across the periods. For instance, $k_{t-1} - \bar{k} < 0$ are more persistent than $k_{t-1} - \bar{k} > 0$. In other words, the periods in which the spread is low relative to its long term value are more persistent than periods in which the spread is high relative to its long run value (Enders, 2010, p.249). This condition can be modeled as

$$[16] \quad k_t = \begin{cases} \bar{k} + a_1(k_{t-1} - \bar{k}) + \varepsilon_{1t} & \text{if } k_{t-1} > \bar{k} \\ \bar{k} + a_2(k_{t-1} - \bar{k}) + \varepsilon_{2t} & \text{if } k_{t-1} \leq \bar{k} \end{cases}$$

since ε_{1t} and ε_{2t} are white-noise processes.

While k_{t-1} is above the threshold value $\bar{k}$, the AR (1) process for the spread is as $k_t = \bar{k} + a_1(k_{t-1} - \bar{k}) + \varepsilon_{1t}$ and when k_{t-1} is below the threshold, the AR (1) process for the spread is as $\bar{k} + a_2(k_{t-1} - \bar{k}) + \varepsilon_{2t}$. If $|a_2| > |a_1|$, periods will be more persistent than other periods while $k_{t-1} < \bar{k}$.

Threshold Autoregressive models might be estimated by using Ordinary Least Squares (OLS) method. To understand how a simple TAR process is applied, assume that zero is threshold value, degree of autoregressive persistent is a_1 if $y_{t-1} > 0$ and it is a_2 if $y_{t-1} < 0$. In this circumstances, y_t can behave as

$$[17] \quad y_t = \begin{cases} a_1 y_{t-1} + \varepsilon_{1t} & \text{when } y_{t-1} > 0 \\ a_2 y_{t-1} + \varepsilon_{2t} & \text{when } y_{t-1} \leq 0 \end{cases}$$

As is seen, y_t has a one autoregressive process when y_{t-1} is higher than zero, however, it has a different autoregressive process when y_{t-1} is lower than zero. Even though y_t has a linear pattern in each regime; as a whole, y_t shows a nonlinear behavior through regime shift. Regime switching results from the shocks to disturbance terms (ε_{1t} or ε_{2t}). In the TAR model, the variances of these error terms assumed to be equal $\{ \text{var}(\varepsilon_{1t}) = \text{var}(\varepsilon_{2t}) \}$. In this case, equation [17] can be written as

$$[18] \quad y_t = a_1 I_t y_{t-1} + a_2 (1 - I_t) y_{t-1} + \varepsilon_t$$

since $I_t = 1$ when $y_{t-1} > 0$ and $I_t = 0$ when $y_{t-1} \leq 0$.

I_t is an indicator function (dummy variable) and if y_{t-1} is above the threshold, it takes the value of one, or else, value of zero. If $y_{t-1} > 0$, so $I_t = 1$ and $(1 - I_t) = 0$, y_t is governed by $a_1 y_{t-1} + \varepsilon_t$. While $y_{t-1} < 0$, hence $I_t = 0$ and $(1 - I_t) = 1$, y_t is governed by $a_2 y_{t-1} + \varepsilon_t$ (Enders, 2010, p.440).

It is possible to generalize this methodology for a higher-order autoregressive process in each regime. A general equation can be written as

$$[19] \quad y_t = I_t [a_{10} + \sum_{i=1}^p a_{1i} y_{t-i}] + (1 - I_t) [a_{20} + \sum_{i=1}^r a_{2i} y_{t-i}] + \varepsilon_t$$

since $I_t = 1$ when $y_{t-1} > \tau$ and $I_t = 0$ when $y_{t-1} \leq \tau$ where τ is a threshold value. In the general model, there are two different regimes relates to the value of y_{t-1} . If $y_{t-1} > \tau$, so $I_t = 1$ and $(1 - I_t) = 0$, y_t is governed by $a_{10} + a_{11} y_{t-1} + \dots + a_{1p} y_{t-p} + \varepsilon_t$. While $y_{t-1} \leq \tau$, $I_t = 0$ and $(1 - I_t) = 1$, y_t is equal to $a_{20} + a_{21} y_{t-1} + \dots + a_{2r} y_{t-r} + \varepsilon_t$.

As it is understood above, critical point in studying TAR model is whether threshold value is known or not. If the threshold value is known, TAR model estimation is possible by creating dummy variable and using OLS. However, if it is unknown, Chan's (1993)

methodology might be used in order for obtaining super-consistent estimate of threshold.

