THE RELATIONSHIP BETWEEN UNEMPLOYMENT RATE AND GROWTH: TIME SERIES APPROACH FOR TURKEY

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ABSTRACT

THE RELATIONSHIP BETWEEN UNEMPLOYMENT RATE AND GROWTH: TIME SERIES APPROACH FOR TURKEY

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This study analyzes the relationship of economic growth and unemployment by using quarterly data for the period 2005:Q1-2016:Q1 for Turkish Economy. Three different versions of Okun's law which are difference, gap and dynamic versions are investigated in the study. According to results, it is found that Okun's Law is valid for Turkey. In addition, productivity variable is added to dynamic models to test effect of productivity on unemployment rate and models results reveal positive relationship between productivity and unemployment rate. Then the rate of output growth consistent with a stable unemployment rate in Turkey is calculated by using each versions of Okun's Law. Growth rate to keep unemployment rate stable is calculated as 3.57 percent for difference model, 4.15 percent for dynamic model and 3.87 percent for dynamic model including productivity. In addition, the short term relationship between growth and unemployment rate is examined by using vector autoregressive model (VAR) and Granger Causality test. According to results, it is found that there is a short run relationship between GDP and unemployment rate. Even though GDP Granger cause unemployment rate, unemployment rate does not Granger cause GDP.

Keywords: Okun's Law, Unemployment, GDP, VAR Analyses

ÖZ

İŞSİZLİK ORANI VE BÜYÜME ARASINDAKİ İLİŞKİ: TÜRKİYE İÇİN ZAMAN SERİLERİ YAKLAŞIMI

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Bu çalışmada 2005Ç1-2016Ç1 dönemi çeyreklik verileri kullanılarak büyüme ile işsizlik oranı arasındaki ilişki incelenmiştir. İlk olarak Okun Yasası'nın Türkiye için geçerliliği test edilmiştir. Okun Yasası'na ilişkin fark denklemi, aralık denklemi ve dinamik denklemleri oluşturulmuş ve yasanın Türkiye için geçerli olduğu sonucuna ulaşılmış ve Okun katsayıları elde edilmiştir. Ayrıca, verimliliğin işsizlik oranı üzerine etkisini test etmek amacıyla Okun dinamik denklemine verimlilik değişkeni ilave edilmiş, verimlilik artışının işsizlik oranını artırıcı etkisi olduğu sonucuna ulaşılmıştır. Okun fark ve dinamik denklemleri kullanılarak Türkiye'ye ilişkin işsizliği sabit tutan büyüme oranları hesaplanmıştır. İşsizliği sabit tutan büyüme oranları fark modeli için yüzde 3,57, dinamik model için yüzde 4,15 ve verimlilik etkisinin ölçüldüğü dinamik model için yüzde 3,87 olarak hesaplanmıştır. Çalışmanın ikinci bölümünde ise büyüme ile işsizlik oranı arasındaki ilişki VAR modeli yaklaşımı ve Granger nedensellik testi ile ele alınmıştır. Yapılan analiz sonucunda büyüme ile işsizlik oranı arasında kısa dönemli bir ilişki olduğu sonucuna ulaşılmıştır. Granger nedensellik testi sonucuna göre, büyümeden işsizlik oranına doğru nedensellik ilişkisi bulunurken, işsizlik oranından büyüme yönüne bir nedensellik ilişkisi belirlenememiştir.

Anahtar Sözcükler: Okun Yasası, İşsizlik, Büyüme,VAR Analizi

To My Family

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LIST OF ABBREVIATIONS

AIC	Akaike information criterion
AR	Autoregressive
BIC	Bayesian information criterion
EU	European Union
GDP	Gross Domestic Product
Hpgdp	Trend of Gross Domestic Product
Hpu	Trend of unemployment rate
IMF	International Money Fund
OLS	Ordinary Least Squares
Q	Quarter
SA	Seasonally Adjusted
SBIC	Schwarz Bayesian information criterion
TURKSTAT	Turkish Statistical Institute
U	Unemployment rate
V	Productivity
VAR	Vector Autoregressive
yoy	Year over year

CHAPTER 1

INTRODUCTION

Nowadays, unemployment is one of the most challenging concerns that countries encounter and it constitutes a major obstacle for countries in the development process. Hence, international organizations give priorities to growth and employment in the recent years and these organizations assert that creating higher employment opportunities is one of the most important challenge to reach sustainable and higher growth which is comprehensive and in a good quality.

In the literature, the view of increase in output growth corresponds to a decline in the unemployment rate or a decrease in output corresponds to an increase in the unemployment rate in general. However, despite higher growth, sometimes unemployment does not decrease as expected. Even for some periods, unemployment increases with higher economic output growth unexpectedly due to external factors.

For Turkey, considering the 2008-2009 global crises, the analysis of gross domestic product (GDP) growth and employment shows that the capacity of economic growth to create employment differs in pre-crises and post-crises periods. After global crises, elasticity of employment to GDP increases significantly which means growth brought large amount of employment for that period. Specific measures undertaken to encourage women and youth participation in the labor force are the most effective ones at that period. Although employment performance is better, this results in higher unemployment rates due to the high increase in the participation rates. Therefore, higher participation to labor force offset effect of strong employment creation that prevents improvement in unemployment rate.

The relationships between economic growth and unemployment were studied in literature firstly by Okun (1962). In this study, it is proposed that there is a negative correlation between growth and unemployment. This negative relationship between growth and unemployment is known as Okun's Law after Okun's study on this topic. Since 1962, though this law gives different results for different countries, it is valid for many economies. Okun stated three different equations to investigate negative relationship between unemployment and growth, and these equations are difference version, gap version, dynamic version of Okun's law. Details related to Okun's Law versions are given in Chapter 3.

Knotek (2007) studied with 1948-2007 periods quarterly data to test Okun's relationship for US. It is mentioned in the paper that a negative correlation was found between quarterly change in the unemployment rate and real output growth and this result coincides with Okun's original estimates using longer time series. When shorter time horizon is taken into consideration, the relationship between variables has changed substantially. That means Okun's law has not been stable over time and relationship differs in recessions and expansions periods.

Prachowny (1993) examined the relationship between output gap and unemployment rate by using gap version to provide estimates of output changes that separate the influence of unemployment changes from other factors such as changes in hours, productivity and participation rates. In the paper, it was explained that changes in output gap are influenced significantly by changes in working hours per week, capacity utilization in economy and unemployment gap.

Owyang & Sekhposyan (2012) worked on different version of Okun's law to assess effect of time variation in the unemployment and output fluctuations. They focused on three recent US recession and Great Recession particularly. In this paper, it was also found that Okun's coefficient is not stable over time. The correlation between output gap and unemployment rate changes significantly during the recessions that means unemployment on average increase significantly during recessions.

Ball et al. (2013) investigated the effect of short-run unemployment movements on Okun's Law for United States and twenty advanced economies. According to results, in the most countries, Okun's Law is a strong and stable. They also found that the response of unemployment rate to one percent change in output varies substantially across countries.

Demirgil (2010) tested the validity of Okun's Law for the periods 1989-2007 with quarterly data for Turkey. Besides accepted techniques, rolling regression techniques to investigate validity of law for short periods were examined. According to results, it was found that Okun's law is inefficient especially during the periods of exceptional productivity growth. It was stated in the paper that Turkish economy has had structural changes rather than cyclical recovery with the beginnings of 2000's.

Mıhçı & Atlıgan (2010) examined the validity of Okun's Law for Turkey during the periods between 1970 and 2006 by using quarterly data. According to the study, high unemployment rates with high growth rates in Turkey after 2001 economic crisis seems to contradict with this law. In this study, the Okun coefficient was estimated for both manufacturing industry and aggregate economy. The results revealed relatively low Okun's coefficients. That means, the output variations are not very sensitive to unemployment changes in Turkish economy. Both the capacity utilization rate and working hour's effect output level positively.

Kanca (2012) studied the relationship between economic growth and unemployment rate in Turkish Economy for the period 1970-2010. In the study, it was found that there is a long run relationship between economic growth and unemployment rate. In addition, Granger causality test was applied and one-way causal relationship from the growth rate towards the unemployment was found for the period of 1970-2010.

Göçer (2015) applied Okun's Law for Turkey for the period 2001:Q2-2015:Q1. According to results, every 1% point growth rate surplus 4.3% reduces the unemployment rate 0.11% point among 2001-2015 years. In addition, Granger causality analysis was conducted and it was found that economic growth is the Granger cause of the unemployment.

Demirbaş & Kaya (2015) analyzed the relationship between GDP and unemployment using Okun's Law methods. GDP was divided into two parts as gross capital formation of investment and final consumption expenditure to approaches different perspective. In addition, a dummy variable was created to the periods of expansion in the GDP. According to the findings of Johansen Co -integration analyses, there was a co-integration in the long-term between unemployment, gross capital formation, final consumption expenditures and periods of expansion for the data set of Turkey from 1980 to 2009.

Akay et.al. (2016) tested the validity of Okun's Law during the period 1969-2014 for Turkey. In the study, Markov Switching Model was used to determine the relationship between unemployment rate and growth. According to study, there exist short and long run relationship between unemployment and growth. Growth rate that is consistent with stable unemployment rate was found as 4.57 percent in the study.

The main aim of this study is to examine the relationship between economic growth and unemployment and to investigate the effect of economic growth on employment creation in order to obtain the rate of output growth consistent with a stable unemployment rate in Turkey. Using latest seasonally adjusted data, validity of Okun's Law and short term relationships between growth and unemployment rate by using vector autoregressive (VAR) models are investigated. In addition, this study differs from the other studies in the literature in terms of including all different versions of Okun's Law in the same study.

This thesis is organized as follows. The introduction chapter is followed by economic growth and unemployment outlook in Turkey. Then, methodology used in the study will be given. After that, data description and analyses chapter will be focused. Finally, results and discussion will be presented.

CHAPTER 2

ECONOMIC GROWTH AND LABOR MARKET OUTLOOK IN TURKEY

Turkish economy showed rapid recovery from the 2001 crisis by the help of a well-defined medium term roadmap, strong domestic reforms and the prospect of EU accession. Prudent fiscal policy and effective monetary policies applied during that period has provided macroeconomic stability. Structural reforms applied in investment and business environment, labor market, banking sector and trade are the main drivers of the stability achieved since 2002 (Macovei, 2009). In addition, considerable increase in foreign direct investment and high growth rate of private investments boosted labor productivity and result in the sectoral transformation of the economy.

Turkish economy gathered speed during 2002-2007 period and grew on average 6.8 percent annually. Manufacturing and services were the main drivers of growth on the production side while private consumption and investment were the main drivers on the expenditure side. Turkey also attracted more domestic and foreign investment at that period.

