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THE VALIDITY OF THE OKUN'S LAW: AN EMPIRICAL INVESTIGATION FOR THE GREEK ECONOMY

Abstract

The main objective of this study is to evaluate the relationship of Okun's law for the Greek economy over the period 1960–2007. The results of the analysis using the model of the «first differences» showed an inverse relationship between unemployment and GDP. However, the quantitative value of the Okun's law coefficient and the form of this relationship in the case of Greece is quite different from those estimated for other EU countries. This is partially explained by disparities between productivity growth rates in Greece and other EU countries [France and Spain]. Moreover, structural change tests conducted by using dummy variables indicated that the Okun's coefficient for Greece for the period

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from 1980 to 2007 is different from that estimated for the period 1960–1980. Finally, for VAR order $k = 2$, the pairwise Granger causality tests showed that LNGDP Granger causes UN.

Key words:

Okun's law, unemployment rate, stationarity, cointegration, causality.

JEL: E24, E29.

1. Introduction

Even though Greece has gradually significantly decreased the divergence its per capita GDP compared to the EU average, there is still a significant gap between the two values. There is no doubt that the two phenomena, income convergence and the divergence of the EU average, are relevant to the rates of unemployment that exist; however, they have decreased over the last decade, thus promoting the convergence. The fact is that the rates of unemployment have traditionally been high and continue to be above the EU average.

The application of sufficient policies to continue the reduction of unemployment while increasing output constitutes one of the main objectives of the policymakers at the regional and national levels (Kolokontes and Chatzitheodoridis, 2008), (Loizou et al, 1997) . In order to devise these policies, it would be important to clarify whether a relation between unemployment and economic output exists. This relation, known as Okun's law (Okun, 1962, 1970), simply demands the existence of a negative empirical relation between the changes in the unemployment rate and the changes in the real Gross Domestic Product (GDP).

Okun's law, which is named after the economist Arthur Okun, who proposed the relation in 1962, describes a relation between the change in the unemployment rate and the change of real GDP. The fundamental inverse relation between the percentage of unemployment and the increase of the real output of the economy has long been known to economists. Okun (1962) standardises this relation in a statistical relation that shows the degree to which the percentage of unemployment is negatively connected to the real increase in the economy's output (GDP). He has also pointed out that there are other factors that connect the rate of unemployment and the real output in the abovementioned relation (Altig and Rupert, 1997). For example, a decrease in the rate of unemployment is expected to cause an increase in work force participation, work hours and productivity, thus leading to an increase in the real output. Using the GDP of the US, Okun shows that when the unemployment rate decreases (increases) to 1 % higher (lower) than the natural unemployment rate, the real economic output increases (decreases) by almost 3 % per year.

As it was proposed by Okun (1970), two special cases of the law exist: the first differences model and the «gap» model. According to the first model, the relation between the natural logarithm of observed real output of the economy (y_t) and the unemployment rate (u_t), it is given by the function:

$$(y_t - y_{t-1}) = a + b\,(u_t - u_{t-1}) + e_t, \tag{1}$$

Where a – is the intercept, b – is Okun's coefficient and **e** is the error term. In order for the above equation to be correct, one of two conditions should hold: firstly, the two time series, in the parentheses, should be stationary, and secondly, if the time series are not stationary, they must be cointegrated in order to avoid spurious regressions (Hamilton 1989). The traditional approach of Dickey-Fuller is used for the stationarity and cointegration tests.

The «gap» model is specified by the following relation:

$$(y_t - y_t^*) = a + b\,(u_t - u_t^*), \tag{2}$$

Where y^* represents the natural logarithm of the potential output of the economy, u_t^* is the natural unemployment rate (NAIRU) and all other terms are as specified above.

As stated by Harris and Silverstone (2001), Okun's law is important for both theoretical and empirical reasons. From a theoretical point of view, Okun's law, which is rooted in old and new Keynesianism2 is, along with the Phillips curve, a key element to derive the aggregate supply curve; from an empirical perspective, «Okun's coefficient is a useful indication in forecasting and policy – making» (Harris and Silverstone, 2001; Villaverde, j. and Maza, A., 2007).

In the last two decades, a significant number of empirical studies have examined the validity of Okun's law (see Adanu, 2005) with findings that generally tend to support it. However, it has been shown that the absolute value of the estimated Okun's coefficient (considered to be around 3) varies according to the examined period and samples under review; moreover, it tends to take values far below 3 (Perman and Tavera, 2004). Furthermore, variations in factors such as the size of the workforce, the productivity and the weekly working hours tend to influence the value of the coefficient. It is also important to stress that the values of this coefficient change according to the specification of Okun's law and the method employed to estimate it.

As is mentioned in the international literature, the stability of Okun's coefficient has decreased for many reasons; see Blanchard (1999). The reasons for this is the strongest international competition, less legal protection for workers and generally less expensive labor changes that lead companies to reduce to overstaffing. The work of Moosa (1997) estimated the Okun coefficients for seven OECD countries and the stability is controlled using the "rolling" OLS method and the Chow-test for structural changes (Chow break point test). For Germany and France concluded a significant drop in the rate of Okun. The Weber (1995) estimated the Okun coefficient for the U.S. economy and tested whether the unemployment-GDP relationship has changed since 1973, so no indication of a structural break in 1973 can be supported by the data. Moreover, the author provides a brief overview on previous estimates of Okun's Law.

Recent advances in understanding the functioning of the institutions of the European labor market were the motivation for the Jim Lee (2000) to examine whether the Okun's Law continues to be valid in today's economic environment. He concluded that Okun's law is statistically valid for the most countries and that the estimates are not uniform. He found that apart from the heterogeneity of the coefficient among OECD countries, the data show strong findings for structural change in the relationship of Okun.