According to his model,

Threshold value (τ) must lie between the maximum and minimum values of the series. In practice, the highest and lowest 15 percent of the values are excluded from the search to ensure an adequate number of observations on each side of the threshold. (...) τ should lie within the band containing the middle 70 percent of the observation. Each data point within the band has the potential to be the threshold (Enders, 2010, p.444).

Since each data could potentially be a threshold value, all observation should be tested if it is a threshold value. Ultimately, the regression that contains the smallest residual sum of squares has the consistent estimate of the threshold (Enders, 2010, p.444).

4.2. Data, Preliminary Data Analysis and Unit Root Tests

The data set employed in this study covers the unemployment rate in logarithm and real GDP in logarithm that is measured by expenditure approach and it is based on 1998 constant prices for Turkey. The sample period starts from the second quarter of 2001 and ends in the fourth quarter of 2012, including a total of 57 quarterly observations.⁹ Dependent variable is unemployment gap and independent variable is output gap as Okun originally performs.¹⁰ Both of data are obtained from Turkish Statistical Institute (TURKSTAT). A question may arise that why the data series starts from second quarter of 2001 rather than using long data set. There are two interdependent answers of this question. Firstly, it is aimed to detect the impact of Policy for Transition to Strong Economy on the economic growth and

⁹ In order to eliminate the seasonality, CENSUS-X12 is used.

¹⁰ Some studies assert that unemployment rate is not meaningful indicator of the labor market conditions. Rather, employment rate might reflect better the conditions of labor market (Worldbank, 2006, p.13). For example, see Afşin et. al. (2013), Chinn, Ferrara and Mignon (2013).

unemployment nexus. Secondly, as mentioned before, the sources of the economic growth and unemployment in 1990s and 2000s are visibly different from each other. The reason underlying this condition is that the economic policies which were applied in these two periods are remarkably different. Therefore, even though in order to use a long data set may give econometrically more robust results, regarding these differences in economic policy, economic interpretation of the results would not be easy for economists.

Since the gap model is applied in order to analyze the asymmetric relationship in Okun's law, in this study, first step is to detect the cyclical components of the variables. To that end, HP Filter is used in order to decompose the (log) unemployment rate and (log) real GDP into trend and cyclical components.¹¹ Time series plots of the cyclical components of (log) unemployment rate (unemployment gap) and (log) real GDP (output gap) obtained by using the HP filter is seen from the appendix 1. Not surprisingly, the movements of the cyclical components of (log) real GDP and (log) unemployment rate are in opposite directions. In addition, peaks in cyclical (log) real GDP, in general, coincide with troughs in cyclical (log) unemployment rate; and peaks in cyclical (log) unemployment rate generally occurs while (log) real GDP is at troughs. This opposite direction of the variables is also affirmed by the highly negative correlation, -0.8142, between these two cyclical series.

The summary statistics of the variables in logarithmic form are summarized in Table 4.1. An interesting feature of data is that either output gap or unemployment gap has fat-tailed distribution that exhibits large skewness and kurtosis. In this sense, both variables suffer from excess skewness and kurtosis. This can be attributed to the fact that these variables are not normally distributed. As is seen from table, output gap is positively skewed

¹¹ Based on Ravn and Uhlig (2002), smoothing parameter value is chosen as 1600.

whereas unemployment gap is negatively skewed. Besides, both output gap and unemployment gap suffer from positively excess kurtosis that is indicated by a peak. These characteristics of the data hint at that a model that takes into account the time-varying and nonlinear dynamics may give more efficient results in comparison with the other models that capture linear specifications of time series. In other words, using linear model instead of nonlinear model in such a case might conduce to biased estimation. Furthermore, standard deviation of unemployment gap is higher than standard deviation of output gap. This can be attributed to the fact that the sensitivity of unemployment to the shocks is higher than sensitivity of output.

