The Effects of Unemployment on Economic Growth in Greece. An ARDL Bound Test Approach.

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The aim of this paper is to investigate the relationship between unemployment rate, economic growth and inflation rate in Greece, using annual data covering the period 1995-2015. The unit root tests results indicated that the variables have different integration order. Subsequently, the bounds testing (ARDL) approach and ECM-ARDL model are applied in order to examine the long-run and the causal relationship between the variables. The empirical results of the study revealed, both in the short and long-run, that there is a unidirectional causal relationship between unemployment and economic growth with direction from unemployment to economic growth, as well as a unidirectional causality running from inflation to economic growth.

Keywords: Unemployment, Economic Growth, Inflation, ARDL, Vector Error Correction Model
JEL Classifications: C22, E31, E50

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1. Introduction

The global financial and economic crisis of 2007-2008, which started from the United States of America (USA) and extended internationally, has influenced and continues to influence negatively most of the European countries. Even today, there are still countries in Europe that are facing serious structural problems. Low productivity, lack of competitiveness and high unemployment rates have dismantled the production structure of these countries.

The negative effects of the crisis seem to have greater depth and prolonged duration in Greece than in other European countries. The production base of Greek economy is based in sectors such as tourism, shipping and construction. These sectors are the first sectors that were influenced by the crisis.

In 2008, before the outbreak of the crisis, the unemployment rate in Greece was 7.8% while today (2016) is 23.5% (AMECO, 2016). During these years, Greek unemployment rates were the highest in the European Unioin (EU). In addition, Spain was the only other EU country which reached with more than a fifth of its population unemployed. In 2013, the unemployment rates in Greece and Spain were 27.5% and 26.1% respectively *(AMECO, 2016).*

The relationship between unemployment and output is negative in nature. Unemployment generates welfare loss in terms of lower output and afterwards leads to lower income and well being of the citizens (Raheem, 1993). Okun (1962) supported that there is an inverse relationship between output and unemployment, which has since come to be known as Okun's law. Output is influenced by the amount of labor that is used in the production process.

Unemployment and inflation are considered as two of the main factors that cause underdevelopment in any country. The purpose of this paper is to examine the relationship between unemployment, inflation and economic growth in Greece using annual data over the period 1995-2015. During the last years, high unemployment rates and

deflation seem to maintain the recession in the absence of a sustainable and productive extrovert model.
The structure of the paper is as follows: Section 2 briefly reviews the literature. Section 3 presents data and methodology. Empirical results are discussed in section 4. Concluding remarks are given in the final section.

2. Brief Literature Review

The credit crunch and global recession of 2008 has had a heavy impact on the economies of the most EU countries. Many EU economies has suffered a large and particularly sustained negative shock to GDP, having as a result high unemployment rates. Greece and Spain are the countries that have been hit particularly hard. In recent years, there is an increasing number of empirical studies concerning the impact of unemployment on economic growth, both in developed and developing countries.
Villaverde and Maza (2008) examined the relationship between unemployment and output for Spain over the period 1980-2004. Their results showed that there is an inverse relationship between unemployment and output. They concluded that Okun's law still holds for most of the Spanish regions and for the whole country.
Tiryaki and Ozkan (2011) investigated the relationship between economic growth and unemployment in Turkey using quarterly data covering the period 1998:1-2010:4. This study found that there is a unidirectional causality running from GDP gap to unemployment. In addition they found that after recession periods, while economic activity seems to be strong, the same recovery is not seen in the reduction of unemployment.
Yelwa et al. (2015) examined the relationship between inflation, unemployment and economic growth in Nigeria over the period 1987-2012. Findings derived that both unemployment and inflation have a negative impact on economic growth. They concluded that Nigerian

government should improve macroeconomic policy instruments in order to achieve a stable economic environment that will increase its domestic output.

A similar study (Mohsenia and Jouzaryan, 2016) investigated the relationship between inflation, unemployment and economic growth in Iran for the period 1996-2012. The results of the study revealed, both in short and long-run, a negative effect of inflation and unemployment on economic growth. They concluded that policy makers could attempt to control inflation and reduce unemployment in order to achieve sustainable economic growth.

It is worth to say that there are also studies that failed to show such relationships. The results seem to depend on the infrastructure and the level of the domestic economy of each country.