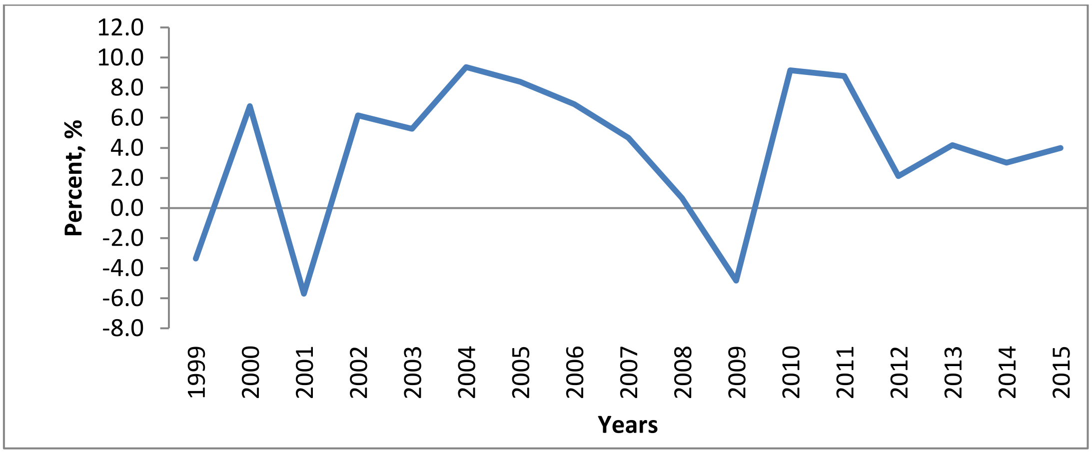

Figure 1 GDP Growth
Source: TURKSTAT

According to many economists, 2008-2009 global financial crisis was considered as the worst financial crisis after Great Depression. Turkish economy was adversely affected by the crisis and that caused to dramatic slowdown in economic activity in Turkey. Turkish economy started to shrink in the fourth quarter of 2008 year over year (yoy) and it continued to decline until the fourth quarter of 2009. Turkey grew only 0.7 percent in 2008 and declined by 4.8 percent in 2009 (Figure 1).

Turkey is one of the countries that overcome crisis very fast by the help of fiscal and monetary policies and structural reforms that applied effectively. Indeed, Turkey exhibited great performance and grew 9.2 percent and 8.8 percent in 2010 and 2011 respectively. However, in 2011, strong domestic demand and high oil prices resulted in huge increase in import bill and current account deficit reached 9.6% of GDP at the end of 2011. Therefore, the policy tailored to rebalance the economy and macro prudential measures have been taken in order to bring current account deficits under control. This action limited credit growth and external demand, therefore, growth rate declined by expenditure side.

Population and work force have been growing at a positive rate in Turkey. While total population[1] has been increasing by 1.4% annually on average between 2007-2015, the working age population (15 years old and older) grew by 1.8% annually. Labor force participation rate has also shown significant improvement. Compared to the first quarter of 2005, there is 7.4 percent increment in seasonally adjusted participation rate as of April 2016. That corresponds to 9.02 million increments in labor force at the same period (Figure 2). This performance is mainly due to increase in participation of women in the labor force especially since global crisis.

[1] Total population has reached to 78.7 million as of 2015. Working age population has reached to 58.6 million as of April 2016.

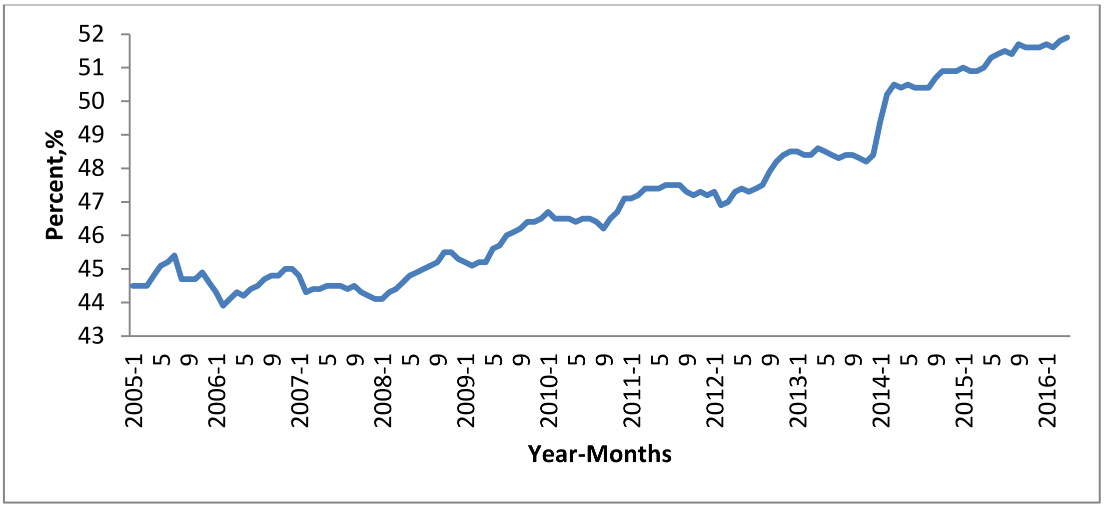

Figure 2 Labor Participation Rate in Turkey, Seasonally Adjusted (SA)
Source: TURKSTAT

Since 2008-2009 financial crisis, there has been a significant improvement in creating employment in Turkey. Before 2009, total employment showed a steady pattern over the years and was around 20 million. Since then, employment (seasonally adjusted) gained a momentum and reached 27.5 million as of April 2016 (Figure 3). Employment excluding agriculture has exhibited the same pattern as well. While seasonally adjusted employment grew 0.5 percent on average for 2005Q2-2008Q3, average growth rate increased to 1.1 in the post-crisis period. In 2015, annual employment growth realized as 2.7 percent.

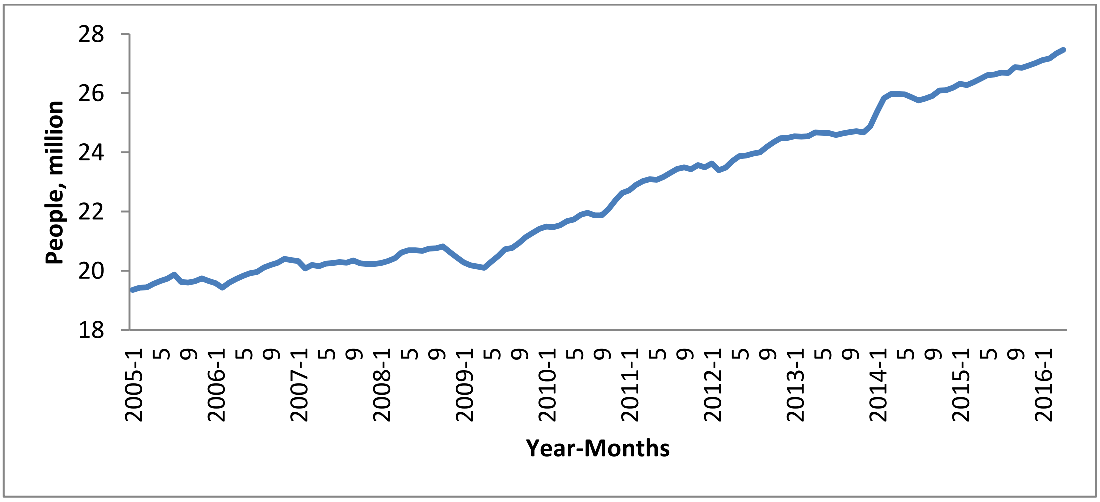

Figure 3 Total Employment (SA)
Source: TURKSTAT

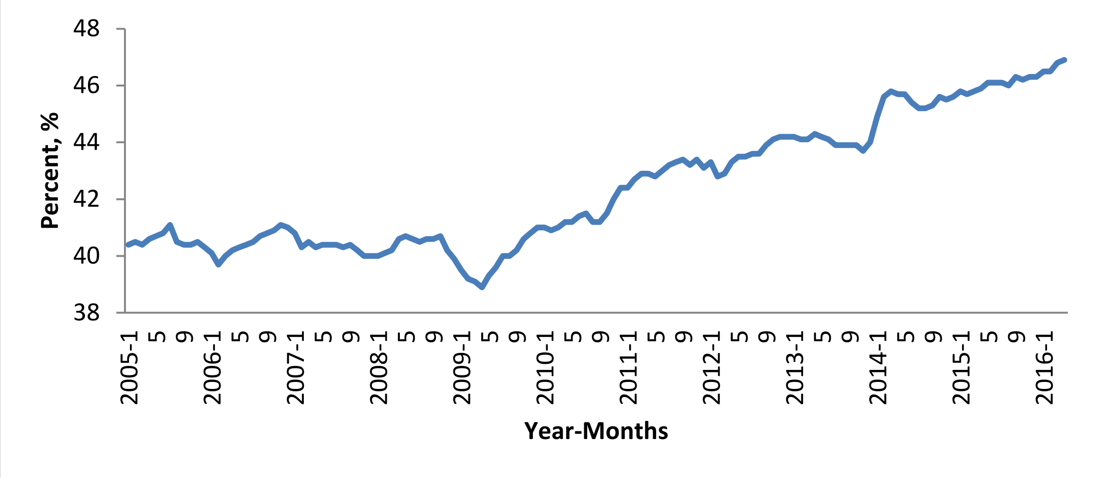

Figure 4 Employment Rate (SA)
Source: TURKSTAT

There has been structural change in Turkey's labor market moving from agriculture to other sectors since 1980s. The share of agriculture in total employment declined significantly from 46.4 percent in 1988 to 20.6 percent in 2015. According to Figure 5, although employment in agriculture deteriorated before crisis significantly, after crisis there has been a noticeable improvement in the sector and employment in that sector increased 5.5 million in 2015 from 4.5 million in the crisis periods.

Likewise total employment, sectoral seasonally adjusted employments showed rapid improvement after crisis. Since financial crisis to 2011, seasonally adjusted industry employment has shown great improvement. After 2011, the smoother pattern has been seen in the sector (Figure 6).

The services sector consist of business, communication, construction and related engineering, financial, tourism and travel related, educational and health services. It is seen in the Figure 7, employment in the services constitute half of the total employment and has shown increasing pattern over time.

Although employment in construction sector has been affected from crisis period, generally sector has exhibited an increasing pattern over the years (Figure 8). In addition, employment in construction sector started to gain momentum since the global crisis period.