The empirical study of Okun's law has indeed bloomed since the publication of the work of Prachowny (1993); however, the majority of the studies deal only with data at the national level. In the past few years, certain studies have attempted to examine the dynamics of economic output and the labour market with the introduction of a regional dimension in the analysis of the relation between economic output and unemployment (Freeman, 2000; Christopoulos, 2004; Adanu, 2005; José Villaverde and Adolfo Maza, 2007).

The major aim of the present study is to estimate Okun's coefficient for the Greek economy by employing the first differences model and with the use of dummy variables to test the existence of structural breaks in the period under examination. It is important to know the degree to which the unemployment rate affects the output of the economy and, moreover, to see behind the mechanism through which these effects take place. Moreover, the stability of Okun's law is examined. This is also important, given that an analysis of the stability of Okun's law indirectly provides information on the role of external shocks in the relation between unemployment and GDP. Additionally, by investigating the labour supply and demand, we have the ability to determine whether changes in Okun's relation are a result of the supply or of the demand for labour.

Finally, the validity of Okun's law is examined comparatively between the economies of Greece, France and Spain; additionally, causality tests between natural logarithm GDP ($LNGDP_t$) and unemployment (UN_t) are performed for the three countries.

2. Data and Methodology

2a. Data

This essay uses data with regard to the unemployment rate and the real GDP of three countries, Greece, France and Spain, in order to determine Okun's coefficient for each country with the method of first differences. The form of first differences, as adopted by Mankiw (1994), inter alia, represents a suitable way to achieve stationarity in the data that contain a unit-root. The approach of «the gap», as it was applied by Gordon (1984) and Hsing (1991), for example, provides the possibility to extract the conclusions on the behaviour of time series during the business cycle. For a balanced approach to the question, it would be preferable to examine both approaches. The second approach escapes the aim of this present work; perhaps it will be examined in the future.

Eurostat is the source of data. The time series are annual, and their range is 48 years (1960-2007). Okun used the Gross National Product (GNP) in his initial work. However, many authors since then have produced estimates of Okun's coefficients using real Gross Domestic Product (GDP) (Harris and Silverstone, 2001 and Moosa, 1997) and other elements of economic output, including the product without the rural sector (non-farm business sector output) (Prachowny, 1993), and the Gross State Product (Freeman, 2000 and José Villaverde and Adolfo Maza, 2007). Walsh (1999) has ascertained, however, that the estimates of Okun's coefficients also tend to be sensitive to the choice of the data of the real product.

In figures 1a and 1b, the natural logarithm of the GDP and the unemployment rate are presented, and in figures 2a and 2b, the first differences of the natural logarithm of GDP ($\Delta LNGDP_t = LNGDP_t - LNGDP_{t\text{-}1}$) and the rate of unemployment rate ($\Delta u_t = u_t - u_{t\text{-}1}$) for Greece during the period 1960–2007 are presented, respectively. The inverse relation between the first differences of the natural logarithm of real GDP and the first differences of unemployment rate are very apparent from these diagrams. The first differences of the two variables present a wide difference in this examined period. The higher simultaneous variations in the values of first differences for the two variables are presented during the 1973 oil crisis and with the accession of Greece to the EEC in 1980. This led us to the thought to look into the existence of structural breaks in Okun's coefficient in 1973 and in 1980 with the use of dummies.

Figure 1

(a) The logarithm GDP and
(b) the unemployment rate, in Greece

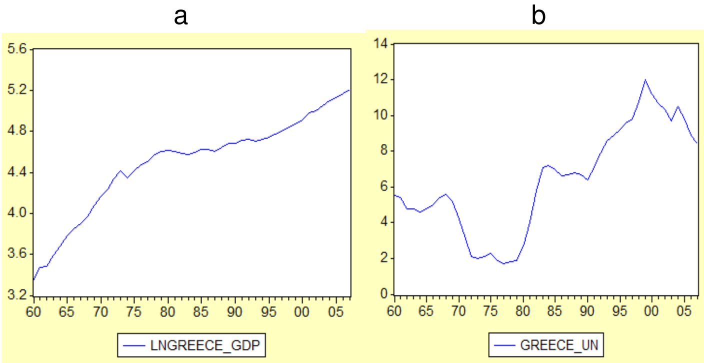
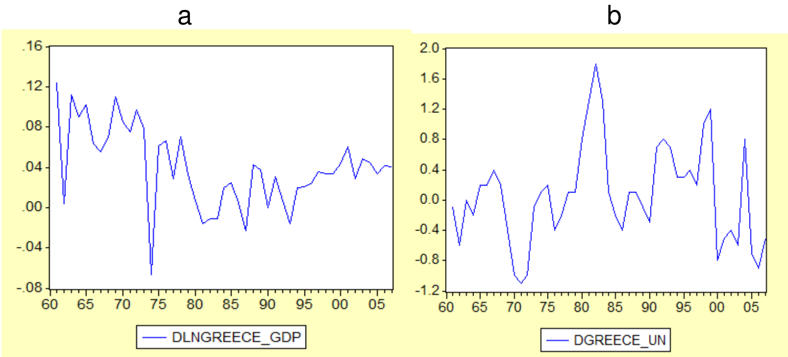


Figure 2

(a) The first differences of the natural logarithm of GDP and
(b) the unemployment rate, in Greece



2b. Methodology

As it was proposed by Okun (1970), two types of specialisation of Okun's Law exist: the first-difference model and the «gap» model (Attfield and Silverstone 1997). According to the first difference model, the relation between the natural logarithm of the real economy's output (y_t) and the observed unemployment rate (u_t) are given by the function (1). In order for the above specialisation to be right, one of the two conditions has to be in effect: the time series in the parentheses would be stationary, and if the time series are not stationary, they would be co-integrated in order to avoid the spurious regression. The traditional approach to test for stationarity and cointegration is the Dickey-Fuller test.