3. Data and Methodology

Data

The variables that are used in this study are gross domestic product (GDP) measured in constant 2010 EUR, unemployment (UN) expressed as a percentage of civilian labor force and inflation rate (INF). The data are annual covering the period 1995-2015. All data, collected from the Annual Macroeconomic Database (AMECO, 2016) and the International Monetary Fund (IMF, 2016).

Econometric Methodology

The purpose of this paper is to investigate the relationship between economic growth, unemployment and inflation in Greece over the period 1995-2015. The methodological approach of the study includes the following steps:

- The first step is to check the stationarity properties of the series in order to define their integration order. For this reason, we apply the Augmented Dickey Fuller test (ADF) (1979; 1981), the Phillips Perron test (PP) (1988) as well as the Elliott, Rothenberg and Stock test (DF-GLS) (1996).

- The next step is to examine the long-run relationship between the variables using the analysis of Auto-Regressive Distributed Lag (ARDL), developed by Pesaran et al. (2001).
- The third is to estimate the short-run and long-run relationship between the variables.
- Finally, the vector error correction model (VECM) is used in order to find the causality relations.

The ARDL cointegration technique as a general vector autoregressive (VAR) model of order p is expressed in equation (1):

$$K_t = (GDP_t, UN_t, INF_t) \qquad (1)$$

where K_t is a column vector composed of the three variables.

4. Empirical Results

Unit Root Analysis

The literature proposes several approaches for testing unit root. Considering that these methods may give different results we have applied test of ADF by Dickey and Fuller (1979), PP by Philips and Perron (1988) and DF-GLS by Elliott et al. (1996). The results of level and first difference unit root tests are provided in table 1.

Table 1

Unit Root Results

Var.	ADF		P-P		DF-GLS	
	C	C-T	C	C-T	C	C-T
GDP	-1.74(1)	-2.19(1)	0.36[5]	-1.09[4]	50.3(1)	6.00(1)
DGDP	-3.19(0)**	-3.39(0)*	-3.27[3]**	-3.48[3]*	-1.79(0)***	5.43(0)**
UN	-2.73(1)*	-3.53(1)*	-2.80[3]*	-1.27[2]	0.00(1)***	0.33(1)***
DUN	-2.74(1)*	-2.94(1)	-3.15[3]	-2.90[4]	1.18(1)**	2.13(1)**

			**		*	*
INF	-1.93(0)	- 2.63(0)	- 1.88[1]	- 2.61[1]	2.27(0)	14.6(0)
DINF	-5.25(0) ***	- 5.12(0)	- 5.25[1] ***	- 5.12[1] ***	2.61(0)**	9.27(0)

***, **, * show significant at 1%, 5% and 10% levels respectively. The numbers within parentheses followed by ADF statistics represent the lag length of the dependent variable used to obtain white noise residuals. The lag lengths for ADF equation were selected using SIC. Mackinnon (1996) critical value for rejection of hypothesis of unit root applied. The numbers within brackets followed by PP statistics represent the bandwidth selected based on Newey-West (1994) method using Bartlett Kernel. C=Constant, T=Trend.

As can be seen from Table 2, the results showed that the variables have different integration order. So, we continue applying the ARDL bounds test.

Cointegration Analysis

Since unit root tests have been applied, the next step is to use the ARDL approach, developed by Pesaran et al. (2001) in order to investigate the long-run relationship between the examined variables.

The bounds testing ARDL provide valid results regardless of whether the variables are integrated *I*(0) or *I*(1). In addition, compared with the other cointegration approaches, reduces the potential problems of autocorrelation and endogeneity in the model. Moreover, the ARDL approach provides effective and consistent results when the sample is small. Finally, a dynamic error correction model can be derived from the ARDL method through a simple linear transformation.

The ARDL models that are used in this study are shown below:

$$\Delta UN_t = \beta_{01} + k_{11}GDP_{t-1} + k_{21}INF_{t-1} + k_{31}UN_{t-1} +$$
$$+\sum_{i=1}^{p} \alpha_{1i}\Delta UN_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta GDP_{t-i} + \sum_{i=0}^{c} \alpha_{3i}\Delta INF_{t-i} + \varepsilon_{1t} \quad (1)$$

$$\Delta INF_t = \beta_{02} + k_{12}GDP_{t-1} + k_{22}INF_{t-1} + k_{32}UN_{t-1} +$$
$$+\sum_{i=1}^{p} \alpha_{1i}\Delta INF_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta GDP_{t-i} + \sum_{i=0}^{c} \alpha_{3i}\Delta UN_{t-i} + \varepsilon_{2t} \quad (2)$$

