Okun's Coefficient for Four Mediterranean Member Countries of EU: An Empirical Study

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Abstract

In this paper, we estimate Okun's coefficients for four Mediterranean countries of EU using real GDP and unemployment rate data. For the empirical analysis of the research we used annual data for the period 1961 – 2002 and Hodrick and Prescott filter (1997), a mathematical tool used in macro-economics and especially in business cycles theory, in order to find fictitious data using variation and correlation for both variables. Research results showed that unemployment cost, from the real GDP loss viewpoint, is larger for Italy (-0.024) and smaller for Greece (-0.007).

Keywords: Okun's law, Unit roots, Mediterranean countries

1. Introduction

One of the largest problems that most governments face is unemployment. Unemployment can be regarded as the cause of poverty and income dispersion. Many scientists have worked on issues such as unemployment which is characterized as an important power for governments and also for international economic policies.

The main causes of unemployment and how we can examine it have been explained during the last century as a linkage from many factors. Such a cause is ruled from two important laws. The first one is the demand law for internal factors, which indicate that the number of employers changes as long as the labour productivity, wages demand and price product changes as well. The second one is the supply law. Employment level is being supported on factors such as the status of an economy and economic cycles, technological and educational refinement and intension, productivity and profits. The supply surplus in terms of demand is measured as the unemployment in percentage units which are available in society and is known as transitional unemployment. Unemployment is created by deficit capital, technology development and from tendencies of fall (Kooros, 2006).

The relationship between unemployment rate and the rise of real production is well known from economists. Okun (1962) using data from American economy showed that for every per unit decrease of GNP, the unemployment rate is increasing more than the natural percentage. Okun pursued to use the relationship between the gap of real GNP and the gap of unemployment rate to predict the potential GDP given the former relationship between unemployment and GDP. He noted that changes in unemployment rate cannot be regarded as the referencing point of the change of real production which is the result of the variated unemployment. In other words, there are intermediary factors which connect the unemployment rate and real production (Kwami, 2005).

Okun's law was consistent with the relationship between unemployment rate and real production for many decades. Even if the negative relationship between the "gap" of unemployment rate and the increase of real production has been quite stable, the absolute value of Okun's coefficient seems to vary in different time periods and from country to country (Altig et. Al, 2002).

A simple specification of Okun's law can be the following:

$$(Y - Y^*)_t = \alpha + \beta (UN - UN^*)_t + \varepsilon_t \tag{1}$$

where

Y is the natural log of real output

UN is the unemployment rate

Y* is the potential output

UN* is natural rate of unemployment respectively

Prachowny (1993) took a logarithmic linear relationship from a Cobb-Douglas production function and shown that Okun's coefficient (β) should be approximately -0.6 per cent. Of course, the model consisted of factors such as productivity, labour supply and also weekly hour wages. Prachowny's results were criticized later due to shortcomings in the procedure of the data modeling.

Using a current model, Aoki and Yoshikawa (2003) exhibited a relation between unemployment rates and GDP similar to that of the Okun's law in its business fluctuations. Their simulation results revealed that Okun's coefficient increases as the average GDP increases.

Geidenhuys and Marinkov (2007) tried to give answer to the question if unemployment responds to changes in output in South Africa. For this reason, they estimated the relationship between economic activity and unemployment rate. The results indicated the presence of an Okun's law relationship in South Africa over the period 1970 -2005 with more evidence in favour of asymmetries during recessions.

Noor et al (2007) examined whether there exist an Okun – type relationship between output and unemployment in the Malaysian economy. The empirical results shown that there was a negative relationship between output and unemployment.

Villaverde and Maza (2007) analysed Okun's Law for Spain and its seventeen regions over the period 1980 – 2004. Using two different detrending techniques, the results showed an inverse relationship between unemployment and output for most of the Spanish regions and for the whole country. However, the values of Okun's coefficients for these regions are different and lower than those initially estimated by Okun and others.

Perman and Tavera (2007) tested for the presence of convergence of the Okun's Law coefficient (OLC) among several alternative groups of European economies. They used a testing procedure suggested by Evans in order to investigate the convergence or non – convergence of the OLC in several groups of European countries by examining how the cross – country variance of the OLC evolves over time in these groups. A hypothesis of medium – term convergence of the OLC is rejected for most of the European country groups examined.