TABLE 4.1: Summary Statistics (a)

Series	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis
y^c	2.47E-12	0.040300	-0.116111	0.076016	-0.483547	3.109660
u^c	1.45E-13	0.107478	-0.236265	0.269213	0.276066	2.704464

Source: Author's own calculation

a) y^c : Cyclical Output, u^c : Cyclical Unemployment

In order to comprehend the stochastic properties of the variables, six unit root tests that are based on linear specification are applied. The results reported in table 4.2. for the Augmented Dickey Fuller (1979) (ADF), Phillips and Perron (1988) (PP), Elliot *et. al.*'s (1996) Dickey- Fuller GLS, Kwiatkowski *et. al.* (1992) (Kwiatkowski, Phillips, Schmidt and Shin — KPSS), Elliot, Rothenberg and Stock Point Optimal (1988) (ERS) and NG and Perron's (2001) (NP) MZalfa unit root tests. The null hypothesis of KPSS, that is stationarity,

differs from the null hypothesis of the other unit root tests. Thus, a significant KPSS statistic means rejection of stationarity. According to the results, all tests agree that the output gap is stationary in tune with economic theory. Just PP test shows that the output gap is non-stationary. Besides, unemployment gap is stationary that is compatible with economic theory with respect to the unit root test as well.

Table 4.2: Unit Root Test Results

Test (Level)	Output Gap	Unemployment Gap
	<i>Constant</i>	<i>Constant</i>
ADF	-3.354068** (1) [0.0175]	-2.959172** (1) [0.0458]
PP	-2.280298 [0.1821]	-2.818134* [0.0628]
DF-GLS	-3.184284* (1)	-2.922009*** (1)
ERS	1.508847 (1)	1.766886*** (1)
NG-PERRON		
MZalfa	-17.1913***	-14.7203***
MZt	-2.92418***	-2.71105***
MSB	0.17010***	0.18417**
MPT	1.45350***	1.67170***
KPSS	0.069168***	0.057774***
KSS Test	-2.640735**	-2.754609**

Notes: Test regression includes only constant term. Optimum lag length is indicated in parenthesis. ***, **, * denote the rejection of null hypothesis of unit root at 1%, 5% and 10%, respectively. For KPSS test, asteriks symbolize the acception of null hypothesis of stationarity. P-values of test statistics are provided in bracket. Optimal lag lengths in ADF and DF-GLS Tests are selected via Schwarz Information Criteria. Critical values in constant model are -2.61 (%1), -1.94 (%5) and -1.61 (%10) for DF-GLS test [Elliot-Rothenberg-Stock 1996, Table 1). “AR Spectral OLS” method is used in ERS Test and optimal lag length is selected via Schwarz Information Criteria. Critical values in constant model are 1.922 (%1), 3.151 (%5) ve 4.280 (%10) [Elliot-Rothenberg-Stock 1996, Table 1). “Barlet Kernel” and “Newey West Bandwidth” methods are used in PP test. In NG-PERRON Test, “AR GLS-Detrended” Spectral Estimation Method is used and optimal lag length is selected through Schwarz Information Criteria. Critical values for KSS test are -2.82 (1%), -2.22 (5%) and -1.92 (10%) [Kapetanios *et. al.*, 2003, p. 364].

It is widely known that traditional unit root tests have low power to detect stationarity/non-stationarity if data generating process has regime shifts. For instance, when the process exhibits unit root in one of the regimes, although it is globally stationary, utilizing standard unit root tests may give biased estimation results (Hasanov *et. al.*, 2010, p. 1108). This problem is tried to be solved by two ways. Firstly, some studies use the panel data analysis in order to increase the power of standard unit root tests. Secondly, alternative forms of stationarity to AR and ARMA such like nonlinear transition dynamics are employed (e.g. Pesaran and Potter, 1997, and Kapetanios, Shin and Snell, 2003). Regarding these problems of standard unit root tests, Kapetanios, Shin and Snell (KSS) test is applied as well in this study. They advance the standard ADF test to capture non-linearity in the time series. They assume the null hypothesis of non-stationarity as in the ADF test against the alternative hypothesis of nonlinear but globally stationary process. According to the results, both output gap and unemployment gap reject the non-stationarity assumption at 5% significant level. Namely, either output gap or unemployment gap are nonlinear and globally stationary. Therefore, it can be said that output gap and unemployment gap are $I(0)$ processes and have a nonlinear pattern.

4.3. Empirical Models

4.3.1. Linear and Nonlinear Specification

As it is mentioned before, Okun's law implies the inverse relationship between cyclical unemployment and cyclical output. In this sense, Weber (1995) uses the following static, linear, bivariate model specification in order to detect this relation:

$$[20] \quad y_t^c = y_t - y_t^n$$

$$[21] \quad u_t^c = u_t - u^n$$

$$[22] \quad u_t^c = \mathcal{G}y_t^c + \varepsilon_t$$

where y_t^c is logarithm of output gap, y_t is logarithm of actual output, y^n is logarithm of potential output, u_t^c is the logarithm of unemployment gap, u_t is observed unemployment rate, u^n is natural unemployment rate; and ε_t is an error term. The term $\mathcal{G}$ denotes the Okun's coefficient and it is estimated to be smaller than zero, such that $\mathcal{G} < 0$. Hence, equation [18] is one version of Okun's law.