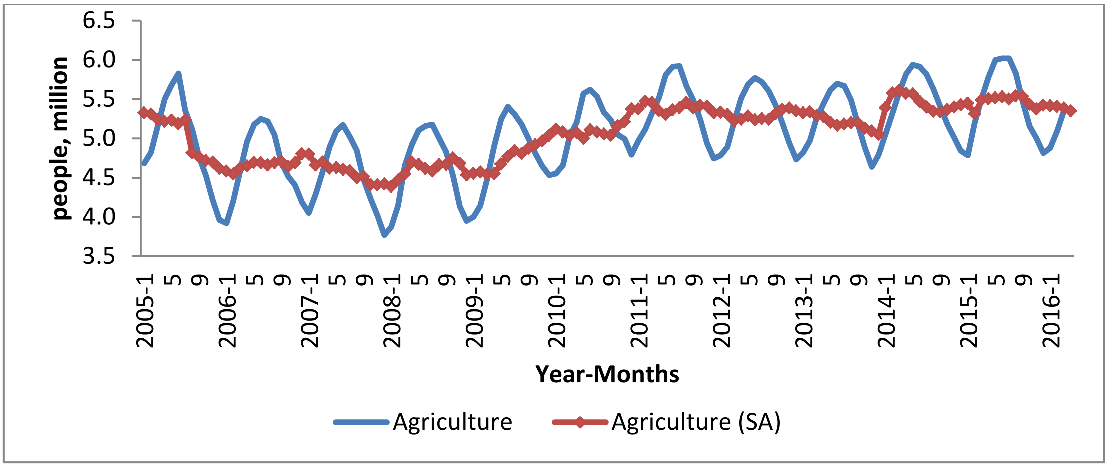

Figure 5 Employment in Agriculture
Source: TURKSTAT

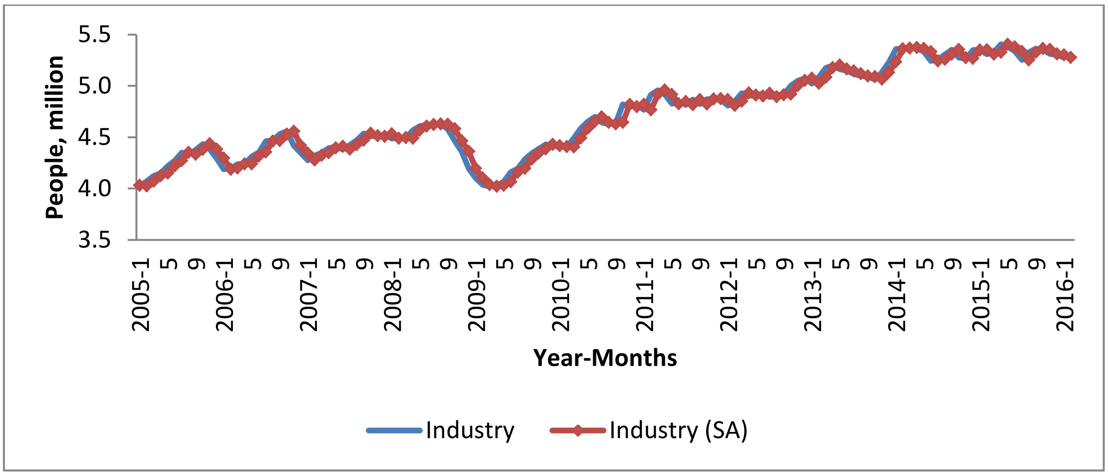

Figure 6 Employment in Industry
Source: TURKSTAT

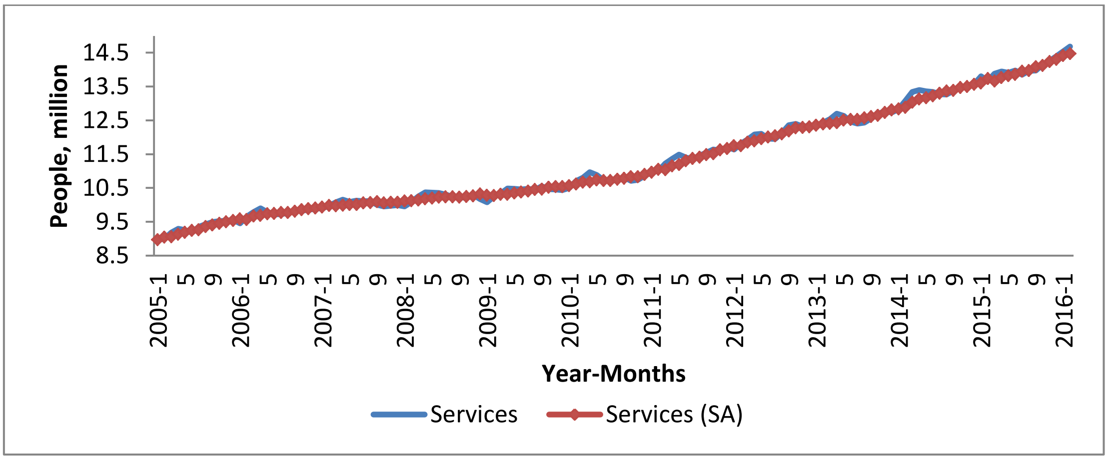

Figure 7 Employment in Services
Source: TURKSTAT

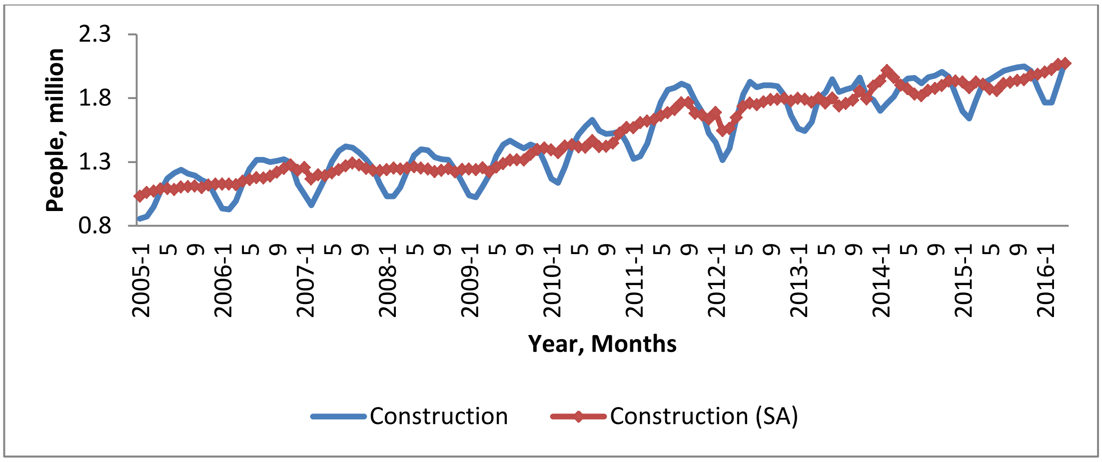

Figure 8 Employment in Construction
Source: TURKSTAT

Besides, creating enough employment and decreasing unemployment rates is a big challenge not only for Turkey but also for all countries in the world. Notably, after 2008-2009 global financial crisis unemployment become a big controversial issue for advanced economies. During crisis period in Turkey, the negative growth performance of the economy deteriorated the already weakened employment conditions. Seasonally adjusted unemployment rate increased to highest levels of 13.9 percent in April 2009 since January 2005. After the global crisis, unemployment rate showed downward trend over the years until the mid of 2012 and started to increase again mainly because of high labor force participations (Figure 9).

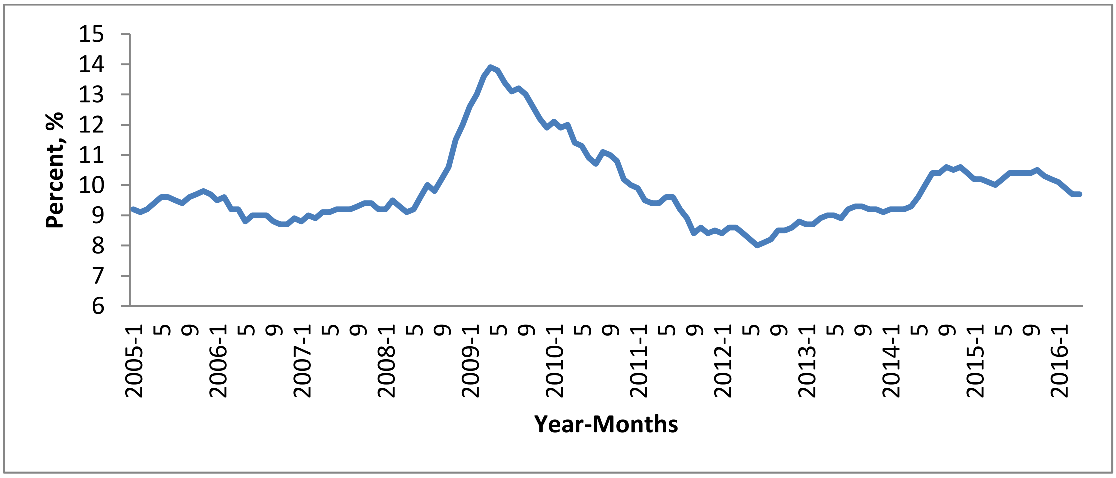

Figure 9 Unemployment Rate (SA)
Source: TURKSTAT

In the last few years, although there has been a great performance in creating employment, unemployment could not be decreased. As mentioned above, higher participation in labor force offset positive effect of strong employment creation that cause higher unemployment rate in the recent years. Measures taken toward labor market after crisis are the main reasons of increasing trend in labor force participation rates.

In the post-crisis period, the rapid growth of GDP and employment accompanied by upskilling and formalization of employment in the labor market. Employment elasticity of growth increased and employment creation in Turkey got better. (Ministry of Development & World Bank, 2013). Employment elasticity corresponds to a percentage change in employment related to 1 percentage change in economic growth. During the period 2005Q1 to 2008Q3 average employment elasticity of growth realized as 0.31. However, after crisis employment elasticity of growth significantly increased and realized 0.8 from period 2009Q4 to 2016Q1 on the average. That means, after the global crisis, the ability of economy to create employment as a percent of GDP growth increased compared to the post-crisis periods. When the linear trend of the employment elasticity of growth is examined in Figure 10, it can be said that there is a smooth increase in the employment elasticity trough time[2].

[2] Extreme employment elasticity variables are stated as an outlier and they are removed from both graph and trend calculations.

