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Inflation, Unemployment and the NAIRU in Greece

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Abstract

The current paper examines the Phillips Curve approach for Greece using annual data from 1980 until 2010. Phillips Curve approach helps in examining the relationship between inflation and unemployment. The results show that there is a long run and causal relationship between inflation and unemployment for the aforementioned period. Finally, the impulse responses applied for the 10-year forecasting, suggest that shocks in inflation rate cause a reduction on unemployment index for the first years, following by a slight rise for the remaining years under examination.

Keywords: Phillips Curve, NAIRU, Cointegration, Granger Causality, Impulse Response Function

1. Introduction

The relationship between inflation and unemployment had been widely discussed and examined during the last years. In 1958 William Phillips [1] first examined this relationship on his paper “The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957”. This empirical study was formed by a curve which is known as “Phillips Curve”. The Phillips curve is an inverse relationship between the rate of unemployment and the rate of inflation an economy. In other words, the lower the unemployment in an economy, the higher the rate of inflation.

During the 70’s many countries suffered from high levels of inflation and unemployment (stagflation), so Phillips curve came under a concerted attack from a group of economists arguing that the Phillips curve relationship was only a short-run phenomenon Friedman [2]. Friedman argued that in the long run there is no trade-off between inflation and unemployment. According to Keynesian theory, governments could tolerate a reasonably high rate of inflation as this would lead to lower unemployment and subsequently a trade-off.

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between inflation and unemployment.

The new theory known as "natural rate of unemployment" is distinguished between the "short-term" Phillips curve and the "long-term" one. The short – term Phillips Curve looks like a normal Phillips Curve but shifts in the long run as expectations changes. In the long run, only a single rate of unemployment ("natural" rate) is consistent with a steady rate of inflation. Thus, the long-run Phillips Curve is vertical, so there is no trade-off between inflation and unemployment Phelps [3].

On diagram 1, the long-run Phillips curve is the vertical line. According to NAIRU theory when unemployment is at the rate defined by this line, inflation will be stable Phelps [3]. However, in the short-run policymakers will face an inflation-unemployment rate trade-off marked by the "Initial Short-Run Phillips Curve" in the graph. Policymakers can therefore reduce the unemployment rate temporarily, moving from point A to point B through expansionary policy. However, according to the NAIRU, exploiting this short-run trade-off will raise inflation expectations, shifting the short-run curve rightward to the "New Short-Run Phillips Curve" and moving the point of equilibrium from B to C. Thus the reduction in unemployment below the "Natural Rate" will be temporary, and lead only to higher inflation in the long run (Wikipedia:Identifying reliable sources, From Wikipedia, the free encyclopedia).

Since the short-run curve shifts outward due to the attempt to reduce unemployment, the expansionary policy ultimately worsens the exploitable tradeoff between unemployment and inflation rate. That results in more inflation for every short-run unemployment rate. The name "NAIRU" arises because with actual unemployment below “NAIRU”, inflation accelerates, while with unemployment above it, inflation decelerates. With the actual rate equal to it, inflation is stable (From Wikipedia, the free encyclopedia).

In Greece, unemployment has been the central issue for many macroeconomic studies. Various factors are discussed in the literature in order to determine the rate of unemployment and inflation. These factors are high taxation, lack of investment, stability of monetary policy, continuous corruption etc.

The purpose of this paper is to examine the existence of Phillips curve in Greece using time series data for the period 1980 -2010. In order to achieve this aim, the following targets should be achieved:

- To estimate a long-run relationship between inflation and unemployment over the last 30 years.
- To estimate causal relationships between unemployment rate and inflation rate.
- To forecast supply shocks which drive both inflation and unemployment in the long-run.