Since using static models usually lead to arise the serial correlation problem, it is necessary to add lagged cyclical variables into the model (Moosa, 1997, p.340).¹² In order to remove serial correlation and to allow for some short-run dynamics, Weber (1995) employs the autoregressive distributed lag model to estimate Okun's coefficient:

$$[23] \quad u_t^c = \gamma_0 + \sum_{i=1}^p \alpha_i u_{t-i}^c + \sum_{i=1}^q \beta_i y_{t-i}^c + \varepsilon_t$$

¹² Mizon (1995) puts forward that serial correlation may be an indicator for misspecification of the model. Therefore, instead of correcting the serial correlation problem, the model should be respecified. He claims that correction for autocorrelation might cause inconsistent estimates and this method is generally invalid and cannot be justified on the grounds of "robustifying" estimation against the presence of residual serial correlation.

where the value that minimizes the Akaike's information criterion or the Bayesian information criterion can be selected as the optimal lag length, k . The model is based on the lagged values of unemployment gap and output gap. Theoretically, the lagged output gap is included into the model due to existence of output adjustment cost which means that the effect of a change in output gap on unemployment gap might not be felt fully in some periods (Palley, 1993, p. 145). This equation allows us to calculate the long-run effect of cyclical output on cyclical unemployment, which follows as:

$$[24] \quad \eta^{LR} = \frac{(\sum_{i=1}^q \beta_i)}{(1 - \sum_{i=1}^p \alpha_i)}$$

since η^{LR} denotes the long-run effect of cyclical output on cyclical unemployment.

In order to analyze the existence of threshold impact, Hansen (1996, 2000)'s methods that provide new techniques on threshold autoregressive models are utilized. In this sense, Hansen (2000) suggests a data-sorting method that gives an opportunity to data to split the sample endogenously into two regimes by using a threshold variable which is exogenously given in order to test the null of linearity against threshold alternative (Hansen, 2000, p. 576). The main issue on threshold estimation is that because threshold value is generally unknown, it must be estimated. Therefore, Hansen (2000) develops an asymptotic theory in order for constructing asymptotic confidence intervals for ordinary least squares estimates of threshold parameters (Hansen, 2000, p.589).

Consider the following TAR model that has two-regime structural forms:

$$[25] \quad y_t = \theta_1 x_t + \varepsilon_{1t} \quad \text{if} \quad q_t \leq \gamma$$

$$[26] \quad y_t = \theta_2 x_t + \varepsilon_{2t} \quad \text{if} \quad q_t > \gamma$$

since q_t is the threshold variable that is used to split the sample into two groups. y_t and x_t are the dependent variable and explanatory variable respectively. ε_{1t} and ε_{2t} are the error terms which are white noise and γ are threshold parameter. If the magnitude of threshold variable is smaller than threshold parameter, equation 25 should be employed and equation 26 should be used in case of the threshold variable is higher than threshold parameter. Three questions should be answered in order to test the existence of threshold effect: i) how can the threshold variable be estimated; ii) how can the confidence intervals be constructed; iii) how can the asymptotic distribution of slope parameters be obtained (Girma, 2005, p. 7).

As is mentioned, the threshold regression model tells that the regression parameters alter depending upon the threshold variable. The model [25] and [26] may be written in the following equation by defining dummy variable $d_t(\gamma) = \{q_t \leq \gamma\}$, where $\{\cdot\}$ is the indicator function, and setting $x_t(\gamma) = x_t d_t(\gamma)$:

$$[27] \quad y_t = \theta x_t + \delta x_t(\gamma) + \varepsilon_t$$

where $\theta = \theta_2$ and $\delta = \theta_1 - \theta_2$. Let $S_1(\gamma) = \varepsilon_t'(\gamma)\varepsilon_t'(\gamma)$ presents the sum of squared errors of estimating the OLS regression parameters θ , δ and γ , the optimal threshold level can be selected to minimize $S_1(\gamma)$, as follows (Hansen, 2000, pp.577-578):

$$[28] \quad \gamma' = \arg \min_{\gamma} \{S_1(\gamma)\}$$

Conditional on a threshold variable γ' , equation 28 is linear in θ and δ , so it might be minimized to yield the conditional OLS estimates of $\theta'(\gamma)$ and $\delta(\gamma)$.