For the non-stationarity, we tested the existence of the unit-root in the two examined variables. For each variable, we assumed that the lack of stationarity is due to the existence of the unit-root in its auto-regressive form. The augmented Dickey-Fuller test (ADF) (1981) was used for the detection of unit-root in each variable of the system. The three mathematical forms of the models that were used for each variable are shown below:

$$\Delta X_t = \delta_2 X_{t\text{-}1} + \sum_{i=1}^{p} \beta_i \Delta X_{t\text{-}1} + e_t \tag{3}$$

$$\Delta X_t = \delta_0 + \delta_2 X_{t\text{-}1} + \sum_{i=1}^{p} \beta_i \Delta X_{t\text{-}1} + e_t \tag{4}$$

$$\Delta X_t = \delta_0 + \delta_1 t + \delta_2 X_{t\text{-}1} + \sum_{i=1}^{p} \beta_i \Delta X_{t\text{-}1} + e_t \tag{5}$$

Where: $i = 1, 2, 3,\ldots, p$ the number of time lags, δ_0 δ_1 δ_2 and β_i $i = 1, 2, 3,\ldots, p$ are the parameters and t is the time trend.

The hypotheses that we have for the three above models (3, 4 and 5) are the following:

$H_0 : \delta_2 = 0$ (The series X_t contains a unit-root, hence it is non-stationary).

$H_a : \delta_2 < 0$ (the H_0 is not valid).

The hypotheses were tested by t-statistic using the critical values of Mackinnon (1991) from Table 1 of Dickey-Fuller. The test is the same with the simple Dickey-Fuller test (DF), and only the regression equation differs, which has increased with the lags of the depending variable. Dickey-Fuller has shown that an asymptote distribution of the t-statistic for the test of statistical significance is independent from the number of the time lags of the depending variable. What influences the values of the t-distribution is the presence or lack of the deterministic factors such as the intercept and the time trend.

The number of time lags must be such that the auto-correlated residuals do not exist. For the determination of the suitable number of time lags p, we used the Breusch-Godfrey test or otherwise the statistical criterion of the Lagrange Multiplier (LM). Moreover, for the choice of the model, namely, for the determination of the number of time lags, we used the criteria of Akaike (AIC) and Schwartz (SCH).

It was ascertained that the two variables ($y_t = LNGDP_t$ and $u_t = UN_t$) are stationary in the first differences, and it was tested whether they are co-integrated at the levels. For the test of cointegration, two basic methods are also used: the Engle-Granger method (1987) and the Johansen method (1988). The first method is related to the methods of one equation and is based on Ordinary Least Squares (OLS) Estimation, and the second method is related to the system of equations based on the method of maximum likelihood. In the first category, we have the tests of cointegration with two variables and the tests with more than two variables. In the second category, we have the tests based on the methodology of the VAR model, and we can determine the maximum number of the relations of cointegration that the variables of the examined model can have. However, this is not possible for the first category of one equation. The most frequent method of this type is outlined by Johansen (1988).

The models of the vector auto-regression (VAR model) constitute a system of equations where all the variables are endogenous and where each one is determined as a function of the preceding values of all variables of the system itself. The number of preceding values (lags) is determined by the system itself. The test of the order of the VAR model was performed with the likelihood ratio (*LR*) test and the criteria of Akaike, Schwartz and Hanna and Quinn (*HQ*).

$$LNGDP_t = a_{10} + a_{11} UN_{t-1} + a_{12}\, UN_{t-2} + b_{11}\, LNGDP_{t-1} + b_{12}\, LNGDP_{t-2} + u_{1t} \quad (6)$$

$$UN_t = a_{20} + a_{21} UN_{t-1} + a_{22}\, UN_{t-2} + b_{21}\, LNGDP_{t-1} + b_{22}\, LNGDP_{t-2} + u_{2t} \quad (7)$$

Finally, after the determination of the vector auto-regression (model VAR), we performed Granger's test of causality. This test is based on the syllogism that the future cannot cause the present or the past. In practice, the tests for the existence of causality take place with the use of the VAR model. Namely, in order for a variable X to cause Y, it should the coefficients of all time lags of X in the equation of Y to differ significantly from zero, while the coefficients of time lags of Y in the equation of X do not differ significantly from zero. This test took place using the criterion of F-distribution of Wald for the significance of all coefficients of time lags of the corresponding variables.

The reliability of the test of causality according to Granger depends on the order of the VAR model as well as on the stationarity of the variables that take part in functions (6) and (7). According to Geweke et al. (1983), the reliability of Granger's causality test is diminished if the variables that take part in this test are non-stationary. Granger (1988) later extends this test, taking into consideration the notion of cointegration. Consequently, in order to apply Granger's causality test, we should know the order of the corresponding VAR model. The order test of the VAR model takes place with the well-known criterion of the Likelihood ratio (*LR*) and the criteria of Akaike, Schwartz and Hanna and Quinn (*HQ*).

3. Results and Discussion

According to Granger and Newbold (1974), when the value of the multiple coefficient of determination R^2 is high and the value of the Durbin-Watson statistic is low, particularly when $R^2 > DW$, it is probable that the regression may not be real but fictitious. In this case, it is preferable to estimate the relation between the first differences instead of the levels of variables. The stationarity tests of the variables were performed with the diagrams and the methodology of the unit-roots. Figures 1a and 1b reveal the following: 1. The time series of the natural logarithm of GDP ($LNGDP_t$) for the period 1960–2007 present slight increasing trend, but it is also probable that it is stationary because it expresses the logarithm of GDP. 2. The time series of the rate of unemployment for the period 1960–2007 reflect intense descending trend in the beginning of the 1970s, increasing trend for the following two decades, and finally intense variations with somewhat descending divergence.