This paper is organized in five sections. Section 2 presents a literature review. Section 3 analyzes the theoretical methodology. Section 4 provides data source and methodological framework. The empirical results are presented in Section 5 and finally the concluding remarks are contained in section 6.
2. Literature Review

Samuelson and Solow [4] were the first researchers who supported the Phillips hypothesis in their paper for USA supporting the negative relationship between unemployment and inflation. Later, Phelps [5] and Friedman (1968) criticized the Phillips hypothesis and mentioned that there is no trade-off relationship between unemployment and inflation. Meanwhile, Lucas [6] strongly opposed the proposition of the existence of the Phillips curve, supporting that there could be a trade-off relationship between unemployment and inflation, providing that policy makers haven’t create a situation where high-inflation is paired with low unemployment. In a different case, employees would predict inflation and an increase in wages would be possible. In such a case there would be high unemployment and high inflation rate known as the “Lucas critique”.

In the 1980’s although Phillips hypothesis was forgotten for a while by researchers, however it was regarded as an important tool for policymakers in many countries. In the 1990’s, Phillips curve came to the front giving mixed results. For example, Alogoskoufis and Smith [7] presented empirical data for USA and Great Britain supporting “Lucas critique”. In contrast, King and Watson [8] tested the existence of the Phillips curve using macroeconomic data for USA. Their findings provided empirical support to the existence of the trade-off relationship between unemployment and inflation over the examined period.

Islam et al. [9] examined Phillips hypothesis for USA data from 1950 until 1999 and found a weak long-run cointegrating relationship between unemployment and inflation. Reichel [10] applied cointegration methodology on Phillips hypothesis for the industrialized economies and found trade-off between inflation and unemployment only for USA and Japan. Furuoka [11] established the long – run and causal relationship between unemployment rate and inflation rate in Malaysia during the period of 1975-2004. Finally, Islam et al. [12] examined the Phillips hypothesis for North Cyprus. The estimates point to the existence of Phillips curve both in the long and the short run.

The research for Phillips curve for Greece is restricted. Alogoskoufis and Philippopoulos [13] examined a “rational partisan model” of inflation and unemployment for Greece which exhibit a high inflation rate in the last two decades for the examined period, attributing this situation in the failure of political parties to stabilize the prices, while unemployment seems independent from inflation rate. Ricardo Llaudes [14] examines the short and long run relationship between unemployment and inflation for OECD countries including Greece. The results of their paper show that unemployment duration matters in the determination of prices and wages, and that a smaller weight ought to be given to the long-term unemployed.

3. Theoretical Methodology

The natural rate of unemployment also called structural unemployment rate is a meaning of economic activity developed in the 1960’s from Nobelists Friedman [2] and Phelps [5]. In their papers, authors support that the natural rate of unemployment is the unemployment which appears when labor market is in equilibrium, meaning that the rate of inflation is stable. If unemployment will tend to decrease below the natural rate, then there is an increased risk of inflation. If unemployment will tend to rise above its natural rate then inflation tends to fall.

New theories, such as NAIRU arose to explain how stagflation could appear. The last theory known as “natural rate of unemployment” is distinguished between “short – term” and “long-term” Phillips curve. The short – term Phillips curve looks like a normal Phillips curve but it shifts in the long run when expectations change. In the long – run, only the NAIRU is consistent with a stable rate of inflation.

According to the above theory and also to Lucas approach, the short – run supply function of Phillips curve can be written as:

\[ Y = Y^* + \alpha(P - P^*) \]  \hspace{1cm} (1)

where \( Y \) is log value of the actual output, \( Y^* \) is log value of the natural level of output, \( \alpha \) is a positive
constant, $P$ is log value of the actual price level and $P^*$ is log value of the expected price level.