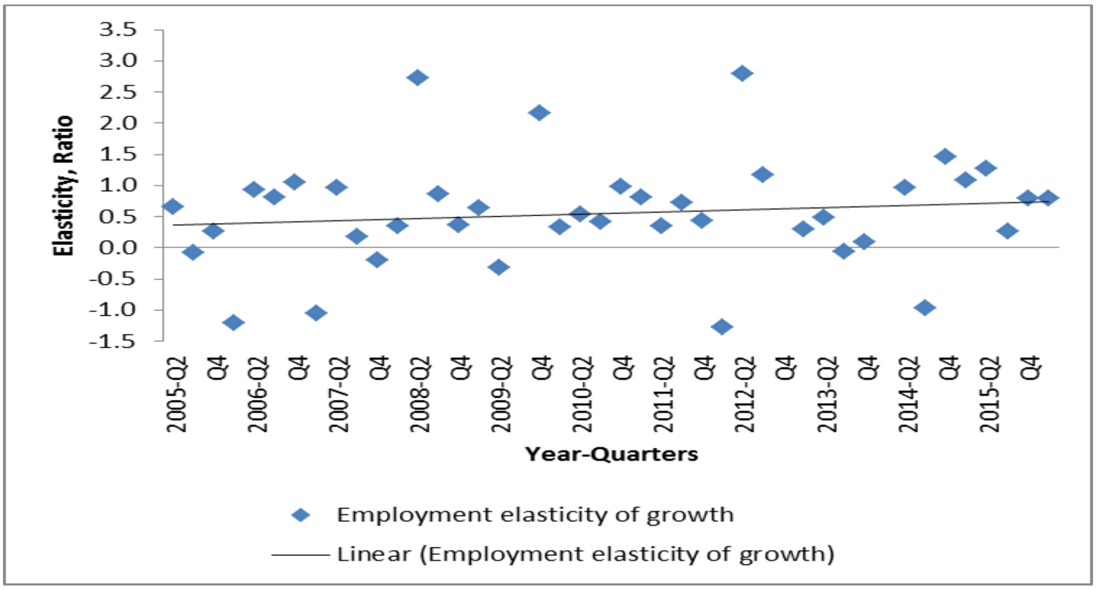

Figure 10 Employment Elasticity of GDP Growth

In the literature, it is commonly accepted that when GDP increases the unemployment rate decreases. In Figure 11, it can be concluded that there is an inverse relationship between growth and unemployment rate between 2005-2015. The negative relationship between variables is seen more clearly until 2011. After 2011, although growth has brought large amount of employment, due to higher participation rate, unemployment rate has not decreased as expected.

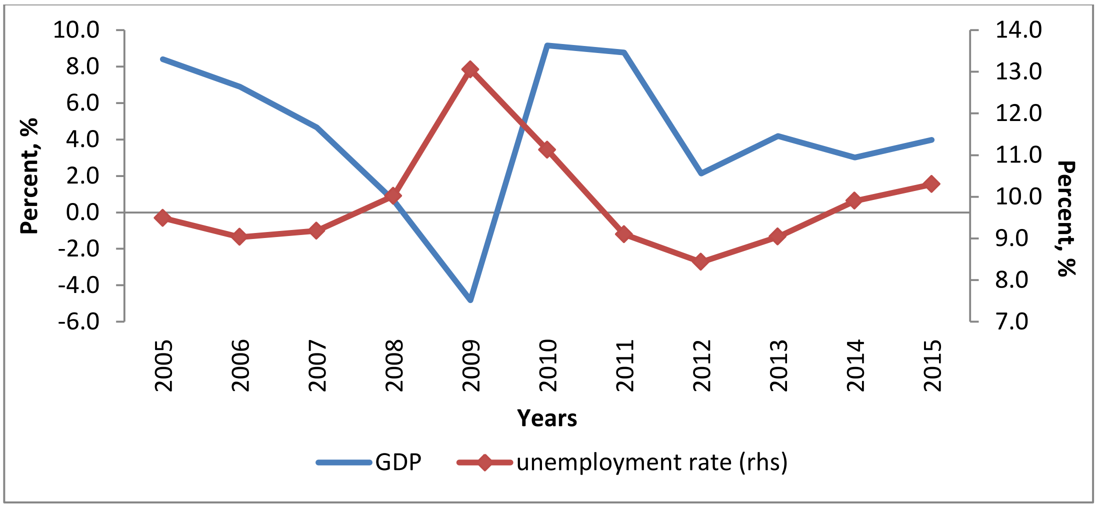

Figure 11 GDP and Unemployment Rate
Source: TURKSTAT

CHAPTER 3

METHODOLOGY

In this chapter, information about commonly used Okun's equations in the literature will be given firstly. Then, the basic information related to stationary time series and the procedures used in a time series analysis will be explained in the second part. Finally, vector autoregressive models will be discussed.

3.1 Okun's Law Equations

There are three types of equation; difference version, gap version and dynamic version.

Difference Version:

This version is expressed as:

Change in the unemployment rate = a + b(Real output growth) + ε_t . (3.1)

In that version, real output growth is regressed with changes in unemployment rate and reveal contemporaneous correlation between variables. *b* is represented as Okun's coefficient and is expected to have negative sign, since Okun presents a negative relation between unemployment rate and growth. *b* refers to changing unemployment rate corresponding to 1 percentage point change in growth rate. The ratio *–a/b* correspond the rate of output growth consistent with a stable unemployment rate.

Gap Version:

This version is expressed as:

Unemployment rate – Natural unemployment rate = d (Potential output -actual output) + ε_t . (3.2)

In this form of Okun's Law, the relation between gap between potential output and actual output, and gap between full unemployment rate and actual unemployment rate are investigated. Full unemployment rate or natural rate of unemployment correspond to a level of unemployment rates that the highest amount of skilled and unskilled labor could be employed within an economy at any given time. In addition, potential output is GDP growth produced by an economy that it's all resources are fully employed.

Dynamic Version:

The version is expressed as:

$$\Delta u_t = a + b_1\,gdp_t + b_2\,gdp_{t-1} + b_3\,gdp_{t-2} + c_1\,\Delta u_{t-1} + c_2\,\Delta u_{t-2} + \varepsilon_t. \qquad (3.3)$$

where Δ denotes the difference operator, $\Delta u_t = u_t - u_{t-1}$, u_t denotes unemployment rate and *gdp* denotes output growth. In the dynamic version, lags of unemployment rate and growth variables are used in the model.

In the dynamic version of Okun's law, both past and current outputs have an impact on the current level of unemployment rate. In the model, current output growth, past output growth, and past changes in the unemployment rate are used as explanatory variables. This type of model can be extended by using more lags of variables.

3.2 OLS in Time Series

Time Series is a set of data measured over time. The analysis of time series is the most important area of both statistics and economics. The main objective of time series modeling is to develop sample models capable of forecasting, interpreting and testing hypothesis regarding data.

Time series analysis is a process of building a proper model using time series and estimating related parameters using the observed data values. In addition, time series analysis ensures to understand the nature of the series and also is often useful to forecast the future values (Adhikari & Agrawal, 2013).

In time series modeling, some assumptions have to be validated. One of the most important assumptions in time series is being stationary. In modeling part to get correct result, model adequacy checking related to error terms of model are also vital for time series.

In addition, in order to get best linear unbiased estimator for the least square modeling, three main assumptions must be satisfied. They are;

1) The residuals are normally distributed with zero mean.
2) The residuals have a constant variance.
3) The successive residuals are not correlated.

3.2.1 Stationary

Stationary means time series' behavior do not change over time. An important assumption of the Ordinary Least Squares (OLS) regression is studying with stationary time series in the analyses. If two or more non-stationary time series are regressed, this will produce invalid results such as spurious regression. Spurious regression cause high R^2 statistics and very low Durbin-Watson statistics. Mainly, process is stationary if mean and variance of process are constant trough time. The following conditions must be satisfied in order to be stationary:

$$E[Z_t] = \mu, \forall t, \tag{3.4}$$

$$Var[Z_t] = \sigma^2 < \infty, \forall t, \tag{3.5}$$

$$Cov[Z_t, Z_{t-k}] = \gamma_k, \forall t, \tag{3.6}$$

$$Corr[Z_t, Z_{t-k}] = \rho_k, \forall t. \tag{3.7}$$

Formal tests can help to determine the existence of trend in the system. If there is a trend in the system, these tests can give information whether the trend is deterministic or stochastic. In deterministic trend, series is an explicit function of trend. A simple linear trend model is given as follows:

$$Z_t = \mu + \beta t + \varepsilon_t \tag{3.8}$$

where μ is constant, β is coefficient of time trend and ε_t is the randomly distributed errors.

If a series has a deterministic trend, series Z_t is regressed on an intercept and time trend that is commonly known as de-trending method. This method removes the trend effect from the series. When de-trending is applied to transform a non-stationary process, there is no observation loss.

If the trend has stochastic behavior, differencing operator is used for obtaining stationary series. Determining whether trend is deterministic or stochastic is crucial. Applying differencing to a series with a deterministic trend creates unit root problem in error terms.

Dickey Fuller (DF) test is available to check whether underlying time series are stationary or not.

Dickey Fuller (DF) test

Dickey and Fuller (1979) considered three autoregressive equations to detect the existence of a unit root.

$$\Delta Y_t = \delta Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t, \tag{3.9}$$

$$\Delta Y_t = \mu + \delta Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t, \tag{3.10}$$

$$\Delta Y_t = \mu + \delta Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \beta t + \varepsilon_t, \qquad (3.11)$$

where δ and γ_j are coefficients, μ is constant, t is time index, β is the coefficient on time trend and ε_t is the randomly distributed errors.

For level;

H_0 : Y_t is random walk OR $\delta = 0$

H_1 : Y_t is a stationary process OR $\delta < 0$.

For drift;

H_0 : Y_t is random walk with a drift OR $\delta = 0$ $\mu \neq 0$

H_1 : Y_t is a stationary process OR $\delta < 0$ $\mu \neq 0$.

For trend;

H_0 : Y_t is random walk with trend and a drift OR $\delta = 0$ $\mu \neq 0$ $\beta \neq 0$

H_1 : Y_t is a stationary process OR $\delta < 0$ $\mu \neq 0$ $\beta \neq 0$,

The last test is useful for understanding the type of non-stationarity.

3.2.2 Diagnostic Checks

Jarque-Bera Normality Test

Jarque-Bera Test is applied to check the normality of the error terms. (Jarque & Bera, 1980). The null hypothesis for this test is;

H_0 : Errors terms are normally distributed.

Jarque-Bera test statistic is; $JB = \frac{T}{6}\left[\hat{\beta}_1^2 + \frac{(\hat{\beta}_2 - 3)^2}{4}\right] \sim \chi_2^2$ asymptotically under H_0

where

$$\beta_1 = \frac{E(a_t^3)}{[E(a_t^2)]^{3/2}} = skewness,$$

$$\beta_2 = \frac{E(a_t^4)}{[E(a_t^2)]^2} = kurtosis.$$

Jarque-Bera test is applied to test normality for the univariate case. In multivariate version of this test, Choleski decomposition of the variance –covariance matrix are used to standardize the residuals. Then test statistic is computed using these standardized residuals (Pfaff, 2008).

Consider k-variate data series with length T. The test statistic is calculated as;

$JB_{mv} = S + K$ where;

$S = Tb_1'b_1/6$ and $K = T(b_2 - 3_n)'(b_2 - 3_n)/24$.

where $b_1 = (b_{11}, \dots, b_{1n})'$, $b_2 = (b_{21}, \dots, b_{2n})'$ and $3_n = (3, \dots, 3)'$.

b_1 and b_2 correspond to the third and fourth non-central moment vectors of the standardized residuals $\hat{\varepsilon}_t^s = \tilde{P} - (\hat{\varepsilon}_t - \bar{\hat{\varepsilon}}_t)$ respectively and $\tilde{P}$ correspond to a lower triangular matrix with positive diagonal such that $\tilde{P}\tilde{P}' = \tilde{\Sigma}_\varepsilon$. The test statistics JB_{mv} is distributed as approximately χ^2_{2n}, S and K are distributed as approximately χ^2_n.