The use of logarithm GDP in place of GDP for the estimation of Okun's coefficient is justified as follows: A usual process that takes place in order to modify the increasing trend of variables to be stationary is to create the percentage change in these variables (Katos, 2004):

$$X_t = (X_t - X_{t-1}) / X_{t-1} \approx LN\,(X_t / X_{t-1}) \tag{8}$$

Often the data of variables are expressed in logarithms in order to include the multiplier effect of variables (Dritsaki et. al., 2004). Also, the logarithmic transformation can create stationary time series (Box and Jenkins, 1976). According to the above, it holds for GDP:

$$\Delta LNGDP_t = LNGDP_t - LNGDP_{t-1} = LN\,(GDP_t / GDP_{t-1}) \approx (GDP_t - GDP_{t-1}) / GDP_t \tag{9}$$

Where: $LNGDP_t$ = the natural logarithm of GDP and t=the time.

For the test of the existence of unit-root, the following criteria were used for the selection of time lags: the multiple coefficient of determination R^2, corrected as the degree of freedom ($adg - R^2$), the criteria of Akaike (AIK) and Schwartz (SBC), the criterion of maximisation of the logarithm of likelihood, and the criterion of Hannan and Qinn (HQ). For the test of the autocorrelation of the residuals, u_t, the Breusch-Godfrey test or, alternatively, Lagrange's Multiplier (LM) test, which simultaneously re-tests the choice of time lags, was used. We chose the specialisation of the model that was indicated by the most criteria. In the tables that follow, we present only the criteria of Akaike (AIC) and Schwartz (SBC).

In table 1, we present the critical values for the time lags $\rho = 0$ and for the three forms of equations 3, 4 and 5, for statistical significance of 1 %, 5 %, and 10 % respectively. Here, it must be mentioned that in cases when the number of time lags is higher than $\rho = 0$, the critical values in table 1 are differentiated at minimum.

Table 1

The critical values of Mackinnon from the table of Dickey-Fuller for the unit-root test

Forms of equations	Statistical significance		
	1 %	5 %	10 %
With constant, Without trend	–2,62	–1,95	–1,61
Without constant, Without trend	–3,58	–2,93	–2,60
With constant, With trend	–4,15	–3,50	–3,18

In tables 2 and 3, the estimations of equations 3, 4 and 5 are mentioned for the variables of our model, namely, *LNGDP* and *UN*, and for time lags $\rho = 0$, $\rho = 1$ and $\rho = 2$. The Dickey-Fuller tests for the existence of unit roots for the variables LNGDP and UN were both at the levels of variables, and the values of their first differences. Table 2 presents the results on the existence of unit-root in the levels and in the first difference of the logarithm of GDP ($LNGDP_t$) and indicates that:

- The logarithm of GDP is stationary at primary levels with specification: constant without trend and without time lag.
- The logarithm of GDP in values of first differences is stationary for all forms of Dickey-Fuller functions with zero time lags.
- For the forms of the selected functions and the number of time lags, there is no autocorrelation for the residuals, according to the Breusch–Godfrey test and Lagrange Multipliers (*LM*).

We conclude from the above that the logarithm of GDP is stationary in primary levels and in first differences. We then have $\Delta LNGDP \sim I(0)$, a condition that has to be fulfilled for the estimation of Okun's coefficient.

In the table 3, the results on the existence of unit-root in the levels and in the first differences of the unemployment rate are presented, from which it results that:

- The unemployment rate at primary levels is non- stationary.
- The unemployment rate at the values of first differences is stationary for the two first forms of functions of Dickey-Fuller (*DF*) with zero, one and two time lags.
- The best form of function (best specification) for the values of first differences of the unemployment rate is that with constant without trend and two time lags (blue italics). Besides, there is no problem in autocorrelation according to the statistic of Lagrange Multipliers (*LM*).

Table 2

Dickey-Fuller Tests for the existence of unit-root in the levels and in the first differences of logarithm of GDP

LNGDP							
Forms of equations	Statistics	Levels			First Differences		
		Lags			Lags		
		ρ = 0	ρ = 1	ρ = 2	ρ = 0	ρ = 1	ρ = 2
Without constant without trend	DF/ADF	6,1765	2,9578	1,7934	-3,4120	-1,6762	-1,6402
	LM	6,7938	0,14844	0,52573	2,9952	0,56914	0,49602
	[prob]	0,009	0,700	0,982	0,084	0,451	0,481
	Akaike	82,3980*#	86,1527*	86,4135*	82,0817*#	85,7533*	88,0149
	Schwartz	81,4729*#	84,3241*	83,7036*	82,0674*#	83,9466	85,3387
With constant without trend	DF/ADF	-4,0264	-2,4484	-2,7343	-5,0038	-2,7470	-2,2017
	LM	1,4831	1,8957	0,88961	0,0014	0,6367	0,27800
	[prob]	0,223	0,169	0,346	0,970	0,801	0,598
	Akaike	91,1780	89,0923	89,88155	87,0905	87,0468	88,2157
	Schwartz	89,3278	86,3493	86,2022#	85,2618	84,3368	84,6473
With constant with trend	DF/ADF	-3,1649	-2,3503	-3,4490	-5,3212	-3,1637	-2,1153
	LM	1,4565	1,1906	0,0181	0,6476	0,8137	0,13836
	[prob]	0,227	0,275	0,893	0,421	0,367	0,710
	Akaike	91,9453	89,3364#	92,1029	87,4944	87,2448	
	Schwartz	89,1700	85,6791#	87,5863	84,7514	83,6315*	82,9084*

Note:

* indicates the best form of function (vertical test)

\# indicates the best number of time lags (Horizontal test). The blue italics indicate the best stationary specification. The brackets indicate **statistical significance.**

Table 3

Dickey-Fuller tests for the existence of unit-root at the levels and to the first differences of the unemployment rate