In the neoclassical theory, Lucas’ advocates claim that inflationary expectations should be taken into consideration helping the markets to be in equilibrium. Equation (1) can be formed as follows:

$$P = P^* + \frac{Y - Y^*}{\alpha}$$ \hspace{1cm} (2)

On the above equation (2), if we add an unexpected exogenous shock from world supply then equation (2) becomes:

$$P = P^* + \frac{Y - Y^*}{\alpha} + WS$$ \hspace{1cm} (3)

Subtracting last year's price levels $P(-1)$ will give us inflation rates,

$$P - P(-1) = INF \text{ (inflation rate)}$$ \hspace{1cm} (3a)

$$P^* - P^*(-1) = INF^* \text{ (expected inflation rate)}$$ \hspace{1cm} (3b)

According to Okun’s law, there is a negative relationship between output and unemployment (equation 4).

$$\frac{Y - Y^*}{\alpha} = -\beta(UN - UN^*)$$ \hspace{1cm} (4)

where $UN$ is unemployment rate, $UN^*$ is the natural rate of unemployment, $\beta$ is a positive constant. According to equation (4), (3a) and (3b), equation (3) is written as:

$$INF = INF^* - \beta(UN - UN^*) + WS$$ \hspace{1cm} (5)

we arrive at the final form of the short-run Phillips curve.

Equation (5) indicates the negative slope of Phillips curve between the rate of inflation (INF) and unemployment rate (UN).

Using the natural rate of unemployment (NAIRUN) equation (5) can be expressed as follows:

$$INF_t = \alpha(L)INF_{t-1} + \beta(L)(UN_t - NAIRUN_t) + \epsilon_t$$ \hspace{1cm} (6)

where $\alpha(L)$ and $\beta(L)$ are polynomials in the lag operation, $UN_t$ is actual unemployment rate in the year $t$, $NAIRUN_t$ is natural rate of unemployment in the year $t$.

Equation (6) can be modified as follows:

$$INF_t = \alpha(L)INF_{t-1} + \beta(L)UNGAP_t + \epsilon_t$$ \hspace{1cm} (7)

where $UNGAP_t$ is the unemployment gap (the actual unemployment rate minus natural rate of unemployment rate). To support the Phillips curve, we would require negative and significant coefficients for the unemployment gap.

This paper uses Hodrick – Prescott filter [15] (HP, with $\lambda = 100$) 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 natural rate of unemployment (NAIRUN). 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 [16].
4. Data Sources and Methodological Framework

The current paper investigates the impact of unemployment on inflation in the case of Greece within the Phillips Curve (1958) context, by using the tests/procedures below:

- time series unit root tests
- test of the cointegration long-run relationship among the variables
- short and long-run causality tests with the Vector Error Correction Model
- by describing the reaction of endogenous variable at the time of impulse / shock and over subsequent points in time.

All data used come from the International Monetary Fund over the period 1980 - 2010. Summary statistics are presented in table 1. Jarque-Bera [17] test results indicate that inflation and unemployment rates data sets follow a normal distribution. Figure 1 and Figure 2 plot the actual and forecast values of inflation and unemployment rates respectively.

| Variables     | Mean  | Std   | Max   | Min   | Skewness | Kurtosis | J-B     |
|---------------|-------|-------|-------|-------|----------|----------|---------|
| Inflation     | 11.22 | 8.231 | 26.53 | 1.35  | 0.406    | 1.672    | 3.129   |
| Unemployment  | 8.598 | 2.180 | 12.45 | 2.66  | -0.621   | 3.607    | 2.473   |

Notes: 1. J-B denotes the Jarque-Bera test for normality.

4.1 Unit root test

The Augmented Dickey–Fuller (ADF) [18] and Phillips-Perron [19] tests were used to determine the presence of unit roots in the data sets. The ADF test is based on the estimate of the following regression:

\[ \Delta X_t = \delta_0 + \delta_1 t + \delta_2 X_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta X_{t-i} + u_t \]  

(8)

where, \( \Delta \) is the first-difference operator, \( X_t \) is the series, \( \delta_0, \delta_1, \delta_2 \), and \( \alpha_i \) are being estimated and \( u_t \) is the error term. The null and the alternative hypothesis for the existence of unit root in variable \( X_t \) is: \( H_0: \delta_2 = 0 \) against
$H_0: \delta_2 < 0$. The PP unit root test is utilized in this case in preference to ADF unit root tests for the following reasons. The PP tests do not require an assumption of homoscedasticity of the error term Phillips, [20] and the test corrects the serial correlation and autoregressive heteroscedasticity of the error terms. Kwiatkowski et al. [21] 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.