The Breusch–Godfrey serial correlation LM test

Durbin-Watson test is used for regular regression with independent variables. It is not appropriate for time series models with lagged dependent variables. It only tests for AR(1) errors. However, Breusch-Godfrey Test is valid in the presence of lagged dependent variables (Breusch & Godfrey, 1981).

Hypothesis testing is;

H_0: $\beta_1 = \dots = \beta_h = 0$

H_1: At least one of the coefficients is different from 0.

Suppose auxiliary regression is:

$$\hat{\varepsilon}_t = \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + CD_t + \beta_1 \hat{\varepsilon}_{t-1} + \cdots + \beta_h \hat{\varepsilon}_{t-h} + e_t. \quad (3.12)$$

where *D* is deterministic regressor such as dummy variable and *C* is coefficient of *D*.

The test statistics is;

$$LM = T\left(K - tr\left(\tilde{\Sigma}_R^{-1}\tilde{\Sigma}_C\right)\right).$$

where *K* is the number of endogenous variables, *T* is sample size, $\tilde{\Sigma}_R^{-1}$ and $\tilde{\Sigma}_C$ are the residual covariance matrix of the restricted and unrestricted models. Test statistics LM is distributed as $\chi^2_{hK^2}$ asymptotically (Pfaff, 2008).

The White Test for Heteroscedasticity

Heteroscedasticity arise when the homoscedasticity assumption $Var(\varepsilon_i) = Var(Y_i) = \sigma^2$ is violated. According to White (1980), the test is explicitly intended to test for forms of heteroscedasticity.

White test's hypothesis is:

H_0: No heteroscedasticity

H_1: There is heteroscedasticity.

According to Gujarati (2004) the regression model is;

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \varepsilon_i. \quad (3.13)$$

Firstly, residuals $\hat{\varepsilon}_i$ are obtained. Then the following regression is run:

$$\hat{\varepsilon}_i^2 = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2i} + \alpha_3 X_{1i}^2 + \alpha_4 X_{2i}^2 + \alpha_5 X_{1i} X_{2i} + e_i. \quad (3.14)$$

In equation 3.14, the squared residuals from the regression in equation 3.13 are regressed on the original explanatory variables, their squared values and the cross product(s) of the explanatory variables. Then, R^2 is obtained.

Related test statistic is calculated as $nR^2 \sim \chi^2_{df}$ asymptotically under the null hypothesis that there is no heteroscedasticity. Here, *df* is taken as number of total regressors in the regression. Finally, absence of heteroscedasticity is checked by using White heteroscedasticity test.

3.2.3 Model Selection Criteria

The Akaike information criterion (AIC), the Bayesian information criterion (BIC) and the Hannan-Quinn criterion (HQC) are the most commonly use model selection criteria. According to Fabozzi et al. (2014), the model that has minimum information criterion is preferred by investigated each of the results given by AIC, SBIC and HQC.

Akaike information criterion (AIC)

The AIC (Akaike, 1978) is;

$$AIC = -2\log(\hat{\theta}) + 2k.$$

where

θ = vector of model parameters

$L(\hat{\theta})$ = the likelihood of the candidate model

k = the number of estimated parameters

Schwarz Bayesian information criterion (SBIC)

The SBIC (Schwarz, 1978) is computed as follows:

$$SBIC = -2\log(\hat{\theta}) + klog(n).$$

where the terms above are the same as described in the description of the AIC.

Hannan-Quinn criterion (HQC)

Hannan and Quinn (1979) introduced a model selection criterion to identify an autoregressive model. The criterion is:

$$HQC = log(\hat{\sigma}_k^2) + N^{-1}2kclog(logN).$$

Then adjusted formula is given below:

$$HQC = -2\log(\hat{\theta}) + 2klog(\log(N)).$$

In our study, Eviews (Econometric Views) software program is used. In Eviews, model selection criteria are calculated in transformed form. The model selection criteria formulas used in the Eviews program are given below:

$$AIC = -2\log(\hat{\theta})/n + 2k/n,$$

$$SBIC = -2\log(\hat{\theta})/n + klog(n)/n,$$

$$HQC = -2\log(\hat{\theta})/n + 2klog(\log(N))/n.$$

where *n* correspond to sample size of data that are used in models.

3.3 Vector Autoregressive Model

A VAR model implies that each variable in the system depends on both its own lags and other variables' lags.

A simple VAR model is;

$$y_{1,t} = \alpha_1 + \sum_{i=1}^{p} \beta_{1i}\, y_{1,t-i} + \sum_{i=1}^{p} \gamma_{1i}\, y_{2,t-i} + \varepsilon_{1,t}, \qquad (3.15)$$

$$y_{2,t} = \alpha_2 + \sum_{i=1}^{p} \beta_{2i}\, y_{1,t-i} + \sum_{i=1}^{p} \gamma_{2i}\, y_{2,t-i} + \varepsilon_{2,t}. \qquad (3.16)$$

Let $Y_t = (Y_{1t}, \ldots, Y_{nt})'$, VAR(p) process;

$$Y_t = \alpha + \beta_1 Y_{t-1} + \cdots + \beta_p Y_{t-p} + \varepsilon_t \qquad (3.17)$$

where α is a vector of constant; β_j is coefficient for j=1,…,*p* and the error term ε_t has the properties;

$E(\varepsilon_t) = 0$

$$\mathrm{Cov}(\varepsilon_t, \varepsilon_s) = \begin{cases} \Sigma & for\ t = s \\ 0 & otherwise \end{cases}$$

Σ is the symmetric and positive definite covariance matrix.

In order to estimate VAR model, all variables, both endogenous and exogenous must satisfy the stationary condition. In addition, the optimal lag lengths of VAR and stability conditions have to be determined.

3.3.1 Determination of the optimal lag length of the VAR

In order to select appropriate lag structure for VAR, first the unknown lag length bounded by some finite constant is assumed and then using information criteria such as the AIC, BIC or HQC, optimal lag length is determined (Gonzalo & Pitarakis, 2002). In each case, the lag order p is chosen for VAR (p) model that minimize the value of criterion over the range of alternative lag orders.

3.3.2 Determination of the stability condition

If a process has a constant mean and a constant variance over time, this process is stated as stable.

VAR(p) process can be defined in the form of a log polynomial.

$A_L = \left(I_K - A_1 - \cdots - A_p\right)$ then $\mathrm{A(L)}y_t = \left(I_K - A_1L - A_2L^2 - \cdots A_pL^p\right)y_t$.

According to Pfaff (2008) one important feature of VAR (p) process is its stability. Stability condition can be checked by examining the reverse characteristic polynomial $\Pi(z) = (I_K - A_1z - A_2z^2 - \cdots)$ and roots of characteristic polynomial give information about the stationarity of variables.

It can be summarized that (Cerny & Kocenda, 2015);

1. If all roots $\{z_i\}_{i=1}^{p}$ lie inside the unit circle, that is $|z_i| < 1$ for all i, then the equation and its solution are stable.
2. If at least one characteristic root z_i lies outside the unit circle, that is $|z_i| > 1$, then the equation and its solution are stable.

3. If at least one characteristic root z_i lies on the unit circle, that is $|z_i| = 1$, the equation is unstable and contains a unit root.

3.3.3 Granger Causality Test

Consider bivariate VAR (2) model (Brandt & Williams, 2007);

$$y_t = \alpha_1 + \sum_{i=1}^{p} \beta_{1i}\, y_{t-i} + \sum_{i=1}^{p} \gamma_{1i}\, z_{t-i} + \varepsilon_{1t}, \qquad (3.18)$$

$$z_t = \alpha_2 + \sum_{i=1}^{p} \beta_{2i}\, y_{t-i} + \sum_{i=1}^{p} \gamma_{2i}\, z_{t-i} + \varepsilon_{2t}. \qquad (3.19)$$

Granger causality test is used to determine whether the past values of variable $y_{t-1}, \dots y_{t-p}$ predict the current value of z_t or vice versa. Granger causality test is applied under the null hypothesis that possible casual variable does not cause the other variables.

Hypothesis testing for Granger causality as;

H_0: Granger non-causality (z_t does not predict y_t)

H_A: Granger causality (z_t does predict y_t)

Hypothesis test is implemented by using F test and requires two regression model results.

Unrestricted Model:

$$y_t = \alpha_1 + \sum_{i=1}^{p} \beta_i\, y_{t-i} + \sum_{i=1}^{p} \gamma_i\, z_{t-i} + \varepsilon_{1t}. \qquad (3.20)$$

Restricted Model:

$$y_t = \alpha_1 + \sum_{i=1}^{p} \beta_i\, y_{t-i} + e_t. \qquad (3.21)$$

Then;

$RRS_{Unrestricted} = \sum_{t=1}^{T} \varepsilon_{1t}^2$ and $RRS_{Restricted} = \sum_{t=1}^{T} e_t^2$

The test statistic is:

$$\frac{(RSS_{Restricted} - RSS_{Unresricted})/p}{RSS_{Unrestricted}/(T-2p-1)} \sim F(p, T-2p-1).$$

As a result, if test statistic is greater than the critical value at any given significance level, then null hypothesis is rejected. That means z_t Granger causes y_t.

3.3.4 Diagnostic Tests

After VAR model is estimated, model assumptions which are normality, absence of serial correlation and heteroscedasticity are checked to see whether the residuals satisfy the assumptions or not.

Detailed information related to diagnostic tests were mentioned in chapter 3.2.2.

3.3.5 Impulse Response Analysis and Variance Decompositions

In VAR analysis, besides Granger causality, impulse response analysis and variance decomposition are used to explain relationship between variables.

According to Sjö (2011), impulse response analysis is a graphical or numerical presentation of simulation system. In this system, response of any given unexpected shocks is taken into account. Duration of shock in y_t until effect of it will die and it's sign (negative or positive) are main concerns of the impulse response.

Let $y_t = C(L)e_t = \sum_{i=0}^{t} C_i e_{t-i}$ where C_i is the matrix of coefficients for lag i.

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \sum_{i=0}^{t} \begin{bmatrix} c_{11,i} & c_{12,i} \\ c_{21,i} & c_{22,i} \end{bmatrix} \begin{bmatrix} e_{1i} \\ e_{2i} \end{bmatrix}.$$

Here, impulse response function is C_i for i=0,…,j. Under the condition i=0, C_0 corresponds to initial effect of shock, matrix of total $\sum_{i=0}^{\infty} C_i$correspond to long run multiplier.

The variance decomposition is used to calculate contributions of each shock in the variance of the error made in forecasting a variable at a specific time horizon. It reveals that how much of the forecast error variance of the variables explained by any other variables that has specific shock.

In order to obtain forecast error variance decomposition, MA representation of VAR (*p*) process is taken into account (Seymen, 2008). The MA (or Wold) representation is;

$$y_t = CD_t + \sum_{i=0}^{\infty} \theta_i \omega_{t-i}, \tag{3.22}$$

where

y_t is endogenous variable

θ_i: i^{th} MA coefficient

ω_t: vector of orthogonal white noise innovations

C: coefficient matrix of the deterministic terms D_t.