Ho-Chuan Huang and Shu-Chin Lin (2008), motivated by a simple theoretical model, proposed the Bayesian approach for estimating Okun's coefficients using U.S. quarterly data from 1948: Q1 to 2006: Q1. The results showed that there is overwhelming evidence in favor of smooth –time – varying Okun's law which is positively related to productivity trend. Also their results indicated that the commonly – used Okun's law coefficient can lead to inappropriate results.

Turturean (2008) based on the inflation rate and unemployment rate registered in Romania for the period 1993 – 2004, examined how to show Okun's Law. Results consisted of two distinct models explaining the dependency between the GDP's growth rate and unemployment rate's growth and vice versa. This shows that in the case of Romania there was no two – way relationship using the same model, the direct and mutual dependencies between growth of unemployment rate and the growth rate of GDP's as shown in the original formulation of Okun's Law.

Basically, Okun's law consists of the divergence of real production and unemployment rate from long run levels or from employment levels. Therefore, an important step on Okun's coefficient estimation is the determination of physical production and physical unemployment rate. Unfortunately, these values are not observable and should be estimated. Generally, there is no other way that this estimation can be done with accuracy. For the estimation of these values, we use the Hodrick – Prescott (1997) technique. This technique is being used in macroeconomic theory, particularly in economic cycles' theory, in order to find out fictitious data and can reduce the high from low frequencies from time series.

The aim of this paper is to estimate Okun's coefficient for four member countries of European Union and to examine the differences that exist in every country, those that are created due to the correspondence of the 'gap' of real production on the changes of the 'gap' of real unemployment.

The remainder of the paper proceeds as follows. Section 1 is referred to the role of unemployment on production increase of every country. On section 2 the data used in the empirical analysis are described as well as the specification of the model. Section 3 employs with unit root tests and examines the stationarity of the data used. The results of this research are presented on section 4 while section 5 provides the conclusions of this paper.

2. Data and model specification

As suggested by Okun (1970), there are two classes of Okun's law specifications: The 'gap' model and the 'first-difference' model. According to the 'gap' model, the relationship between log of real GDP 'gap' and the unemployment 'gap' for the four member countries of European Union is the following function used:

$$LGDPGAP_t = \alpha + \beta UNGAP_t + \sum_{j=1}^{k} \gamma_j LGDPGAP_{t-j} + \varepsilon_t \tag{2}$$

where:

LGDPGAP$_t$ is the log of real GDP 'gap' series

UNGAP$_t$ is unemployment 'gap' series

α   is the intercept.

β is the Okun's coefficient to be estimated.

γ is the coefficient to be estimated.

ε$_t$ is the disturbance term.

This study uses data on the unemployment rate and real GDP for four Mediterranean countries in order to estimate Okun's coefficient. The data derives from European Economy data. All series are annual, covering forty – two years (1961 – 2002).

In his first research, Okun used data from Gross National Product. Later, many academics have estimated Okun's coefficient using Gross Domestic Product (Harris and Silverstone 2001) and production as well (Prachowny 1993, and Freeman 2000).

This paper uses Hodrick – Prescott filter (HP, with λ = 100) to decompose the two time series with trend and cyclical components. The aim of using this filter is to be able to observe the sensitivity of estimated Okun's coefficient. An advantage for using the Hodrick – Prescott filter is that time series which comes out is static when we remove the trend (Cogley and Nason 1995).

The reverse relationship of the logarithm between the 'gap' of real GDP and the 'gap' of unemployment is obvious from the data that derives from the four countries that we examine.

The model hypotheses (1) take into account that variables are stationary and the next step is to proceed with the unit root test using augmented Dickey – Fuller test (1979) and Kwiatkowski et al test (1992).

3. Unit root test

Many macroeconomic time series contain unit roots dominated by stochastic trends according to Nelson and Plosser (1982). Unit root tests are important in examining the stationarity of a time series, because a non-stationary regressor invalidates many standard empirical results. The existence of stochastic trend is determined by testing the presence of unit roots in time series data. In this study, unit root test is being tested using augmented Dickey – Fuller test (1979) and Kwiatkowski et al test (1992).