Equation [27] “allows the marginal effects of explanatory variables on the dependent variable to vary around a threshold value of any variable, which can or cannot be a regressor” (Arabacı and Eryiğit, 2012, p. 35). The significant issue mentioned above is to analyze whether or not the threshold effect is statistically significant. The hypothesis of no threshold effect can be written as $H_0 : \gamma = \gamma_0$, which implies linearity against two-regime model, since γ_0 symbolizes the true value of γ . Under the null hypothesis of no threshold effect, because threshold variable is not identified, the distributions of classical test are not standard (Girma, 2005, p. 7). Hence, Hansen (1996, 2000) proposes a Lagrange Multiplier (LM) test that is both heteroscedasticity consistent and autocorrelation robust and the bootstrap method to determine the asymptotic distribution of LR test for H_0 :

$$[29] \quad LR_1(\gamma) = \{S_1(\gamma) - S_1(\gamma')\} / H_1$$

where $S_1(\gamma)$ and $S_1(\gamma')$ are the residual sum of squares under $H_0 : \gamma \neq \gamma_0$ and $H_0 : \gamma \neq \gamma_0$; and σ^2 is the residual variance under H_1 . It should be emphasized that under the normality assumption, the likelihood ratio test statistic is employed in standard applications. However, Hansen comes up with that Lagrange multiplier test statistic has not a standard chi-square distribution under the endogenous sample splitting scheme (Girma, 2005, p. 8).

The last issue is to establish the asymptotic distribution of the slope coefficient. Even though these parameters depend upon the estimated threshold value, Hansen (2000) discusses that this dependence is not of first-order asymptotic importance. As a result, the usual distribution theory might be applied to the estimated slope coefficients (Girma, 2005, p.8).

4.3.2. Results from Linear Model

After obtaining the estimates of output gap and unemployment gap by using HP filter, the estimation results under both linear static model and linear autoregressive distributed lag model for equation [22] and [23] are presented in table 4.3. Diagnostics are also reported for first-order serial correlation and heteroscedasticity in the table. The lag length of the autoregressive terms of cyclical unemployment rate and cyclical output is chosen to be the one minimizing Schwarz information criterion and Akaike's information criterion among lags between one and five and is selected to be four. Both static model and autoregressive distributed lag model are estimated by ordinary least squares approach.

From the static model, the coefficient of y_t^c , e.g. ϑ , namely Okun's coefficient, is -2.08 and statistically significant at the one percentage level. There is no heteroscedasticity problem; however, the model suffers from serial correlation problem. With regard to Hendry and Mizon (1978) and Mizon (1995), autocorrelation is taken as an indicator for misspecified dynamics; therefore, the static model may lead to specification bias. Because of this reason, Okun's law is tested using dynamic autoregressive distributed lag model, by equation [23].

According to the dynamic model, it is observed that intercept is positive and statistically insignificant. In addition, the coefficient of α_1 is statistically significant at 5% significance level and positive, the coefficient of α_3 is also statistically significant at 5% significance level and positive. However, the estimate of α_4 is statistically significant at 5% significance level and negative. Besides, short-run Okun's coefficient, β , is statistically significant at 5% significance and negative, i.e. -1.27. As is seen, there are no heteroscedasticity and serial correlation problems in the model. Compared with the Okun (1962)'s and Arabacı and Arabacı (2010)'s results, the estimated Okun's coefficient is smaller in absolute magnitudes. The value of long-run impacts of cyclical output on cyclical unemployment, η^{LR} , is also reported. The long run responses of unemployment gap to output gap is -1.89. Tezcan and Abasız (2010) find the long-run Okun's coefficient as -0.48. One possible explanation for the difference between two results may be that they utilize from the long-period data set in contrast with the data set of this study. What's more, Mıhçı and Atılğan (2010) acquire the long-run Okun's coefficient as 0.73. The reason underlying the low Okun's coefficient might be that they include working hours and capacity utilization as explanatory variables in addition to employment into the model. As a consequence, the

estimation result proves that the inverse relationship between the cyclical unemployment and cyclical output is valid for Turkish economy.