$$\Delta GDP_t = \beta_{03} + k_{13}GDP_{t-1} + k_{23}INF_{t-1} + k_{33}UN_{t-1} +$$
$$+\sum_{i=1}^{p} \alpha_{1i}\Delta GDP_{t-i} + \sum_{i=0}^{q} \alpha_{2i}\Delta INF_{t-i} + \sum_{i=0}^{c} \alpha_{3i}\Delta UN_{t-i} + \varepsilon_{3t} \quad (3)$$

where Δ denotes the first difference operator and ε_{1t}, ε_{2t}, ε_{3t} are error terms assumed to be independently and identically distributed. In order to estimtate the parameters of equations (2), (3) and (4) we have to find the order of the VAR model. The optimal lag length is selected by the minimum value of Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Criterion (HQC), and Likelihood Ratio (LR).
The results of these criteria are presented in table 2.

Table 2

Var Lag Order Selection Criteria (Max=3)

Lag	LogL	LR	FPE	AIC	SIC	HQC
0	-163.1	NA	21006.1	18.4	18.6	18.4
1	-108.1	85.6	128.5	13.3	13.9	13.4
2	-92.2	19.3*	66.7*	12.5	13.6*	12.7
3	-80.9	10.0	69.2	12.3*	13.8	12.5*

*denotes the optimal lag selection.

Most of the results showed that the optimal lag length of the variables is 2.

Since the calculation of ARDL bounds is sensitive in the selection of the lag length, we select the optimal lag length from the first difference of the dependent variables by the minimum values of criteria Akaike, Schwarz and Hannan-Quinn in accordance with the following models.

$$\Delta UN_t = \beta_{01} + \sum_{i=1}^{p} \alpha_{1i} UN_{t-i} + \sum_{i=0}^{q} \alpha_{2i} GDP_{t-i} + \sum_{i=0}^{c} \alpha_{3i} INF_{t-i} + \mu_{1t} \quad (4)$$

$$\Delta INF_t = \beta_{02} + \sum_{i=1}^{p} \alpha_{1i} INF_{t-i} + \sum_{i=0}^{q} \alpha_{2i} GDP_{t-i} + \sum_{i=0}^{c} \alpha_{3i} UN_{t-i} + \mu_{2t} \quad (5)$$

$$\Delta GDP_t = \beta_{03} + \sum_{i=1}^{p} \alpha_{1i} GDP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} INF_{t-i} + \sum_{i=0}^{c} \alpha_{3i} UN_{t-i} + \mu_{3t} \quad (6)$$

where ΔUN_t, ΔINF_t, and ΔGDP_t are the dependent variables, α_{1i}, α_{2i}, α_{3i} are the long terms and (p, q, c) are the optimal lag of the ARDL model.

Pesaran et al. (2001) suggests F-test for joint significance of the coefficients of the lagged level of variables. The null hypothesis of no cointegration among the variables in equations (2), (3) and (4) is:

$H_0: k_{11} = k_{21} = k_{31} = 0$ against $H_1: k_{11} \neq k_{21} \neq k_{31} \neq 0$
and

$H_0: k_{12} = k_{22} = k_{32} = 0$ against $H_1: k_{12} \neq k_{22} \neq k_{32} \neq 0$

and
$H_0: k_{13} = k_{23} = k_{33} = 0$ against $H_1: k_{13} \neq k_{23} \neq k_{33} \neq 0$

The null hypothesis of no cointegration is rejected when the F–statistic is greater than the upper critical value. However, we accept the null hypothesis if the computed F-statistic is less than the lower critical value. Finally, the decision of cointegration is unclear when the F-value is between the lower and the upper limit. Table 3 shows the cointegration results using ARDL bounds test.

Table 3

The Results of ARDL Cointegration Test

Bounds testing to cointegration			**Diagnostic tests**			
Estimated models	**Optimal lag**	**F-stat.**	X^2_{NOR}	X^2_{ARCH}	X^2_{RESET}	X^2_{SERIAL}
F_{UN}(UN/GDP,INF)	(1,1,0)	0.85	6.75	0.02 [1]	4.92 [1]	0.17 [2]
F_{INF}(INF/GDP,UN)	(1,0,0)	0.52	2.44	0.13 [1]	9.66 [1]	0.03 [2]
F_{GDP}(GDP/INF,UN)	(1,0,0)	13.7 ***	0.37	0.61 [1]	0.27 [1]	0.43 [2]
Significant level			Critical values (T=30)			
			Lower bounds		Upper bounds	
			I(0)		I(1)	

1%	7.977	9.413
5%	5.550	6.747
10%	4.577	5.600

The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. Critical values are collected from Narayan (2005). *** show significant at 1% level.