3.1 Augmented Dickey – Fuller test (ADF test)

The Augmented Dickey – Fuller test (1979) is referred to the t statistic criterion of δ$_2$ coefficient on the following regression:

$$\Delta \mathbf{X_t} = \boldsymbol{\delta_0} + \boldsymbol{\delta_2} \mathbf{X_{t-1}} + \sum_{i=1}^{k} \alpha_i \Delta X_{t-i} + u_t \tag{3}$$

The ADF regression tests for the existence of unit root on X$_t$, namely on logarithm of the 'gap' of real GDP and the 'gap' of unemployment. The variable ΔX_{t-i} expresses the first differences with k time lags and final u$_t$ is the variable that adjusts the errors of autocorrelation. The coefficients δ$_0$, δ$_2$, and α$_i$ are being estimated. The null and the alternative hypothesis for the existence of unit root in variable X$_t$ is:

H$_o$: δ$_2$ = 0   H$_\varepsilon$: δ$_2$ < 0

This paper follows the suggestion of Engle and Yoo (1987) using the Akaike information criterion (AIC) (1974), to determine the optimal specification of Equation (2). The appropriate order of the model is determined by computing Equation (2) over a selected grid of values of the number of k lags and finding that value of k at which the AIC attains its minimum. The distribution of the ADF statistic is non- standard and the critical values tabulated by Mackinnon (1991) are used.

3.2 Kwiatkowski, Phillips, Schmidt, and Shin's test (KPSS test)

As long as the null hypothesis, in the augmented Dickey – Fuller test, is that time series consists of unit root, the above hypothesis is accepted unless there is dynamic evidence against it. However, this approach can have a lower impact against the stationary unit root procedure. In contrast, Kwiatkowski et al (1992) presented a test where the null hypothesis is referred to a stationary time series. KPSS test implements the augmented Dickey – Fuller test considering that the power for both tests can be determined from the comparison of the significance of statistical criteria on both tests. A stationary time series has statistical significant criteria for ADF test and non statistical significant criteria on KPSS test (Note1)

4. Empirical Results

Table 1 presents the results of ADF stationarity tests and KPSS tests which were applied on the 'gap' of unemployment rate and on the logarithm of real GDP for four Mediterranean countries on EU in their levels.

Insert Table 1 here

ADF test show that all variables are stationary on their levels for the four European countries. Also, KPSS test rejects the null hypothesis on the levels of time series for the examined countries. Therefore, the corresponding variables on both tests (ADF, KPSS) can be characterized as integrated order null I(0).

Table 2 presents the results of equation (1) for every examined country. As it was mentioned on section 2, the 'gap' variables that are used on equation (1), are static so there is no need for diversification on the data.

Starting with a maximum of five lags (k=5) of the logarithm of the 'gap' for real GDP which represents the restrictions as far as the size of the sample is concerned, we adopt a continuing procedure in order to define the most suitable structure for the model's lags. The accepted hypothesis is exactly above the one which produced an important result. The well- ordered hypotheses are as follows:

$$H_0^1 : \gamma_5 = 0$$
$$H_0^2 : \gamma_5 = \gamma_4 = 0$$
$$H_0^3 : \gamma_5 = \gamma_4 = \gamma_3 = 0$$
$$H_0^4 : \gamma_5 = \gamma_4 = \gamma_3 = \gamma_2 = 0$$
$$H_0^5 : \gamma_5 = \gamma_4 = \gamma_3 = \gamma_2 = \gamma_1 = 0$$

Insert Table 2 here

The estimated coefficients on table 2 are stable enough and statistical significant on 5% level according to Hodrick and Prescott method with an exception on data for Greece where coefficient is not statistical significant and has one time lag. It is worth mentioning that some relationships might appear on lags if the direction is not clear enough. Moosa (1997) on the long- run regression of his model, added one period lag on the unemployment rate in order to introduce a dynamic on his model.

The estimated Okun's coefficients are just an aspect of the variance of unemployment cost for the four examined countries. The results, using Hodrick and Prescott's filter and the method of trend removing, suggest that the cost in the increase per unit on unemployment rate from the decrease of real GDP is higher in Italy and lower in Greece.

Diagnostic tests for residuals consist of LM test for a possible existence of autocorrelation and heteroscedasticity, the Jarque – Bera test for normality and Ramsey RESET test for incorrect specification of the model with its functional form. For the verification of forecasting ability of the model, the first and second Chow test were adopted while for the extraction of predictions out of the sample (Ex – ante), the Theil's statistic was used.