Table 4.3: Linear Model Results

<i>Estimation Method and Coefficients</i>	<i>Estimate ^a</i>	<i>B-P-G Test ^b</i>	<i>LM Test ^c</i>
<i>Static OLS</i>		2.523583 (0.1192)	3.654961* (0.0123)
ϑ	-2.081976* (0.229641)		
<i>Dynamic OLS</i>		0.621055 (0.6500)	2.093717 (0.1007)
α_0	0.002058 (0.7305)		
α_1	0.376842* (0.133576)		
α_3	0.326817* (0.114282)		
α_4	-0.381704* (0.096856)		
β	-1.278870* (0.287959)		
η^{LR}	-1.89		

^a Estimation results of equation 22 and 23 using HP filtered data by ordinary least squares. Standard errors are in parenthesis. * symbolize the significance at 1% level.

^bB-P-G Test denotes Breusch-Pagan- Godfrey test for heteroscedasticity; p values are in parentheses.

^cBreusch-Godfrey LM Statistic for serial correlation under the null hypothesis of no serial correlation. P values are in parentheses. * denotes the rejection of null hypothesis of no serial correlation.

4.3.3. Results From Nonlinear Model

4.3.3.1. Testing for Nonlinearity

The first step to be taken before analyzing the estimation results is to test whether the series have threshold nonlinearity pattern or a linear one. To that end, Hansen (2000) suggests a method that gives an opportunity to data to split the sample into two regimes by using a threshold variable which is exogenously given in order to test the null of linearity against threshold alternative (Hansen, 2000, p. 576). Furthermore, Hansen (2000) develops an asymptotic theory in order for constructing asymptotic confidence intervals for least squares estimates of threshold parameters (Hansen, 2000, p.589).

In this study, the procedure of Hansen (1996) and Hansen (2000) is used in order to test the linear model, in other words no threshold effect, against the threshold model alternative by using the HP-filtered data. In this sense, LM test which is either heteroscedasticity consistent or autocorrelation robust is utilized to see if threshold effect exists for all variables in the model. The results, using u_{t-3}^c as the threshold variable, can be seen from the table 4.4.¹³ In order to obtain the bootstrap P-value, 1000 replications are used.

According to the results, no threshold effect hypothesis is rejected at 5% significance level against the alternative hypothesis of threshold effect. In addition, 95% confidence interval is estimated as [-0.049, 0.075]. The threshold effect, with threshold variable u_{t-3}^c and threshold parameter -0.020, implies that the regime-dependent impact of output gap on unemployment gap is valid for Turkish economy. Therefore, using linear models for

¹³ Since threshold effects of other variables give insignificant result, they are not reported.

estimating the responsiveness of unemployment gap to output gap may give rise to misleading and incorrect results.

Table 4.4: Test Results of Threshold Effects for Unemployment Rate (a)

	LM Test	Bootstrap p-value	Threshold Estimate	95% Confidence Intervals
$\alpha_3 (u_{t-3}^c)$	11.72	0.05	-0.020	[-0.04780, 0.075099]
a) Null hypothesis of no threshold				

4.3.3.2. Estimation Results

The estimation results can be found in table 4.5. The threshold value separates the data into what it is called the “expansion” ($u_{t-3}^c > \tau$) and “recession” ($u_{t-3}^c \leq \tau$) in tune with Cuaresma (2003). For the HP filtered data, there are 23 observations in the “recession” regime and 24 observations in the “expansion” state. In this sense, the sign of AR (1) and AR (3) coefficients are positive and statistically significant, while AR (4) coefficient is negative and statistically significant in the “recession” state. In the “expansionary” regime, the sign of AR (1), AR (3) and AR (4) coefficients are the same with the “recession” regime, but these are statistically insignificant. The sum of the autoregressive coefficients, as an indicator for persistence of unemployment, is 0.4142 in the recession state. Furthermore, Okun’s coefficient, β , is significantly negative in “recession” state, while insignificantly negative in “expansionary” case as found in Barışık *et. al.* (2010). This result implies that when actual

output is above the potential output, the unemployment rate is prone to decrease in downturns. On the other hand, this scenario is not valid in upturns of the economy. Moreover the long-run effect, η^{LR} , of output gap on unemployment gap is -2.185 which is higher than the results of Arabacı and Arabacı (2010), in the “recession” regime. Therefore, these empirical results show that there is an asymmetry in Okun’s law in Turkish economy.