Forms of equations	Statistics	Levels			First Differences		
		Lags			Lags		
		ρ = 0	ρ = 1	ρ = 2	ρ = 0	ρ = 1	ρ = 2
Without constant Without trend	DF/ADF	0,3240	-0,3675	-0,0606	-3,3976	-3,4502	-3,1138
	LM	15,9499	0,7719	0,0569	0,8510	0,4594	0,28126
	[prob]	0,0000	0,380	0,812	0,356	0,830	0,867
	Akaike	-47,52253#	-38,4785*	-38,2798	-37,5490	-37,2818	-37,6270#
	Schwartz	-48,4476#	-40371	-40,9898	-38,4633	-39,0885	-40,3032#
With constant Without trend	DF/ADF	-0,6076	-1,4565	-1,2731	-3,3718	-3,4606	-3,1133
	LM	16,8491	0,31430	0,1695	0,8854	0,0143	0,0166
	[prob]	0,0000	0,575	0,681	0,347	0,905	0,898
	Akaike	-48,172#	-38,4024	-38,636*	-38,5099	-38,1359	-38,5102#
	Schwartz	-50,0227#	-41,1453	-41,876	-40,3385	-40,8459	-42,0785#

Forms of equations	Statistics	Levels			First Differences		
		Lags			Lags		
		$\rho = 0$	$\rho = 1$	$\rho = 2$	$\rho = 0$	$\rho = 1$	$\rho = 2$
With constant With trend	*DF/ADF*	-1,5716	-2,4731	-2,0241	-3,3158	-3,3598	-3,0392
	LM	17,6395	0,12126	0,8320	0,9119	0,0169	0,010624
	[prob]	0,0000	0,645	0,362	0,340	0,897	0,918
	Akaike	-47,9653#	-36,3829	-37,9345	-39,509*#	-39,1285*	-39,5014*
	Schwartz	-50,740*#	-41,0402*	-42,4511*	-42,2528*	-42,7418*	-43,961*#

Note:

* indicates the best form of equation (vertical test).

\# indicates the best number of time lags (Horizontal test). The blue italics indicate the best stationary specification. The brackets indicate **statistical significance**

From the above, it follows that the unemployment rate is stationary in first differences. We then have $\Delta UN \sim I(0)$, a condition that has to be fulfilled for the estimation of Okun's coefficient.

The Okun's relation, the estimation of which we are interested, is reported in the first differences of the variables $LNGDP_t$ and UN_t and is expressed as a linear relation between them. The differences $\Delta LNGDP$ and ΔUN are stationary variables; that is, the variables $\Delta LNGDP_t$ and ΔUN_t are integrated in zero range $I(0)$, and thus there is no question of cointegration (Katos, A., 2004; Dritsakis, N., 2004). Therefore, there is no problem of spurious regression for the variables $\Delta NGDP$ and ΔUN, and we can use the techniques of the regression to estimate the relation. We estimate the long-term relation of equilibrium using the OLS method and get the regression equation:

$$\Delta LN\hat{G}DP_t = \underset{\substack{[7,811] \\ (0,000)}}{4,118} - \underset{\substack{[-3,135] \\ (0,003)}}{2,536} DUN_t \qquad (10)$$

$R^2 = 0,179$ $DW = 1,174$ $LM = 0,3728$ (0,542)

From the results of the regression (10), we note that the coefficient of ΔUN_t is statistically significant at the 1 % level and that the coefficient of determination, R^2, is quite low at 0,179. The statistic Durbin-Watson $DW = 1,714 > R^2 = 0,179$ is significantly greater than the coefficient of determination R^2, $1,5 < DW < 2,5$ and $LM = 0,3728$ (0,542). It means that the regression is not spurious and that all of the residuals are not correlated. Consequently, Okun's coefficient is equal to –2.536 for the Greek economy fluctuations.

As was mentioned before, the first differences of the logarithm of GDP ($\Delta LNGDP$) and the unemployment rate (ΔUN) represent many fluctuations in the period examined. The largest simultaneous value fluctuations of the first differences and for the two variables represent the 1973 oil crisis and the accession of

Greece to the EEC in 1980. It leads us to research the existence of structural breaks in Okun's Coefficient in 1973 and 1980 using dummy variables.

We considered the qualitative variable «previously 1973», «after 1973 and previously 1980» and «after 1980», which has three levels. We introduced two dummy variables, which are defined as follows:

$$D73_t = \begin{cases} 1, \text{ when } t < 1973 \\ 0, \text{ when } t \geq 1973 \end{cases} \qquad (11)$$

and

$$D80_t = \begin{cases} 1, \text{ when } t \geq 1980 \\ 0, \text{ when } t < 1980 \end{cases} \qquad (12)$$

From the above results that the model that is to be estimated is written as follows:

$$\Delta LNGDP_t = a + b\Delta UN_t + c\,(D73_t * \Delta UN_t) + d\,(D80_t * \Delta UN_t) + e_t, \qquad (13)$$

Where

c = the coefficient of discrimination because of oil crisis in 1973

d = the coefficient of discrimination because of the accession of Greece in EU in 1980.

We estimated the above function using the stepwise method of regression, to introduce only significant variables, and got:

$$\begin{array}{lll} \Delta LN\hat{G}DP_t & = & 4{,}118 - 2{,}536 DUN_t \\ t & & [7{,}811] \quad [-3{,}135] \\ & & (0{,}000) \quad (0{,}003) \\ R^2 = 0{,}179 & & DW = 1{,}174 \end{array} \qquad (14)$$

It is the same result as provided by function (10). It means that the coefficients c and d of the function (14) are not significant. Therefore, the oil crisis of 1973 and the accession of Greece to the EEC in 1980, if examined jointly, do not appear to cause important structural breaks to Okun's coefficient. We then estimated using the functions

$$\Delta LNGDP_t = a_1 + b_1\,\Delta UN_t + c_1\,D73_t + d_1\,(D73_t * \Delta UN_t) + e_t \qquad (15)$$

$$\Delta LNGDP_t = a_2 + b_2\,\Delta UN_t + c_2\,(D80_t + d_2\,(D80_t * \Delta UN_t) + u_t \qquad (16)$$

to ascertain if each fact separately causes a structural break in Okun's coefficient and we had the regression functions:

$$\Delta LN\hat{G}DP_t = \underset{\substack{[5,525] \\ (0,000)}}{2,832} - \underset{\substack{[-2,420] \\ (0,020)}}{1,840}\Delta UN_t + \underset{\substack{[4,986] \\ (0,000)}}{5,453}\, D73_t + \underset{\substack{[1,129] \\ (0,265)}}{2,062}\,(D73_t * \Delta UN_t) \quad t \qquad (17)$$

$$R^2 = 0,483 \qquad DW = 2,445$$

$$\Delta LN\hat{G}DP_t = \underset{\substack{[7,914] \\ (0,000)}}{6,313} - \underset{\substack{[-0,961] \\ (0,342)}}{1,604}\Delta UN_t - \underset{\substack{[-3,702] \\ (0,001)}}{3,774}D80_t - \underset{\substack{[-0,016] \\ (0,988)}}{0,09}\,(D80_t * \Delta UN_t) \quad t \qquad (18)$$

$$R^2 = 0,383 \qquad DW = 2,133$$

Function (17) shows that the coefficient of discrimination of the intercept $c_1 = 5,453$ is positive and significant. This means that we have an upwards parallel shift for the years previous to 1973. However, the coefficient of discrimination of the slope $d_1 = 2,062$ is not significant and means that we do not have a function turnaround; that is, we do not have variation in the function's slope for the years prior to 1973. In other words, this means that the constant term (intercept)that expresses the mean annual increase of GDP that is due to all factors other than unemployment is equal to $a_1 + c_1 = 2,832 + 5,453 = 8,285$ for all the years prior to 1973 and is equal to $a_1 = 2,832$ for the year 1973 and afterwards. Inversely, the effect of change in unemployment on the change in GDP remains constant ($b_1 = -1,840$) during the period.

Because equation (18) does not lead us to the conclusions relevant to the differentiation of Okun's relation, we estimate function (16) using the stepwise regression method so as to introduce only the significant variables, producing the function shown below:

$$\Delta LN\hat{G}DP_t = \underset{\substack{[8,552] \\ (0,000)}}{6,308} - \underset{\substack{[-2,174] \\ (0,000)}}{1,672}\Delta UN_t - \underset{\substack{[-3,810] \\ (0,035)}}{3,771}D80_t \quad t \qquad (19)$$

$$R^2 = 0,383 \qquad DW = 2,134$$

From equation (19), it follows that the coefficient of discrimination $c_2 = -3771$ is negative and significant. This means that we have a downward parallel shift for the years after 1980. Inversely, the coefficient of discrimination of the slope $d_2 = 2,062$ is not significant, which means that we do not have a function turnaround. That is, we do not have a variation of the function's slope for the years after 1980. In other words, this means that the constant term that expresses the mean annual increase of GDP that is due to all of the factors other than unemployment is equal to $a_1 = 6,308$ for the years prior to 1980 and is equal to $a_2 + c_2 = 6,308 - 3,771 = 2,537$ for the year 1980 and afterwards. Inversely, the effect of variation of unemployment in the change of GDP remains constant ($b_2 = -1,627$) during the period.

We then considered together the explanatory variables ΔUN_t, $D73_t$, ($D73_t$ * ΔUN_t), $D80_t$ and ($D80_t$ * ΔUN_t) that are presented in equations (15) and (16) and applied stepwise regression, yielding the function shown below:

$$\begin{array}{llll} \Delta LN\hat{G}DP_t = & 2,826 + 5,396D73_t & -1,752(D80_t * \Delta UN_t) & \\ \quad t & [5,515] \quad [5,480] & [-2,285] & (20) \\ & (0,000) \quad (0,000) & (0,027) & \\ R^2 = 0,474 & & DW = 2,427 & \end{array}$$

which is explained as follows: the mean annual increase of GDP prior to 1973 is equal to $a + c_1 = 2,826 + 5,396 = 8,222$. For the years from 1973 to 1980, it is equal to $a = 2,826$, and from 1980 afterwards, the mean annual increase of GDP is estimated by Okun's relation, which is given by the equation:

$$\Delta LN\hat{G}DP_t = 2,537 - 1,752\ \Delta UN_t \qquad (21)$$

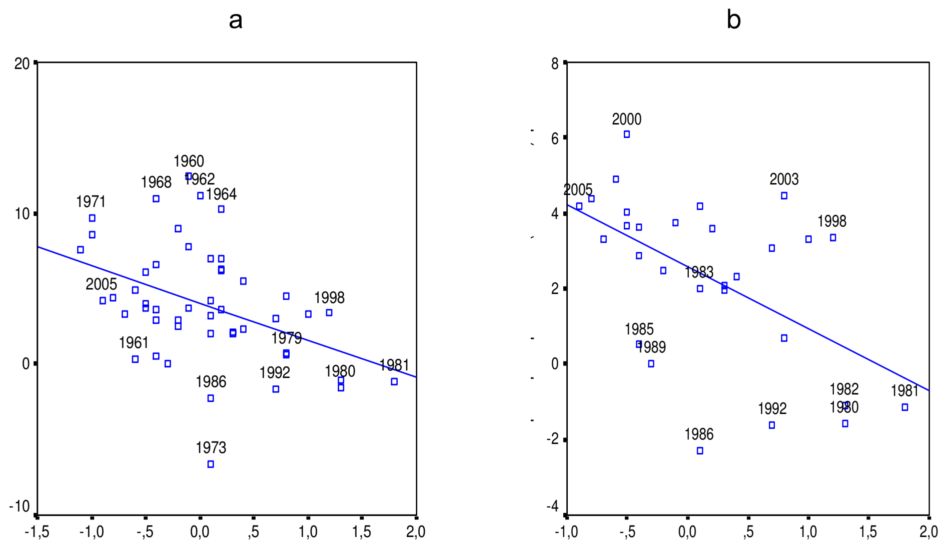
which is similar to equation (19), and which for the years from 1980 onwards takes the form:

$$\Delta LN\hat{G}DP_t = 2,826 - 1,627\ \Delta UN_t \qquad (22)$$

The relations (21) and (22) appear to be more representative of the Greek Economy, if we take into account that the mean change of Greece's GDP has been a 4 % increase for the last decade and the average change in unemployment in the opposite direction to –0.7 %.