The results of table 3 support the presence of one cointegration vector among the examined variables. The null hypothesis of no cointegration is rejected at 1%. Findings confirm a long-run relationship between the variables in equation (4). In other words, the results show that GDP, UN and INF are moving together in the long run.

Estimation of long and short-run relationship

Once cointegration has been established, we proceed with the estimation of the long-run relationship. The equations that are used for the examination of the long-run relationship among the variables of the model are the following:

$$UN_t = \beta_{01} + \sum_{i=1}^{p} k_{11} UN_{t-i} + \sum_{i=0}^{q} k_{21} INF_{t-i} + \sum_{i=0}^{c} k_{31} GDP_{t-i} + e_{1t} \qquad (7)$$

$$INF_t = \beta_{02} + \sum_{i=1}^{p} k_{12} INF_{t-i} + \sum_{i=0}^{q} k_{22} GDP_{t-i} + \sum_{i=0}^{c} k_{32} UN_{t-i} + e_{2t} \qquad (8)$$

$$GDP_t = \beta_{03} + \sum_{i=1}^{p} k_{13} GDP_{t-i} + \sum_{i=0}^{q} k_{23} INF_{t-i} + \sum_{i=0}^{c} k_{33} UN_{t-i} + e_{3t} \qquad (9)$$

In addition, a dynamic error correction model can be derived from the ARDL bounds test through a simple linear transformation. The dynamic unrestricted ECM incorporates the short-run dynamic with the long-run equilibrium.

The equations of the dynamic unrestricted error correction model are shown below:

$$\Delta UN_t = \beta_{01} + \sum_{i=1}^{p} \alpha_{1i} \Delta UN_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta GDP_{t-i} + \sum_{i=0}^{c} \alpha_{3i} INF_{t-i} + \lambda_1 ECM_{t-1} + \varepsilon_{1t} \quad (10)$$

$$\Delta INF_t = \beta_{02} + \sum_{i=1}^{p} \alpha_{1i} \Delta INF_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta GDP_{t-i} + \sum_{i=0}^{c} \alpha_{3i} \Delta UN_{t-i} + \lambda_2 ECM_{t-1} + \varepsilon_{2t} \quad (11)$$

$$\Delta GDP_t = \beta_{03} + \sum_{i=1}^{p} \alpha_{1i} \Delta GDP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta INF_{t-i} + \sum_{i=0}^{c} \alpha_{3i} \Delta UN_{t-i} + \lambda_3 ECM_{t-1} + \varepsilon_{3t} \quad (12)$$

where ECM_{t-1} stands for the lagged error correction term from the long-run cointegration equation. The coefficient of the ECM_{t-1} should be negative and statistically significant. This coefficient indicates the speed of adjustment.
The results of long-run and short-run relationship between the variables are presented in the next table.

Table 4

Long and short-run results

Dependent variable=GDP_t		
Long run analysis		
Variables	**Coefficient**	**T-statistic**
Constant	82.53	4.77***
GDP_{t-1}	0.77	13.65***
INF_t	-1.20	-2.82**
UN_t	-1.83	-4.60***
R^2	0.95	
F-Statistic	116.9	
D-W	1.22	

Dependent variable= ΔGDP_t		
Short run analysis		
Constant	1.65	1.08
ΔGDP_{t-1}	0.57	2.75**
ΔINF_t	-1.61	2.19**
ΔUN_t	-2.65	-2.74**
ECM_{t-1}	-0.52	-2.15**
R^2	0.78	
F-Statistic	12.53	
D-W	1.61	

***, ** show significant at 1% and 5% levels respectively. Δ denotes the first difference operator.

Table 4 indicates that in the long-term equation of GDP a decrease 1% of INF will cause an increase 1.20% of GDP. In addition the results show that a decrease 1% of UN will cause an increase 1.83% of GDP. The ECM_{t-1} is negative and statistically significant. This means that in the short-term the deviations from the long-run equilibrium are adjusted by 52% every year.

Instability Tests

The existence of cointegration between the examined variables does not imply that the estimated coefficients are stable. The ECM of equation (13) is selected to implement Brown et al. (1975) stability tests. The graphical representations of these tests are shown in the next figures.