Regarding the labor supply side, as mentioned before, the impact of changes of output growth on the unemployment rate is related to the responses of labour force participation to such changes. (Palley, 2003, p.149). In other words, cyclical sensitivity of labour force participation can lead to asymmetry in Okun’s law. As is mentioned before, labour force participation rate in Turkey has a volatile pattern since 2001 (see figure 3.4.). In this sense, labor force participation rate is included to the model and tested if the model has a nonlinear pattern in order to understand whether the asymmetry in Okun’s law for Turkish economy results from changes in the labor force participation or not. The estimation results are reported in table 4.6.

It is found that Okun’s coefficients are statistically significant and negative without considering which regime is valid. On the other hand, the estimated Okun’s coefficient differentiates substantially across the regimes. In other words, the behavior of unemployment changes significantly, depending on which regime the economy is in. The Okun’s coefficient is -0.9477 in “recession” regime while it is -1.4134 in the “expansionary” state. As is seen, the magnitude of Okun’s law is higher in expansionary regime than in recession regime. These results are consistent with the hypothesis that rigidity of labor market would lead to asymmetry in unemployment-output relationship. If there are some restrictions on firing but not on hiring, when economy goes into downswing, the response of

unemployment will be slow. When the economy recovers, employers will be willing to hire more workers. Therefore, the response of unemployment to output growth will be fast in expansionary state because restrictions on hiring workers are not strong as Silvapulle *et. al.* (2004) point out.

The estimation results, from both linear models and nonlinear model, provide evidence in support of inverse Okun's law for Turkey. On the other hand, in nonlinear model, the estimated Okun's coefficient differs across regimes. While the coefficient is -1.2795 in the "recession" regime, it is insignificant in "expansionary" regime. This finding might indicate the existence of asymmetry in Turkish economy between the period of 2001:Q2-2012:Q4. In addition, the rationale behind this condition may be explained that cyclical sensitivity of labour force participation might be effective on asymmetry in Okun's law for Turkish economy after 2001.

Table 4.5: Results from Threshold Autoregressive Model

Regime Type	Recession Regime	Expansionary Regime
<i>Coefficients</i>	$u_{t-3}^c \leq -0.020$	$u_{t-3}^c > -0.020$
α_0	0.016480512 (0.012309988)	-0.032218927 (0.0083077556)
α_1	0.44190047* (0.10060234)	0.56494594 (0.15306460)
α_3	0.55674812* (0.14479587)	0.49925122 (0.17303360)
α_4	-0.58441304* (0.093924760)	-0.23975802 (0.096238401)
β	-1.2795892* (0.17305216)	-0.34724028 (0.35461518)
η^{LR}	-2.185	-1.98

Notes: The Standard Errors are in Parenthesis. *, **, *** denotes the significance level at 1%, 5% and 10% respectively. The long run Okun's coefficient is calculated by equation 22 and 23.

Table 4.6: Results from Threshold Autoregression Model with Labour Force

Regime Type	Recession Regime	Expansionary Regime
<i>Coefficients</i>	$u_{t-4}^c \leq 0.015$	$u_{t-4}^c > 0.015$
α_0	-0.026323233** (0.0083301956)	-0.025833599* (0.0095566129)
α_1	0.47892687* (0.084214208)	-0.072040217 (0.17148173)
α_3	0.20995518 (0.16106761)	0.52919607* (0.085547800)
α_4	-0.67906638* (0.13730783)	-0.18395257 (0.10410857)
L	0.16485311 (0.32106490)	0.57719206* (0.11906430)
β	-0.94777289* (0.17367640)	-1.4134521* (0.25392861)

Notes: The Standard Errors are in Parenthesis. *, **, *** denotes the significance level at 1%, 5% and 10% respectively. L denotes the labor force participation rate.

CHAPTER 5: CONCLUSION

Asymmetry in Okun's law has been discussed by many economists due to its significance for both economists and policy makers. More recently, this discussion has also been prolonging for Turkish economy which has experienced stubbornly high unemployment rate in spite of high economic growth since 2001. Accepted belief is that there is an asymmetric relationship between economic growth and unemployment in Turkey. On the other hand, even if several studies affirm the validity of asymmetry in Okun's law, almost none of them explain the reasons underlying the asymmetry.