Then h-step forecast error;

$$y_{t+h} - y_t(h) = \sum_{i=0}^{h-1} \theta_i \omega_{t+h-i}. \tag{3.23}$$

The innovations are uncorrelated and covariance matrix of innovations set to identity matrix without loss of generality. Then h-step MSE matrix of y_t is;

$$E\left[\big(y_{t+h} - y_t(h)\big)\big(y_{t+h} - y_t(h)\big)'\right] = \sum_{i=0}^{h-1} \theta_i \Sigma_\omega \theta_i' = \sum_{i=0}^{h-1} \theta_i \theta_i', \tag{3.24}$$

where Σ_ω is the K dimensional identity matrix correspond to covariance matrix of the structural innovations.

The contribution of the k^{th} structural shock to the forecast error variance of the j^{th} variable for a given forecast horizon is computed by given formula;

$$\sum_{i=0}^{h-1} \big(\vartheta_j' \theta_i \vartheta_k\big)^2,$$

where ϑ_k is the k^{th} column of the K-order identity matrix.

3.4 Cointegration and Error Correction Model (ECM)

In general, it is necessary that time series are stationary in ordinary least squares (OLS) since non-stationary series cause some problems like spurious regression. If non-stationary variables are used in model, evaluating model result is too difficult and wrong evaluations can be reached. Therefore, all variables should be satisfying stationary assumption. If they are non-stationary, integrated model or co-integration model has to be considered. Suppose there are two series as X_t and Y_t that are non-stationary in order one. If the linear combination of these two series become stationary, they are called as co-integrated.

Suppose, $X_t \sim I(1)$ and $Y_t \sim I(1)$ where both X_t and Y_t non-stationary and integrated of order one. Here, $I(d)$ refers integrated of order d and means series are non-stationary. The series became stationary after taking d^{th} difference.

$$Y_t = \beta X_t + \varepsilon_t . \qquad (3.25)$$

If the residuals that are obtained from equation in 3.25 are stationary, the series X_t and Y_t are co-integrated.

In the second step, the model is written in error correction form to allow for standard inference regarding short run impact effects of X_t on Y_t, where $\varepsilon_t = Y_t - \beta X_t$.

Then error correction model is;

$$\Delta Y_t = \alpha_1 \Delta X_t + \alpha_2 \varepsilon_{t-1} + e_t. \qquad (3.26)$$

In the ECM, all variables should be stationary so that first difference of the series is taken. The estimated coefficient α_2 should be negative and statistically significant in the short-run model.

CHAPTER 4

ANALYSES

In the first part of the analysis, the relationship between economic growth and unemployment rate is analyzed by using Okun's Law approach and in the second part short run relationship between economic growth and unemployment rate is investigated by using VAR models. In the study, seasonally adjusted quarterly data from 2005Q1 to 2016Q1 are used to eliminate the seasonal effects. The data on real GDP (TURKSTAT, 2016) and labor market data (TURKSTAT, 2016) are provided by Turkish Statistical Institute (TURKSTAT). E-views software program are used to analyze the data. Before estimation of model, stationarity conditions were checked for each variable. In the gap version of the Okun's Law, the problem arose during modeling due to lack of full employment and potential output data. These data are not announced by any organizations. Therefore, we can use most commonly used Hodrick Prescott (HP) filter to smooth the output and unemployment rate series to reach trend of series in the long term. In the study, unemployment rate (*u*), real GDP growth (*gdp*), productivity (*v*), the trends of unemployment rate (*hpu*) and trends of GDP growth (*hpgdp*) are used. Productivity is defined as GDP in constant price divided by total employment.

4.1 Stationarity of variables

Firstly, the test results regarding to stationarity of variables are listed in Table 1.

Table 1 ADF Test Results

Variable	Model	t-Statistic	critical value 1 % level	critical value 5 % level	P-value
u	Constant, Linear Trend	-2.3934	-4.1865	-3.5181	0.3777
	Constant	-2.4218	-3.5925	-2.9314	0.1419
	None	-0.3994	-2.6199	-1.9487	0.5340
Δu	Constant, Linear Trend	-3.7299	-4.1865	-3.5181	0.0308
	Constant	-3.7748	-3.5925	-2.9314	0.0062
	None	-3.8315	-2.6199	-1.9487	0.0003
gdp	Constant, Linear Trend	-5.1555	-4.1809	-3.5155	0.0007
	Constant	-5.2360	-3.5885	-2.9297	0.0001
	None	-4.5928	-2.6186	-1.9485	0.0000
v	Constant, Linear Trend	-5.2267	-4.1865	-3.5181	0.0006
	Constant	-5.2050	-3.5925	-2.9314	0.0001
	None	-5.1945	-2.6199	-1.9487	0.0000
hpgdp	Constant, Linear Trend	-4.3749	-4.2119	-3.5298	0.0066
	Constant	-4.4431	-3.6105	-2.9390	0.0010
	None	-0.3691	-2.6241	-1.9493	0.5452
u - hpu	Constant, Linear Trend	-2.7658	-4.1865	-3.5181	0.2172
	Constant	-2.8014	-3.5925	-2.9314	0.0665
	None	-2.8329	-2.6199	-1.9487	0.0057
Δ(u - hpu)	Constant, Linear Trend	-3.8910	-4.1865	-3.5181	0.0210
	Constant	-3.9390	-3.5925	-2.9314	0.0039
	None	-3.9899	-2.6199	-1.9487	0.0002

Augmented Dickey Fuller (ADF) is used to check the stationarity of the series. Table 1 gives information about stationarity of both dependent and independent variables. Economic growth (*gdp*), productivity (*v*) and trend of growth (*hpgdp*) variables are stationary. However, unemployment rate and gap between unemployment rate and full unemployment rate are non-stationary, after taking the first difference of them, they become stationary.

4.2 Times Series Models

4.2.1 Difference version

In the difference version of Okun's Law, the relationship between GDP and unemployment rate is investigated. A dummy variable (D09) is added for the 2009 Q1 to eliminate the crisis effect on model.

$$\widehat{\Delta u_t} = 0.186 - 0.211 gdp_t + 1.630 D09. \tag{4.1}$$

Table 2 Summary of Difference Model

Variables	**Dependent variable : Δu**			
	Coefficient	Std. Error	t-Statistic	**Prob.**
C	0.186	0.063	2.946	0.005
gdp	-0.211	0.030	-7.002	0.000
D09	1.630	0.397	4.101	0.000
Sum squared resid				5.766
R-squared				0.566
Adjusted R-squared				0.545
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.413
Breusch-Godfrey Serial Correlation LM Test				0.691
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.793

The result shows that all variables are significant and main model assumptions are satisfied (Table 2). In order to calculate rate of output growth consistent with a stable unemployment rate, we use the formula $-a/b$. In the formula, α corresponds to constant term *C* and *b* corresponds to coefficient of *gdp* in the model. Then, quarterly output growth rate to keep unemployment rate stable is calculated as 0.88 ($-a/b = (-0.186/-0.211)$) percent. Annual growth rate is calculated as 3.57 percentage point under the assumption that growth rate is equal for each quarter. According to model results, 1 percentage point increase in GDP growth above 0.88% result in 0.21 percentage point decrease in unemployment rate.

4.2.2 Gap version

Main purpose of this version is to specify the production level under the condition of full employment. A dummy variable (D09) is added for the 2009 Q1 to eliminate the crisis effect on model.

Table 3 Summary of Gap Model

Variables	**Dependent Variable: Δ(u-Lpu)**			
	Coefficient	Std. Error	t-Statistic	**Prob.**
(gdp - hpgdp) / hpgdp	-0.163	0.023	-6.972	0.000
D09	1.648	0.380	4.333	0.000
Sum squared resid				5.418
R-squared				0.559
Adjusted R-squared				0.549
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.248
Breusch-Godfrey Serial Correlation LM Test				0.897
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.816

Gap version of Okun's equation is as below for Turkey.

$$u_t \widehat{-hpu}_t = -0.163\,(gdp - hpgdp)/hpgdp + 1.648\,D09. \qquad (4.2)$$

Table 3 gives information that model assumptions are satisfied and all variables in the model are significant. When the equation is examined, it can be said that 1 percentage point increases in actual output above the potential output is related to 0.16 percentage decreases in the actual unemployment below the natural unemployment rate.

4.2.3 Dynamic version

In the dynamic version of Okun's Law, lags of output and unemployment rate are used to explain current level of unemployment rate. In first part of this session, three different dynamic versions of Okun's Law are discussed. In the first equation, first lag of difference of unemployment rate (Δu(-1)) is added to model as an explanatory variable. In the second and third equations, first and second lags of *gdp* are also included to models respectively. In these equations, first lag of difference of unemployment rate and dummy variable are removed from models, since after adding lags of *gdp*, these variables become insignificant. After estimating three different models, the best model is selected by using model selection criterion such as AIC, BIC, HQC and sum of squared residuals.

Table 4 Summary of Dynamic Model (1)

Variables	Dependent variable : Δu			
	Coefficient	Std. Error	t-Statistic	**Prob.**
C	0.158	0.062	2.555	0.015
gdp	-0.189	0.031	-6.174	0.000
Δu(-1)	0.238	0.116	2.056	0.047
D09	1.195	0.437	2.732	0.009
Sum squared resid				5.061
R-squared				0.612
Adjusted R-squared				0.582
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.638
Breusch-Godfrey Serial Correlation LM Test				0.418
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.829

Table 5 Summary of Dynamic Model (2)

Variables	Dependent variable : Δu			
	Coefficient	Std. Error	t-Statistic	**Prob.**
C	0.267	0.071	3.770	0.001
gdp	-0.148	0.031	-4.706	0.000
gdp(-1)	-0.100	0.030	-3.299	0.002
Sum squared resid				6.425
R-squared				0.516
Adjusted R-squared				0.493
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.581
Breusch-Godfrey Serial Correlation LM Test				0.962
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.937

Table 6 Summary of Dynamic Model (3)

Variables	Dependent variable : Δu			
	Coefficient	Std. Error	t-Statistic	**Prob.**
C	0.347	0.064	5.437	0.000
gdp	-0.155	0.027	-5.810	0.000
gdp(-1)	-0.088	0.028	-3.190	0.003
gdp(-2)	-0.096	0.026	-3.739	0.001
Sum squared resid				4.279
R-squared				0.672
Adjusted R-squared				0.647
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.638
Breusch-Godfrey Serial Correlation LM Test				0.512
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.943

All models defined in Table 4, Table 5 and Table 6 satisfy model assumptions and all variables in the model are significant. In order to select the best model among these three models, model selection criteria like AIC, BIC, HQC and sum squared residuals values which are given in Table 7 are used.