Figure 1

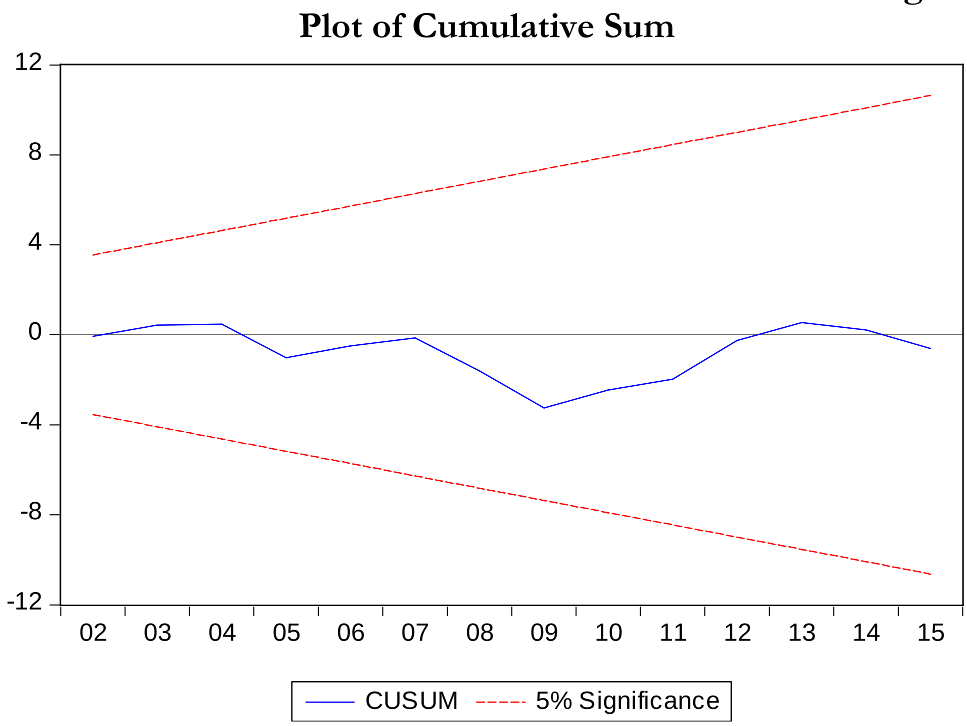
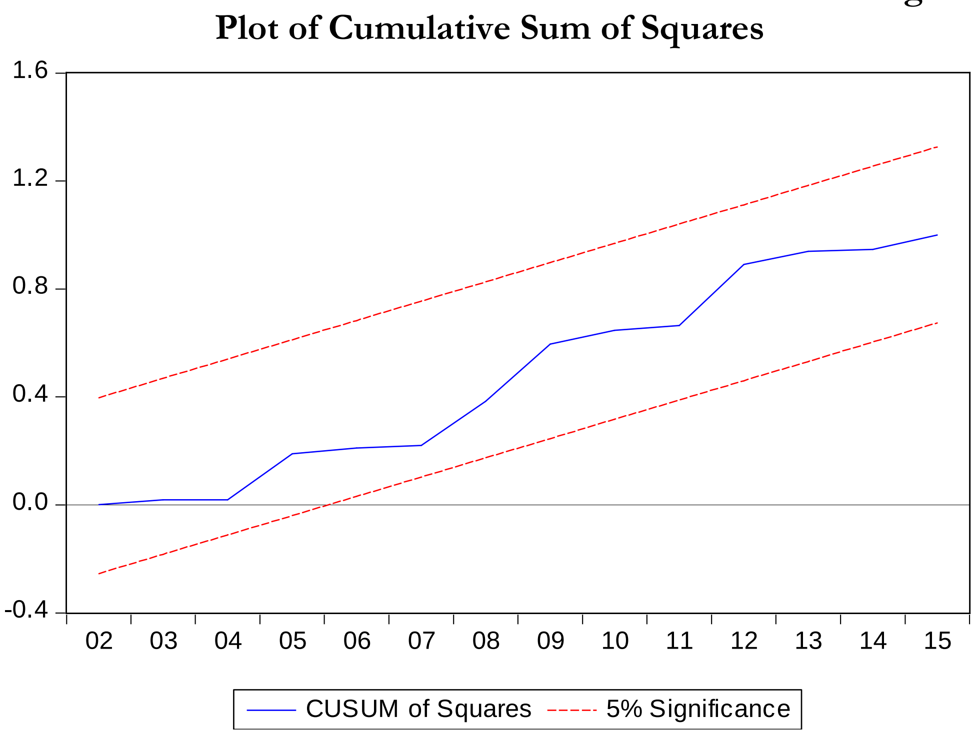

Plot of Cumulative Sum
12
8
4
0
-4
-8
-12
02
03
04
05
06
07
08
09
10
11
12
13
14
15
CUSUM
5% Significance

Figure 2



The graphs of statistical CUSUM and CUSUMQ are within the critical values at 5% significance level, which means that all the coefficients in ECM are stable.