The main goal of this study is not to explain the reason why the cost of unemployment is higher in Italy than in other examined countries. It is obvious that estimated Okun's coefficients are higher in the most industrialized countries with quite larger population and production.

5. Conclusions

On this study we have estimated Okun's coefficients for four member countries of EU using real GDP and unemployment rate. The purpose of this study is to examine the variance on Okun's coefficient for the examined countries. Evaluating the results in 5% level of significance, we obtain coefficients' stability and statistical results for all countries except Greece. The coefficients'estimation is -0.024 for Italy, -0.017 for Spain, - 0.016 for Portugal and -0.007 for Greece and for the EU -15 is -0.12.

Generally, we can conclude that we don't reject the estimations based on results of table 2 according to statistical and diagnostic tests. Furthermore, we claim that the model can predict within the sample period satisfactory (Ex – Post).

To sum up, we can say that unemployment cost from the viewpoint of the loss of real GDP is larger in Italy, which is regarded as an industrial country, and lower in Greece where there is no heavy industry.

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Notes

According to Kwiatkowski et al (1992). The test of KPSS assumes that a time series can be composed into three components, a deterministic time trend, a random walk and a stationary error:

$$y_t = \delta t + r_t + \varepsilon_t$$

where r_t *is a random walk* $r_t = r_{t-1} + u_{t..}$ The u_t is iid $(0, \sigma_u^2)$.

The stationary hypothesis implies that $\sigma_u^2 = 0$.

Under the null, y_t, is stationary around a constant ($\delta=0$) or trend-stationary ($\delta\neq0$). In practice, one simply runs a regression of y_t over a constant (in the case of level-stationarity) ore a constant plus a time trend (in the case of trend-stationary). Using the residuals, e_i, from this regression, one computes the LM statistic

$$LM = T^{-2}\sum_{t=1}^{T} S_t^2 / S_{\varepsilon t}^2$$

where $S_{\varepsilon t}^2$ is the estimate of variance of ε_t.

$$S_t = \sum_{i=1}^{t} e_i, \qquad t = 1,2,......T$$

The distribution of LM is non-standard: the test is an upper tail test and limiting values are provided by Kwiatkowski et al (1992), via Monte Carlo simulation. To allow weaker assumptions about the behaviour of ε_t, one can rely, following Phillips (1987) and Phillips and Perron (1988) on the Newey and West (1987) estimate of the long-run variance of ε_t which is defined as:

$$S^2(l) = T^{-1}\sum_{t=1}^{T} e_i^2 + 2T^{-1}\sum_{s=1}^{l} w(s,l) \sum_{t=s+1}^{T} e_i e_{i-k}$$

where $w(s,l) = 1 - s / (l+1)$. In this case the test becomes

$$\nu = T^{-2}\sum_{t=1}^{T} S_t^2 / S^2(l)$$

which is the one considered here. Obviously the value of the test will depend upon the choice of the 'lag truncation parameter', l. Here we use the sample autocorrelation function of Δe_t to determine the maximum value of the lag length l.

Table 1. Tests of unit roots hypothesis

	ADF	LAGS	KPSS	BANDWIDTH
GREECE				
LGDPGAPGR	-3.543**	0	0.055***	2
ΔLGDPGAPGR	-6.616***	0	0.060***	4
UNGAPGR	-4.743***	1	0.044***	3
ΔUNGAPGR	-4.170***	1	0.057***	3
SPAIN				
LGDPGAPS	-3.466**	1	0.037***	3
ΔLGDPGAPS	-5.354***	0	0.036***	1
UNGAPS	-4.606***	1	0.041***	1
ΔUNGAPS	-4.254***	1	0.046***	1
ITALY				
LGDPGAPS	-3.770***	1	0.074***	1
ΔLGDPGAPS	-5.426***	0	0.249***	16
UNGAPS	-4.815***	1	0.034***	3
ΔUNGAPS	-4.845***	0	0.161***	9
PORTUGAL				
LGDPGAPS	-5.028***	1	0.040***	2
ΔLGDPGAPS	-5.832***	1	0.326***	28
UNGAPS	-4.592***	1	0.043***	2
ΔUNGAPS	-3.899***	0	0.033***	3
EU-15				
LGDPGAPEU	-3.455**	1	0.063***	4
ΔLGDPGAPEU	-4.623***	0	0.047***	2
UNGAPEU	-4.580***	1	0.039***	3
ΔUNGAPEU	-4.548***	1	0.045***	2