Table 7 Model Selection Criterion Results for Dynamic Models

Variables	Model 1	Model 2	Model 3
C	0.158	0.267	0.347
gdp	-0.189	-0.148	-0.155
gdp(-1)		-0.100	-0.088
gdp(-2)			-0.096
Δ u(-1)	0.238		
D09	1.195		
Sum squared resid	5.061	6.425	4.279
R-squared	0.612	0.516	0.672
Adjusted R-squared	0.582	0.493	0.647
Akaike info criterion	0.884	1.050	0.716
Schwarz criterion	1.048	1.172	0.880
Hannan-Quinn criter.	0.945	1.095	0.777

According to Table 7, model 3 has minimum AIC, SBIC and HQC model selection criterion and also it has maximum R-squared and adjusted R-squared. Therefore, the most representative model for dynamic equation is:

$$\widehat{\Delta u_t} = 0.347 - 0.155gdp_t - 0.088gdp_{t-1} - 0.096gdp_{t-1}. \qquad (4.3)$$

Growth rate to keep unemployment rate stable is calculated as 1.02 $(-0.347/(-0.155 - 0.088 - 0.096))$ percentage point in a quarter. In the equation, 1 percentage point increases in GDP above 1.02% in each quarter decreases unemployment rate by 0.34 percent (0.34 is equal to sum of g*dp* coefficients in the model). To keep unemployment rate stable at any year, growth rate must be 4.15 percent in Turkey according to dynamic version of Okun's Law.

In the second part of this section, effect of productivity on unemployment rate is discussed. Productivity is stated as a major force to increase the overall performance of the economy. Productivity gives stimulus to economy by the output growth, real wages, and cost reduction (Landes, 1969). Productivity variable is included in each off the three dynamic equations to test effect of productivity on unemployment rate. In the first equation, first lag of difference of unemployment rate is removed from model, since it become insignificant after adding productivity to model. The models' results are given in Tables 8, 9 and 10.

Table 8 Summary of Dynamic Model (1) (Include Productivity Variable)

Variables	**Dependent variable : Δu**			
	Coefficient	Std. Error	t-Statistic	**Prob.**
C	0.245	0.065	3.766	0.001
gdp	-0.294	0.046	-6.429	0.000
V	0.121	0.052	2.329	0.025
D09	1.464	0.384	3.811	0.001
Sum squared resid				5.077
R-squared				0.618
Adjusted R-squared				0.589
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.679
Breusch-Godfrey Serial Correlation LM Test				0.816
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.181

Table 9 Summary of Dynamic Model (2) (Include Productivity Variable)

Variables	**Dependent variable : Δu**			
	Coefficient	Std. Error	t-Statistic	**Prob.**
C	0.314	0.071	4.398	0.000
gdp	-0.237	0.052	-4.599	0.000
gdp(-1)	-0.085	0.030	-2.834	0.007
V	0.120	0.056	2.142	0.038
Sum squared resid				5.763
R-squared				0.566
Adjusted R-squared				0.534
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.408
Breusch-Godfrey Serial Correlation LM Test				0.947
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.544

Table 10 Summary of Dynamic Model (3) (Include Productivity Variable)

Variables	**Dependent variable : Δu**			
	Coefficient	Std. Error	t-Statistic	**Prob.**
C	0.387	0.062	6.197	0.000
gdp	-0.238	0.043	-5.588	0.000
gdp(-1)	-0.075	0.027	-2.830	0.007
gdp(-2)	-0.092	0.024	-3.815	0.001
V	0.112	0.046	2.411	0.021
Sum squared resid				3.711
R-squared				0.716
Adjusted R-squared				0.686
				Prob.
F Statistic				0.000
Jarque-Bera Normality Test				0.507
Breusch-Godfrey Serial Correlation LM Test				0.792
Heteroskedasticity Test: Breusch-Pagan-Godfrey				0.825

Table 11 Model Selection Criterion Results for Dynamic Models (Include Productivity Variable)

Variables	Model 1	Model 2	Model 3
C	0.245	0.314	0.387
gdp	-0.294	-0.237	-0.238
gdp(-1)		-0.085	-0.075
gdp(-2)			-0.092
V	0.121	0.120	0.112
D09	1.464		
Sum squared resid	5.077	5.763	3.711
R-squared	0.618	0.566	0.716
Adjusted R-squared	0.589	0.534	0.686
Akaike info criterion	0.860	0.987	0.621
Schwarz criterion	1.022	1.149	0.825
Hannan-Quinn criter.	0.920	1.047	0.696

All estimated models satisfy all main model assumptions and variables are significant in models. After studying three different dynamic models under productivity effect, in order to determine the best model, model selection procedures are applied. Models are compared using AIC, SBIC and HQC that estimates the quality of each model. In addition to these items, R-square and adjusted R-square values are also compared. As it is seen in Table 11, model 3 gives more efficient results compared to other models.

Hence, the best dynamic equation with productivity variable is:

$$\widehat{\Delta u_t} = 0.387 - 0.238gdp_t - 0.075gdp_{t-1} - 0.092gdp_{t-2} + 0.112v_t. \qquad (4.4)$$

According to model result, there is a positive relationship between unemployment rate and productivity in Turkey. Employment decreases with increasing productivity and that brings increase in unemployment rate.

There is no certain fact among countries related to the effects of productivity on unemployment rate. While some economist assert that no relationship between unemployment and productivity, some of them has an opinion that there is a negative correlation between productivity and unemployment. However, in our study, we observe the reverse results for Turkey.

Bean & Pissarides (1993) examined the cross-country correlations between growth and unemployment in OECD countries from 1955 to 1985. They find that there is no clear cross correlation between unemployment and productivity growth across OECD economies, they find only weak correlation for period from 1975 to 1985. According to Michelis et al. (2013), policies that are applied to increase production efficiency at the expense of hours of work and/or employment may cause higher unemployment rate. In Turkey, according to our results, productivity results in higher unemployment rate.

Real economic growth of about $0.95\,(-0.387/(-0.238-0.075-0.092))$ percentage point in a quarter was associated with a stable unemployment rate. To keep unemployment rate stable at any year, growth rate must be 3.87 percent at that year in Turkey according to dynamic version of Okun's Law under effect of productivity. In equation, 1 percentage point increases in GDP above 0.95 percent accompanied by productivity effect decreases unemployment rate by 0.4 percent. Table 12 gives summary of three different version of Okun's Law.

Table 12 Growth Consistent with a Stable Unemployment Rate

Variables	Difference Model	Dynamic Model	Dynamic Model (Productivity)
c	0.186	0.347	0.387
gdp	-0.211	-0.155	-0.238
gdp(-1)		-0.088	-0.075
gdp(-2)		-0.096	-0.092
Δu(-1)			
Δv			0.112
D09	1.630		
Rate of output growth consistent with a stable unemployment rate (quarterly, %)	0.882	1.022	0.953
Rate of output growth consistent with a stable unemployment rate (annually, %)	3.574	4.152	3.868

4.3 Vector Autoregressive Model

In this part, VAR model is used to analyze the short term relationship between unemployment rate and economic growth. VAR analysis enables us to decide causality between variables using Granger causality test and enables to evaluate the effect of economic growth on unemployment rate by the help of impulse response functions. Therefore, after estimating VAR model, Granger causality test, variance decomposition and impulse response function analysis will be followed.

Before starting the VAR analysis, the existence of a long run relationship between unemployment and GDP will be examined by using co-integration analysis. In co-integration, there are two series $X_t \sim I(1)$ and $Y_t \sim I(1)$ where both X_t and Y_t non-stationary and integrated of order one and their linear combination of these series is stationary. However, in part 4.1, stationarity of variables is tested and it is concluded that *gdp* is stationary while unemployment rate is nonstationary. That means the long run relationship between unemployment rate and GDP could not be tested.

VAR analysis models are estimated to show relationship between economic growth and unemployment rate for period 2005Q1 to 2016Q1. Related equations are;

$$GDP_t = \alpha_1 + \sum_{i=1}^{p} \beta_{1i}\, GDP_{t-i} + \sum_{i=1}^{p} \gamma_{1i}\, D(U)_{t-i} + \varepsilon_{t_1}, \qquad (4.5)$$

$$D(U)_t = \alpha_2 + \sum_{i=1}^{p} \beta_{2i}\, GDP_{t-i} + \sum_{i=1}^{p} \gamma_{2i}\, D(U)_{t-i} + \varepsilon_{t_2}. \qquad (4.6)$$

Before estimating the VAR model, suitable lag lengths must be determined to reach well specified model. Using the most common lag selection criteria (LR, FPE, AIC, SC and HQ) optimal lag length is chosen as two for our model (Table 13). Since, second lag has the minimum value of model selection criterion according to most of the criteria.

Table 13 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-95.01581	NA	0.549998	5.077734	5.248356	5.138951
1	-85.53998	17.00790	0.415869	4.796922	**5.138166***	4.919357
2	-79.33572	**10.49951***	**0.372713***	**4.683883***	5.195748	**4.867536***
3	-77.80427	2.434621	0.425934	4.810475	5.492962	5.055346
4	-76.84731	1.423173	0.503678	4.966529	5.819637	5.272617
5	-75.10998	2.405532	0.575807	5.082563	6.106293	5.449869

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

After the lag selection, our VAR model becomes;

$$GDP_t = \alpha_1 + \sum_{i=1}^{2} \beta_{1i}\, GDP_{t-i} + \sum_{i=1}^{2} \gamma_{1i}\, D(U)_{t-i} + \varepsilon_{t_1}, \qquad (4.7)$$

$$D(U)_t = \alpha_2 + \sum_{i=1}^{2} \beta_{2i}\, GDP_{t-i} + \sum_{i=1}^{2} \gamma_{2i}\, D(U)_{t-i} + \varepsilon_{t_2}. \qquad (4.8)$$

Table 14 VAR (2) Model Results

	D(U)	GDP
D(U(-1))	0.08938 (0.18976) [0.47102]	-0.48220 (0.70893) [-0.68018]
D(U(-2))	-0.20183 (0.15908) [-1.26871]	0.93610 (0.59431) [1.57509]
GDP(-1)	-0.09448 (0.04431) [-2.13244]**	0.05347 (0.16553) [0.32304]
GDP(-2)	-0.09731 (0.04597) [-2.11669]**	-0.07632 (0.17175) [-0.44437]
C	0.15227 (0.09922) [1.53473]	1.42340 (0.37067) [3.84007]**
D08	0.51454 (0.21964) [2.34263]**	-3.70927 (0.82058) [-4.52030]**
R-squared	0.496303	0.473349
Adj. R-squared	0.426345	0.400203
F-statistic	7.094302	6.471285

Standard errors in ( ) & t-statistics in [ ]
* denotes significance at 10%
** denotes significance at 5%

When the result of VAR model in Table 14 is examined, it is concluded that change in unemployment rate are explained by first and second lag of GDP. However, lags of unemployment rate seem insignificant and do not give any information related to current level of unemployment rate. In the second equation, it can be said that all endogenous variables remain unsuccessful to explain any information related to current level of growth performance.

4.3.1 Granger Causality Test

The causality between variables are tested by using the Granger causality analysis that is shown in Table 15.