4.2 Co-integration tests

The presence of long run equilibrium relationship between dependent and independent variables is referred to as cointegration. The test for cointegration is the procedure of Johansen [22].

4.3 Vector error correction models

The variables are associated with the VAR approach at the cointegration level, before we can form the VECM. So, we need to ensure that the variables are cointegrated. There are other considerations where more than one cointegrating vector exists, thus we can theoretically have more than one error correction term.

4.4 Impulse response function

The impulse response functions can be used to produce the time path of the dependent variables in the VAR, to make shocks from the explanatory variables. The impulse response function defines the effect that a random impulse shock has upon the endogenous variables of VAR model. Usually, these shocks are expressed using the standard deviations of the disturbance terms (one or two standard deviations). Thus, the impulse response function describes the implications on the endogenous variables in a VAR model for a number of future periods when disturbance terms are volatile. VAR models are considered suitable for the achievement of satisfying predictions due to their structure and also to the capability of the estimation of impulse response function and the variance decomposition.

5. Empirical Results

The preliminary step in the current paper is to define the degree of integration of each variable. In order to detect unit roots in the level and first differences of each variable we use a series of tests: ADF (of Dickey and Fuller, [18], PP (of Phillips and Perron, [19]), and KPSS (of Kwiatkowski, Phillips, Schmidt, and Shin, [21]). Table 2 reports the results of the ADF, PP, KPSS tests for the variables of inflation rate and unemployment gap in their levels and their first differences.

| Variables | ADF     | PP      | KPSS     |
|-----------|---------|---------|----------|
| INF       | Level   |         |          |
|           | -1.64(0)| -1.56[2]| 0.67[4]* |
|           | -2.65(0)| -2.58[3]| 0.16[3]* |
| UNGAP     | Level   |         |          |
|           | -2.00(0)| -2.58[7]| 0.07[4]**|
|           | -2.87(0)| -2.29[8]|          |
| ΔINF      | First Differences |        |          |
|           | -6.09(0)** | -8.76[2]*** | 0.74[2]  |
|           | -6.67(0)*** | -11.83[2]*** | 0.34[2]  |
| ΔUNGAP    | First Differences |        |          |
|           | -5.11(3)** | -5.54[7]*** | 0.24[8]  |
|           | -4.99(3)*** | -5.60[6]*** | 0.11[8]  |

Notes: 1. ***, **, * denotes rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively.
2. The numbers within parentheses for the ADF statistics represents the lag length of the dependent variable used to obtain white noise residuals.
3. The lag lengths for ADF equation were selected using Akaike Information Criterion (AIC).
4. The numbers within brackets for the PP and KPSS statistics represent the bandwidth selected based on Newey
The results in Table 2 reveal that both variables are non-stationary in their level data. They become stationary in their first differences, hence could be described as integrated of order one \( I(1) \).

Since it has been determined that the variables under examination are integrated of order one, we then test for cointegration using the Johansen [22] maximum likelihood procedure in order to examine the long-run relationship between the variables of our model. A VAR model is fitted to the data to find an appropriate lag structure. Akaike Information Criterion (AIC) [24] was used to determine the optimum lag length selection, while maximum lag length is set up to level three. Table 3 presents the results from the Johansen cointegration tests.

### Table 3. Johansen Cointegration Test Results

| Null Hypothesis | Statistics | 5% critical value |
|-----------------|------------|-------------------|
| INF, UNGAP (Order VAR = 1) | Trace test | Max-Eigen | Trace test | Max-Eigen |
| \( r = 0 \) | 15.72 | 14.75 | 15.41 | 14.07 |
| \( r \leq 1 \) | 1.97 | 1.97 | 3.76 | 3.76 |

Notes:
1. Critical values derive from Osterwald – Lenum [25]
2. \( r \) denotes the number of cointegrated vectors
3. Akaike and Schwarz criterion are used for the order of VAR model.