The VECM Granger Causality

After the long-run relationship, we continue applying the VECM in order to determine the direction of causality between the examined variables. The equations that are used to test Granger causality are the following:

$$\begin{bmatrix} \Delta UN_t \\ \Delta INF_t \\ \Delta GDP_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{21} & \beta_{22} & \beta_{23} \\ \beta_{31} & \beta_{32} & \beta_{33} \end{bmatrix} \begin{bmatrix} \Delta UN_{t-p} \\ \Delta INF_{t-p} \\ \Delta GDP_{t-p} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{bmatrix} ECM_{t-1} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix} \quad (14)$$

where i (i=1,…p) is the optimal lag length determined by the Schwarz Information Criterion, ECM_{t-1} is the lagged residual obtained from the long-run ARDL relationship presented in equations (8), (9) and (10). λ_1, λ_2, λ_3 are the adjustment coefficients, and u_{1t}, u_{2t}, u_{3t} are the disturbance terms assumed to be uncorrelated with zero means.

Table 5

Granger causality analysis

Dependent variable	**Short run (F-stat)**			**Long run (t-stat)**
	ΔGDP_t	**ΔINF_t**	**ΔUN_t**	**ECM_{t-1}**
ΔGDP_t		-2.29**	5.47**	-1.84*
ΔINF_t	0.11		0.92	-0.51
ΔUN_t	2.53	0.51		-0.61

**, * show significant at 5% and 10% levels respectively, Δ denotes first difference operator.

From the results of Table 5 we see that there is a short-run unidirectional causal relationship between unemployment and economic growth with direction from unemployment to economic growth, as well as a unidirectional causality running from inflation to economic growth.

In the long-run, we see that that the estimated coefficient of ECT in equation of ΔGDP is negative and statistically significant at 10% level.

This implies that there is convergence of dynamic equilibrium in the long run.

5. Conclusion and Policy Implications

Since 2010, Greece is facing serious structural and financial problems. Over this period, the Greek economy is characterized by high unemployment rates, deflation, decreased growth rates, decreased per capita income and many other socioeconomics challenges.

The present study investigates the relationship between unemployment, inflation and economic growth in Greece over the period 1995-2015. For the existence of the long-run relationship among the variables the ARDL approach was used. In addition, the VECM was used in order to find the direction of causality. Findings suggest that there is a strong evidence of cointegration between the three variables, which indicates that there is a long-run equilibrium relationship. The causality results show, both in the short and long-run, a unidirectional causality relation running from unemployment to economic growth, as well as from inflation to economic growth.

The economic variables of growth, inflation and unemployment are interdependent. Therefore, the success of macroeconomic policy cannot be measured by one of these variables in isolation. In the short term, growth rate has implications for other economic variables. A rapid increase of growth includes the inflation acceleration risk. On the other, slow growth rates involves the risk of rising unemployment. Despite the fact that the increase in unemployment is typically associated with economic recession, it is possible for an economy to grow slowly in order to prevent increased unemployment rates.

What is interesting in the long and short-run function of growth is the negative sign of inflation. It is often claimed that a small and continuous increase in the general price level is necessary in order to achieve sustainable growth rates with high employment levels. However, in an unstable economic environment where the price level is constantly changing many problems can arise. Uncertainty about future performance acts a deterrent to investments, having negative impact on productivity and the employment level of a country. This result is consistent partially with the result mentioned in the study of Jayathileke and Rathnayake (2013). They concluded that countries which are characterized by macroeconomic stability and high growth rates do not suffer from inflation impact on their economic growth. On the other inflation has a long-term negative impact on economic growth. Therefore, Greek government needs to develop proper economic policies to encourage self-employment and entrepreneurship to overcome high unemployment rates and achieve stable growth rates in order to return in a steady and sustainable economic environment.

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