Figure 3

The relation of Okun's Law for the period 1960-2007 (a) and for the period 1980-2007 (b)



What follows is a comparative analysis of the relation of Okun's Law for the three Mediterranean countries Greece, France and Spain for the same period, 1960–2007. The long-term equilibrium relation (the relation outlined by Okun's Law) for Greece is given in the column of table 4 «without time lag» (between the variables $\Delta LNGDP_t$ and ΔUN_t). According to the results of the paper of RIGAS, N. et. al. (2008), the long-term equilibrium relation (the relation outlined by Okun's Law) for France and Spain is given in the column of table 4 «with time lag» (between the variables $\Delta LNGDP_t$ and ΔUN_t). For Greece, the relation results from the regression of $\Delta LNGDP_t$ on the variable ΔUN_t, and for France and Spain, the relation results from the regression of $\Delta \mathrm{LNGDP}_t$ on the variables $\Delta \mathrm{UN}_t$ and $\Delta LNGDP_{t-1}$. The use of the time lag for the calculation of Okun's coefficient for developed countries is supported both by Weber (1995) and by Leopold Soegner and Alfred Stiassny (2000) in their essay titled «A cross-country study on Okun' s law».

From table 4, we observe that the contribution of the change of unemployment to the change of GDP in the Greek Economy (which is expressed by the estimated Okun's coefficient (b = –2,536 or b = –1,752 from 1980 and afterwards)) and the form of the relationship are different from that of France and Spain. In these countries the change of GDP is depended and on $\Delta LNGDP_{t-1}$. This means that the development models aimed at tackling unemployment yield about the same for the two countries (France, Spain) and different for Greece. Additionally, this may also mean that the two countries, France and Spain, have approximately the same structural problems in the labour market.

Some basic questions that are often posed and should be answered concern the degree to which the variable $LNGDP_t$ causes the variable UN_t and whether the two are interrelated or totally independent from each other.

In scientific fields, where the realisation of a controlled experiment is possible, it is possible to determine causality. In economics, the determination of causality is almost impossible due to the lack of experimental data. For this reason, many times in economics we consider concrete causality a priori in order to apply the classic econometric methods to evaluate a model.

If we have two variables X and Y, and according to economic theory, the variable X determines the behaviour of Y, the question is whether this relation exists. The method that we follow in order to answer this question is the regression of Y on X using available data and the examination of the statistical significance of coefficient of X.

The existence of high correlation between two variables does not constitute proof that there is a causal relation between the variables under study. The problem of false correlations often comes up in dynamic models.

Table 4

The results of evaluation of the long-term relation equilibrium (and the determination of Okun's coefficient) for the countries of Greece, France and Spain without time lag and with one time lag ($\Delta LNGDP_{t-1}$)

Without time lag					With one time lag ($\Delta LNGDP_{t-1}$)				
Country	a^{*}	b^{**}	R^2	DW	a^{*}	b^{**}	b_1^{***}	R^2	DW
Greece	4,118	-2,536	0,179	1,714	3,201	-1,977	0,178	0,217	1,940
#	[7,811]	[-3,135]			[4,097]	[-2,289]	[1,236]		
	(0,000)	(0,003)			(0,000)	(0,027)	(0,223)		
France	3,220	-1,291	0,170	1,714	1,301	-0,768	0,589	0,496	2,076
	[12,952]	[-3,036]			**#**[3,229]	[-2,221]	[5,327]		
	(0,000)	(0,004)			(0,002)	(0,032)	(0,000)		
Spain	4,073	-0,962	0,246	0,491	1,526	-0,569	0,592	0,667	2,088
	[12,346]	[-3,827]			**#** [3,834]	[-3,470]	[7,019]		
	(0,000)	(0,000)			(0,000)	(0,001)	(0,000)		

* *a* : the constant term,
** *b* : the Okun's coefficient,
*** b_1 : the coefficient of the first time lag ($\Delta LNGDP_{t-1}$),
# It notes the best equation form based:
a) on the significance of Regression Coefficients.
b) on the validity of at least two of the criteria of Akaike, Schwarz, Log – Likelihood and R^2 criteria.
c) on non existence of first class auto-correlation ($dU < DW < 1 - du$).

The difficulties of the determination of causality between the economic variables led Granger (1969) to the development of the known economic notion «Granger Causality». Generally speaking, according to Granger, we say that a variable *X* causes a variable *Y* if all the recent and preceding information about the values of this variable enable a better forecast of the values of *Y*.

We saw previously that the $LNGDP_t$ and UN_t variables are first order-integrated *I* (1). Thus, in order to apply the Granger Causality test, we must find the order of corresponding VAR models. The test of the range VAR model takes place with the known criteria of likelihood ratio (*LR*) and the criteria of Akaike, Schwartz and *HQ*. Because some criteria propose the order of the VAR model for the three countries at $k = 1$ and others at $k = 2$, we applied the Granger Causality test for the order of the VAR model equal to $k = 1$ and $k = 2$ for each country.

Taking into account the order of VAR and supposing that the time series show a trend but that the equations of cointegration have only constant values, we calculated the number of cointegrated vectors. The cointegration test with the steps of Johansen's approach pointed out, as did the Engle-Granger test, that the two variables, $LNGDP_t$ and UN_t, are cointegrated and that there is exactly one cointegration vector for all three countries.