From the results of Table 3 we can see that the test statistics reject the null hypothesis of no cointegrating relationship at the 5% significance level, hence there is a cointegration vector (see the trace test and the maximal-eigenvalue statistics for cointegration test in Table 3). This indicates that there is a long run relationship between INF and UNGAP, over the sample period under investigation.

The next step is to report the Granger causality test results obtained by the vector autoregression (VAR). Since a cointegration vector exists, we run the Granger test with error correction terms from the cointegrating equations included in a regression with the variables in their first differences (\( \Delta \text{INF} \), \( \Delta \text{UNGAP} \)). The dynamic short-run causality (by using Wald test) and the long-run causality by error correction term (ECT\(_t\)) among the relevant variables are shown in Table 4.

### Table 4. Granger Causality Test Based on VECM

| Variables | Wald Test (F-test) (Short-run causality) | T-test (Long-run causality) |
|-----------|----------------------------------------|-----------------------------|
| \( \Delta \text{INF} \) | -3.088 | -6.489 |
| \( \Delta \text{UNGAP} \) | -0.745*** | (-3.295) |

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels of significance, respectively.

Results from Table 4 indicate a long-run causality relationship between inflation rate (INF) and unemployment rate (UNGap). In other words, inflation rate does “Granger cause” unemployment rate in the long-run. The error-correction term is significant with an adjustment coefficient of (-0.745), indicating that inflation rate (IFR) adjusts to its long-run equilibrium level with 74.5% of the adjustment taking place within the first year.

The sign of the error correction term (ECT\(_{t+1}\)) coefficient specifies that changes in the inflation rate adjust in an opposite direction to the previous period's deviation from equilibrium. In other words, the long-run Granger causality does confirm the existence of the long-run equilibrium relationship between unemployment rate and inflation rate as indicated in the Johansen cointegration test.

The short-run causality effect can be obtained by restricting the coefficient of the variables with its lags
equal to zero \( (\text{Ho: } \beta_1 = \beta_2 = \ldots = \beta_k = 0) \). If the null hypothesis of no causality is not rejected, (see table 4) then we conclude that a variable does not Granger cause other variable. Therefore, we conclude that the hypothesis of inflation-unemployment does not exist in Greek economy. In other words, unemployment rate does not “Granger cause” inflation in the short-run.

Figure 3 plots the impulse responses of inflation rate (INF) and unemployment rate (UNGAP) over a horizon of 10 years. Standard errors are calculated by the Monte Carlo method, with 100 repetitions (of ± 2 standard deviations).

Impulse responses suggest that shocks in inflation rate (INF) and unemployment rate (UNGAP) have a negative impact on the variables themselves in the first 6 years whereas there is a stabilisation of unemployment rate over the following 4 years.

Shocks in unemployment rate (UNGAP) cause an increase on inflation rate (INF) over the first four years followed by a stabilisation of the following 6 years.

Shocks in inflation rate (INF) cause a slight decrease on unemployment rate (UNGAP) over the first 3 years followed by a slight increase for the following 7 years under investigation.

The results from variance decompositions are reported in figure 4, and table 5a, and table 5b.

From Figure 4 we observe that the percentage error variance of inflation rate (INF) due to unemployment is zero. On the contrary, the percentage error variance of unemployment rate due to inflation is approximately 10%.