This study investigates the asymmetric relationship between economic growth and unemployment for Turkey between the period of 2001:Q2 and 2012:Q4 by utilizing the methodology of Hansen (1996, 2000) that propose a method that gives an opportunity to data to split the sample into two regimes by using a threshold variable which is exogenously given in order to test the null of linearity against threshold alternative. In addition to this, this paper tries to understand the reasons of asymmetric relationship between the variables. To that end, four regression models, two of them are based on linear specification and the others have nonlinear specification, are run. Since the gap model is employed in all models, the cyclical components of economic growth and unemployment are extracted with the help of Hodrick-Prescott filtering method.

According to the static linear regression results, Okun's coefficient is found as -2.08. There is no heteroscedasticity problem; however, the model suffers from the serial correlation

problem. Because Mizon (1995) points out that serial correlation may be an indicator of misspecification of the model, dynamic linear regression model is employed as well.

The results from the dynamic linear regression model show that the Okun's coefficient is -1.27. There are no heteroscedasticity and serial correlation problems in the model. The estimated Okun's coefficient is smaller in absolute magnitudes in comparison with Okun (1962)'s and Arabacı and Arabacı (2010)'s results. The long-run impact of economic growth on unemployment is -1.89.

According to the nonlinear regression results, while Okun's coefficient is statistically significant and negative as is expected in the "recession", it is statistically insignificant as is found by Barışık *et. al.* (2010). This results support the validity of asymmetric relationship between economic growth and unemployment for Turkey. In other words, there is an asymmetry in Okun's law in Turkish economy between the period of 2001:Q2 and 2012:Q4.

In order to understand the reason underlying the asymmetry in Okun's law, labour force participation rate is included to the model inspired from the paper of Palley (1993). Since the labour force participation has a volatile pattern, it is considered that whether asymmetry in Okun's law results from the changes in the labour force participation. According to the estimation results, Okun's coefficient is -0.94 in the "recession", whereas it is -1.47 in the "expansionary" state. In other words, the response of unemployment to the changes in unemployment is higher in "expansionary" state than "recession" case. In light of these results, it might be said that asymmetry in Okun's law for Turkish economy may result from changes in labour force participation.

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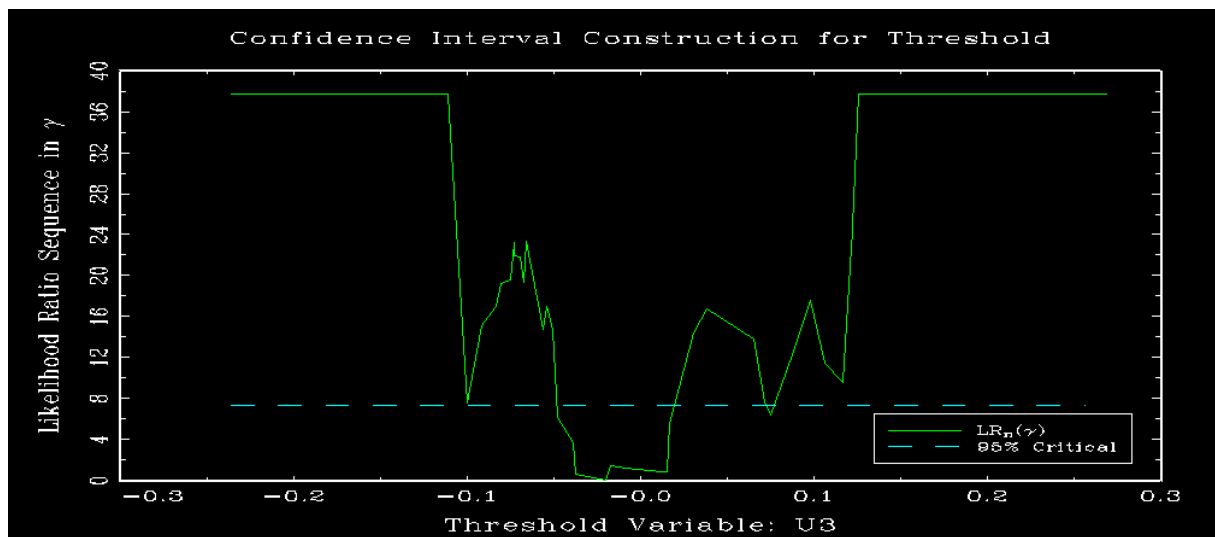
APPENDIX 1

Figure 3.6: Time Series of Cyclical Components of the (log) unemployment rate and (log) real GDP from 2001:Q2 to 2012:Q4 obtained by using the HP Filter.



Source: Author's own estimation

Figure 3.7: Confidence Interval around the Threshold Effect



Source: Author's own estimation