In table 5, we present the causality test for the variables *LNGDP* and *UN* for the three countries of the euro area for k = 1 and k = 2 (order of the VAR model). The corresponding VAR models with k = 1 and k = 2 are as follows:

$k = 1$

$$LNGDP_t = a_{10} + a_{11}\ UN_{t-1} + b_{11}\ LNGDP_{t-1} + u_{1t} \quad (23)$$

$$UN_t = a_{20} + a_{21}\ UN_{t-1} + b_{21}\ LNGDP_{t-1} + u_{2t} \quad (24)$$

$k = 2$

$$LNGDP_t = a_{10} + a_{11}\ UN_{t-1} + a_{12}\ UN_{t-2} + b_{11}\ LNGDP_{t-1} + b_{12}\ LNGDP_{t-2} + u_{1t} \quad (25)$$

$$UN_t = a_{20} + a_{21}\ UN_{t-1} + a_{22}\ UN_{t-2} + b_{21}\ LNGDP_{t-1} + b_{22}\ LNGDP_{t-2} + u_{2t} \quad (26)$$

Table 5

The causality test for LNGDP and UN for Greece, France and Spain by Granger

Null Hypothesis H_0	F-statistic	Probability
Greece k = 1		
The UN does not cause LNGDP	1,6855	0,2010
The LNGDP does not cause UN	2.894	0,0959
k = 2		
The UN does not cause LNGDP	2.6820	0,0804
The LNGDP does not cause UN	5.7470	0,0063
France k = 1		
The UN does not cause LNGDP	0,3007	0,5862
The LNGDP does not cause UN	0,6981	0,4080
k = 2		
The UN does not cause LNGDP	0,8174	0,4487
The LNGDP does not cause UN	6,4459	0,0037
Spain k = 1		
The UN doesn't cause LNGDP	0,2526	0,6178
The LNGDP does not cause UN	1,1290	0,2938
k = 2		
The UN does not cause LNGDP	3,7239	0,0327
The LNGDP does not cause UN	0,7247	0,4906

From the results of table 5 we observe that:

For $k = 1$:

a. For the first case, the Null Hypothesis H_0 is in effect; that is, UN does not cause *LNGDP* at a statistical significance level of 5 % for the three countries. That means that by Granger, the variable *UN* does not influence the variable *LNGDP* for the three countries (according to equation 23).

b. For the second case, the Null Hypothesis H_0 is in effect too; that is, *LNGDP* does not cause UN at a statistical significance level of 5 % for the three countries. That means that by Granger the variable *LNGDP* does not cause the variable *UN* for the three countries (according to equation 24).

For $k = 2$:

a. For the first case, the Null Hypothesis H_0 is in effect, and UN does not cause *LNGDP*, at a statistical significance level of 5 %, for Greece and France. The Null Hypothesis is not in effect for Spain at a statistical significance level of 5 %. This means that the variable *UN* affects the variable *LNGDP* by Granger for Spain (according to equation 25); that is, we have $UN \rightarrow LNGDP$.

b. For the second case, the Null Hypothesis H_0 is not in effect. LNGDP does not influence *UN*, at a statistical significance level of 5 %, for Greece and France, but it is in effect for Spain. That means that the variable *LNGDP* does cause the variable UN by Granger for Greece and France (according to equation 26); that is, we have $LNGDP \rightarrow UN$, but not for Spain.

From the results of cases a and b with $k = 1$ and $k = 2$, we can say that there is no two-way causal relationship between the logarithm of GDP (LNGDP) and the unemployment rate for the three countries.

4. Conclusions

Many researchers support that labour markets and industrial structures in developed countries have developed on new basis, causing the relation between the product of economy and unemployment, known as Okun's law, to require revision. In this essay, we re-estimate the relation for Greece and, for mainly comparative reasons, for two countries in the EU, France and Spain, based on post-war data for the time period 1960–2007.

Various conclusions result from this empirical study. Firstly, the data, generally speaking, support the validity of Okun's law in terms of statistical significance from the estimation of parameters. However, the results are not as durable as those that were initially reported by Okun (1970).

From our estimates, we were led to the conclusion that the reactions of GDP to changes in unemployment and, more generally, to Okun's coefficient differ substantially among the three countries. The differences are reported as being in the number of explanatory variables that are significant for the estimation of Okun's coefficient (ΔUN_t for Greece, ΔUN_t and $\Delta LNGDT_{T\text{-}1}$ for France and Spain) as well as in the regression coefficients themselves (constant term (a) and coefficient of Okun (b)). For Greece, we searched for the existence of structural breaks in Okun's coefficient in 1973 and 1980 using dummy variables, and we were led to the conclusion that for the time period of 1960–2007, Okun's coefficient is equal to –2,536, while from 1980 onwards it is equal to –1,756. The value b = –1,756, combined with the constant *a* = 2,826, appears to be more representative of the Greek Economy for the last three decades.

The differences of Okun's coefficients among the three countries and particularly between Greece and the other two countries are undoubtedly related to a number of different factors. Nevertheless, many researchers have realised that the simple analysis of the increase of GDP shows that one of its main determining factors is the increase of productivity; we consider that it is essential to pay attention to this in order to try to explain the abovementioned differences in Okun's coefficients. The logic behind the value of the Okun's coefficient is that for a given increase in the unemployment rate, the higher the growth of productivity is, the lower the decrease of GDP is. Stating this in a different way, holding all of the other factors constant, we will expect a positive relation between the growth of productivity and Okun's coefficient in normal values or a negative relation in absolute values. From the above results, countries experiencing a relatively low (high) increase of productivity tend to have a high (low) Okun's coefficient in absolute values.

The study shows a smaller loss in economic output to be connected with a given increase of unemployment in recent decades for Greece. This conclusion of different values for different periods of time, which has also been found by other researchers, shows that any empirical rule, should be applied with caution.

The causality tests pointed out:

According to Granger, for k = 1, the variable *UN* does not influence the variable *LNGDP*, and the variable *LNGDP* does not influence the variable *UN* in any of the three countries

According to Granger, for k = 2, the variable *UN* influences the variable *LNGDP* in Spain, but for France and Greece the variable *LNGDP* influences the *UN* variable

A two-way causal relation between the logarithm of *GNP* (*LNGDP*) and the rate unemployment rate (*UN*) does not exist for any of the three countries.

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