The forecast error variance decomposition indicates the proportion of the movements in a sequence due to its “own” shocks versus shocks to the other variables. The overall results of this exercise are reported in table 5a, and table 5b.
Table 5a. Generalized Forecast Error Variance Decomposition of INF

| Years | INF Variance Decomposition of INF | UNGAP Variance Decomposition of INF | S.E |
|-------|----------------------------------|-------------------------------------|-----|
| 1     | 100.0000 (0.00000)               | 0.00000 (0.00000)                  | 0.3464095 |
| 2     | 99.59264 (2.53535)               | 0.407363 (2.53535)                 | 0.4641779 |
| 3     | 99.16849 (5.01516)               | 0.831512 (5.01516)                 | 0.5378512 |
| 4     | 98.84311 (6.83475)               | 1.156893 (6.83475)                 | 0.6222754 |
| 5     | 98.61215 (8.07888)               | 1.387855 (8.07888)                 | 0.6469006 |
| 6     | 98.45149 (8.88210)               | 1.548506 (8.88210)                 | 0.6773919 |
| 7     | 98.33977 (9.39396)               | 1.660229 (9.39396)                 | 0.6645875 |
| 8     | 98.26122 (10.1036)               | 1.738478 (10.1036)                 | 0.6867139 |
| 9     | 98.20622 (10.4099)               | 1.793785 (10.4099)                 | 0.6935280 |

The results from variance decompositions suggest that, over a 10-year horizon, 69.35 percent of the forecast error variance of inflation rate (INF) can be accounted by shocks of unemployment rate (UNGAP).

Table 5b. Generalized Forecast Error Variance Decomposition of UNGAP

| Years | INF Variance Decomposition of UNGAP | UNGAP Variance Decomposition of UNGAP | S.E |
|-------|-------------------------------------|---------------------------------------|-----|
| 1     | 8.345900 (9.28545)                  | 91.65410 (9.28545)                    | 0.094244 |
| 2     | 8.149756 (9.42532)                  | 91.85024 (9.42532)                    | 0.103520 |
| 3     | 8.051117 (9.70301)                  | 91.94888 (9.70301)                    | 0.105303 |
| 4     | 8.012520 (10.1280)                  | 91.98748 (10.1280)                    | 0.105652 |
| 5     | 8.002368 (10.6709)                  | 91.99763 (10.6709)                    | 0.105719 |
| 6     | 8.003313 (11.1820)                  | 91.99669 (11.1820)                    | 0.105733 |
| 7     | 8.007616 (11.6323)                  | 91.99238 (11.6323)                    | 0.105738 |
| 8     | 8.012277 (12.0666)                  | 91.98772 (12.0666)                    | 0.105741 |
| 9     | 8.016320 (12.5082)                  | 91.98368 (12.5082)                    | 0.105743 |
| 10    | 8.019546 (12.9536)                  | 91.98045 (12.9536)                    | 0.105745 |

The results from variance decompositions suggest that, over a 10-year horizon, 10.57 percent of the forecast error variance of unemployment rate (UNGAP) can be accounted by shocks to inflation rate (INF).

6. Conclusion
The aim of the current paper is to explore the hypothesis referred by Phillips Curve in the case of Greece during the period 1980-2010. During this period Greece experienced a rather polarized political system and a problem of persistently high inflation especially during the 80’s and 90’s. High inflation could be due to the failure of political parties to pre-commit to price stability, as Alogoskoufis and Philippopoulos [13] mention
in their study. On the other hand this increased inflation could have resulted to increased job opportunities for Greece which ultimately could have led to economic growth in the country, something that did not occur eventually. Various reasons could have caused this situation:, high taxes, instability in monetary policy, lack of investments, continuous political corruption, and non-existent political initiative.

The results of this paper confirm that the inflation-unemployment hypothesis does not exist in the long-run in the case of Greece. On the contrary, Johansen cointegration test as well as Granger causality tests, reveal a long-run relationship between inflation rate and unemployment rate. Finally, the shocks applied for forecasting over 10 years, suggest that shocks in the proportion of inflation cause a decrease in unemployment during the first years followed by a slight increase over the following years over the period under investigation.

The current paper provides an empirical existence of Phillips Curve in the case of Greece during the long-run. Based on the findings of this paper one could forecast the future trend for the next ten years. Therefore, policy makers could make use of this paper for their future policy-making decisions.

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