Notes:

The t-statistic for testing the significance of δ_2 when a time trend is not included in equation 2..The calculated statistics are those reported in Dickey-Fuller (1981). The critical values at 1%, 5% and 10% are –3.60, -2.90 and –2.60 for τ_μ

The KPSS statistics for testing the null hypothesis that the series are I(0) when the residuals are computed from a regression equation with only an intercept respectively. The critical values at 1%, 5% and 10% are 0.739, 0.463 and 0.347 (Kwiatkowski et al, 1992, table 1).

***, **, * indicate significance at the 1, 5 and 10 percentage levels

Table 2. Estimated equation (1)

	GREECE	ITALY	SPAIN	PORTUGAL	EU-15
Constant	-0.000760	-6.3E-05	0.000837	- 0.00081	-0.00045
	[0.9066]	[0.9899]	[0.8861]	[0.890]	[0.8207]
UNG		-0.02462	-0.01705	-0.016486	-0.01211
		[0.0226]	[0.0000]	[0.0245]	[0.0001]
UNG(-1)	-0.007411				
	[0.3923]				
LG(-1)	0.552824	0.676851	0.506832	0.779563	0.769596
	[0.0003]	[0.0003]	[0.0000]	[0.000]	[0.0000]
LG(-2)		-0.33149		-0.335173	
		[0.0281]		[0.0384]	
$R^{2(2)}$	0.291642	0.562646	0.678984	0.609330	0.721565
$DW^{(3)}$	1.775911	1.968784	1.857702	1.873157	1.656195
Diagnostics Tests					
Serial Correlation LM Test[4]	1.210	0.030	0.324	0.891	1.581
	[0.271]	[0.861]	[0.569]	[0.345]	[0.208]
Normality Test[5]	4.214	14.61	1.338	7.591	0.926
	[0.121]	[0.000]	[0.511]	[0.022]	[0.629]
White Heteroscedasticity[6]	0.916	11.85	0.739	11.68	2.269
	[0.922]	[0.065]	[0.571]	[0.069]	[0.686]
ARCH LM Test[7]	1.169	0.080	0.175	0.365	0.661
	[0.279]	[0.776]	[0.675]	[0.606]	[0.416]
Ramsey RESET Test[8]	0.630	1.606	0.779	0.394	0.578
	[0.432]	[0.213]	[0.382]	[0.533]	[0.451]
Chow Breakpoint Test[9]	0.031	0.058	0.198	0.169	0.598
	[0.992]	[0.993]	[0.896]	[0.957]	[0.620]
Chow Forecast Test[10]	0.068	0.058	0.145	0.169	0.497
	[0.990]	[0.993]	[0.963]	[0.953]	[0.737]
Forecasting					
Theil[11]	0.789	0.554	0.367	0.516	0.468
Bias	0.000	0.000	0.000	0.000	0.001
Variance	0.636	0.314	0.124	0.276	0.118
Covariance	0.363	0.685	0.875	0.723	0.880
RMSE[12]	0.046	0.037	0.041	0.045	0.018
MAE[13]	0.033	0.029	0.034	0.036	0.015
MAPE[14]	117.07	502.6	106.8	1527.1	396.4

Notes:

1. Numbers in brackets indicate significant levels.

2. R^2 = Determination coefficient

3. D-W Durbin – Watson statistic for autocorrelation

4. Breusch – Godfrey (Lagrange-Multiplier) test for up to first order of the residuals.

5. Jarque-Bera test for normality of the residuals

6. White test for heteroscedasticity of the residuals

7. ARCH Autoregressive conditional heteroscedasticity statistic of order one.

8. Ramsey reset test of functional from based on the inclusion of two fitted terms.

9. Chow breakpoint test for break in 1999.

10. Chow forecast test from 1999.

11. Theil inequality coefficient decomposition into bias proportion, variance proportion and covariance proportion.

12. Root mean squared error.

13. Mean absolute error

14. Mean absolute percent error.