Table 15 VAR Granger Causality Tests

Dependent variable: D(U)			
Excluded	Chi-sq	df	Prob.
GDP	9.095699	2	0.0106
All	9.095699	2	0.0106
Dependent variable: GDP			
Excluded	Chi-sq	df	Prob.
D(U)	2.470260	2	0.2908
All	2.470260	2	0.2908

Granger causality null hypotheses are:

H_{01}: GDP does not Granger cause D(U).

H_{02}: D(U) does not Granger cause GDP.

According to VAR Granger causality test, first hypothesis is rejected. Therefore, we can say that GDP Granger cause change in the unemployment rate while change in unemployment rate does not granger cause GDP.

The result of the VAR analysis and Granger causality test confirm that an increase in economic growth decreases the unemployment rate.

4.3.2 Diagnostic Tests

According to the estimated VAR model, inverse roots of AR characteristic polynomial lie inside the unit circle. That means, sufficient and necessary conditions are satisfied for stability in our model (Figure 12).

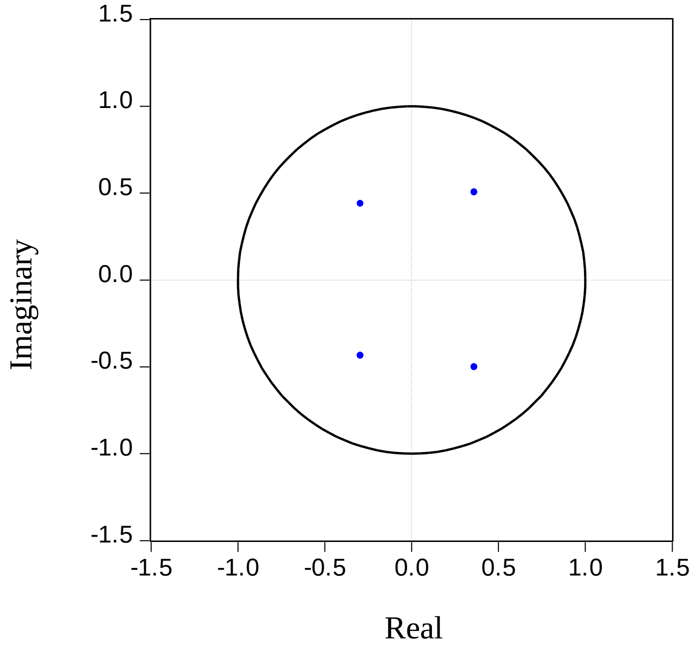

Figure 12 Inverse Roots of Characteristic Polynomial

Normality of errors is tested by using Jarque-Bera normality test. According to test result given in Table 16, the null hypothesis that is normality cannot be rejected. That means, the model satisfies normality assumption.

Table 16 VAR Residual Normality Test

Component	Skewness	Chi-sq	df	Prob.
1	-0.233443	0.381469	1	0.5368
2	0.381823	1.020522	1	0.3124
Joint		1.401992	2	0.4961
Component	Kurtosis	Chi-sq	df	Prob.
1	2.225333	1.050192	1	0.3055
2	2.889021	0.021554	1	0.8833
Joint		1.071745	2	0.5852
Component	Jarque-Bera	df	Prob.	
1	1.431661	2	0.4888	
2	1.042076	2	0.5939	
Joint	2.473737	4	0.6493	

Absence of serial correlation and heteroscedasticity are checked by using LM test and white test respectively. According to the results of VAR residuals serial correlation LM test, p-value for each lags is greater than 0.05 significance level and null hypothesis cannot be rejected for each of the lags. Therefore, it can be said that there is no serial correlation problem for our model (Table 17). When white heteroscedasticity test examined that is given in Table 18, probability of test statistics is greater than 0.05 and it is concluded that there is not heteroscedasticity problem in our model. Therefore, there is no serial correlation in the error terms and variance is constant over time for our model.

Table 17 VAR Residual Serial Correlation Tests

Lags	LM-Stat	Prob
1	4.146719	0.3865
2	1.252689	0.8693
3	2.987310	0.5600
4	2.169838	0.7046
5	3.832354	0.4292
6	3.821892	0.4306
7	3.573101	0.4669
8	4.929632	0.2946
9	8.765806	0.0672
10	2.742735	0.6018
11	4.305015	0.3663
12	6.047428	0.1956

Probs from chi-square with 4 df.

Table 18 VAR Residual Heteroscedasticity Test

Joint test:		
Chi-sq	df	Prob.
34.55703	27	0.1504

4.3.3 Impulse Response Analysis and Variance Decompositions

In VAR analysis, besides Granger causality, impulse response analysis and variance decomposition are used to explain relationship between variables. The variance decomposition calculates the contribution of a specific shock to the variance of the error made in forecasting a variable at a specific time period.

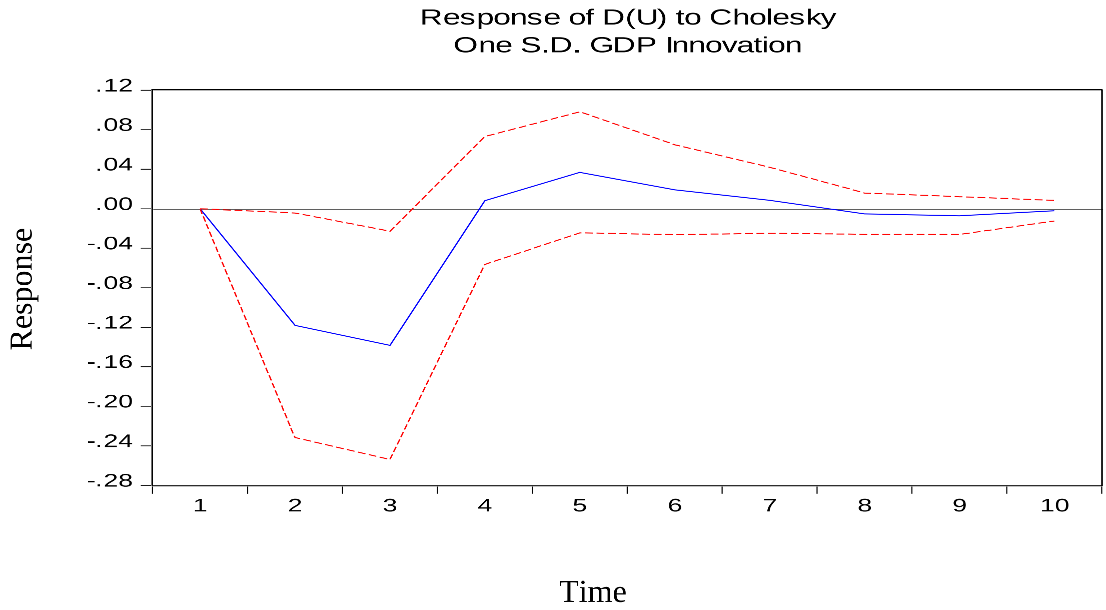

Figure 13 Impulse-Response Analysis

Against one standard deviation shock from GDP, D(U) responses negatively in the four time periods and response of shock turn positive sign between periods 4 and 7 which is represented in Figure 13. After seventh period, D(U) responds shocks negatively. In the future periods, response become weak and converges to equilibrium level.

Table 19 Variance Decomposition

Period	S.E.	D(U)	GDP
1	0.428125	100.0000	0.000000
2	0.463482	93.51731	6.482689
3	0.486004	85.99500	14.00500
4	0.487331	86.04256	13.95744
5	0.493022	85.80427	14.19573
6	0.493662	85.69006	14.30994
7	0.493816	85.66912	14.33088
8	0.493952	85.66637	14.33363
9	0.494049	85.65111	14.34889
10	0.494053	85.64963	14.35037

Cholesky Ordering: D(U) GDP

The variation in an endogenous variable is separated into the component shocks to the VAR by using variance decomposition (Table 19) and this gives relative contributions of each shock to the total variance of each variable in model (Rees, 2011). According to variance decomposition, 14 percent of forecast error variance of unemployment rate is determined by GDP growth.

CHAPTER 5

CONCLUSION

In this study, the relationship between unemployment rate and economic growth in Turkey over period of 2005Q1-2016Q1 is investigated by OLS in the view of Okun's Law approach and VAR model. In the study, seasonally adjusted quarterly series are used. In addition, rates of output growth consistent with a stable unemployment rate are calculated both quarterly and annually for each version of the Okun's Law equations.

Results of the models show that there is a negative linear relationship between unemployment rate and economic growth that indicate validity of Okun's Law for Turkey. In the first part of the study, different versions of Okun's Law are examined. In the difference version, quarterly rate of output growth consistent with a stable unemployment rate is calculated as 0.88 percentage point and that correspond to an annual growth rate of 3.57 percent. According results, 1 percentage point increases in GDP growth above 0.88% result in 0.21 percentage point decreases in unemployment rate.

In the gap version of Okun's Law, gap between unemployment rate and natural unemployment rate is regressed on gap between actual output and potential output. In this model, how much output is to be produced at natural rate of unemployment can be estimated. It can be said that 1 percentage point increase in actual output above the potential output related to 0.16 percentage decrease in the actual unemployment below the natural unemployment rate from one quarter to next quarter.

According to the dynamic version of Okun's Law, both current and past level of output effect current unemployment rate negatively. Therefore, 3 different models which include past level of output and unemployment rate are analyzed and the best model is chosen by using model selection criteria. In addition, in order to discuss effect of productivity on unemployment rate, productivity variable is added to models. According to the best model, increase in productivity ensures increase in unemployment rate in Turkey. In the dynamic version, output growth rate to keep unemployment rate stable is calculated as 1.02 percentage point in a quarter and calculated as 4.15 percent at any year in Turkey. In the dynamic model that has productivity variable, rate of output growth consistent with stable unemployment rate get smaller compared to dynamic model's result. Real economic growth of about 0.95 percent is associated with a stable unemployment rate in a quarter. To keep unemployment rate stable at any year, growth rate must be 3.87 percent in Turkey according to dynamic version of Okun's Law under effect of productivity.

In the second part of the study, short term relationship between output and unemployment rate is investigated by VAR model approach. According to results, the sign of GDP in the model is negative as expected. There is a Granger cause relationship between GDP and unemployment rate from GDP towards unemployment rate. GDP determines the 14 percent of forecast error variance related to unemployment rate. When the impulse response functions are analyzed, it can be said that after any given shocks to GDP in the first period, unemployment rate responses this shock negatively in the four periods. Between fourth and seventh period, sign of response of unemployment towards shock become positive but fading. Then, it converges long run equilibrium.

According to results, we can say that Okun's Law is valid for Turkey in line with literature. Okun's coefficients that are found in our study are greater than most of the other studies' coefficients that correspond to smaller rate of output growth consistent with a stable unemployment rate.

In addition, unemployment rate gives different reactions to the various expenditure components of the GDP growth such as private consumption, public spending, investment and foreign trade. Therefore, Okun's Law by using disaggregated GDP variables can give more precise information about relationship between GDP and unemployment rate. That topic need to be further investigated.

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