# EFFECTS OF DEBT AND GDP ON THE UNEMPLOYMENT RATE: AN EMPIRICAL STUDY

Morsheda Hassan, Wiley College
mthassan@wileyc.edu

Raja Nassar, Louisiana Tech University
Ran1@suddenlink.net

## ABSTRACT

Debt and GDP and their effects on the unemployment rate are of fundamental importance to the economy of a country. In this study, the authors used time series analysis to investigate, in different countries, the empirical relationship between unemployment rate and percent debt and GDP. Also, the study examined the empirical relationship between debt and GDP in order to ascertain the true relationship between unemployment and debt. Results showed that GDP was negatively correlated with debt or deficit and with unemployment. On the other hand, debt or deficit was positively correlated with unemployment. It was concluded that the effect of debt or deficit on unemployment was largely a result of the GDP's negative effect on debt (deficit) and unemployment. Where possible, time series models were developed relating percent debt and GDP as independent variables to unemployment rate as the dependent variable. The models gave good fit to the observed data.

## INTRODUCTION

Among all the economics variables that have an effect on unemployment, the most important is perhaps the GDP. It is known that GDP is negatively correlated with unemployment. When the economy is down, unemployment is up because of a slow-down in hiring and layoffs by industry. On the other hand, the effect of debt and deficit on the economy and unemployment is not as clear and is debatable. In general, liberal economists argue that debt and deficit spending in the form of economic stimulus by the government will help create jobs and reduce unemployment, which in turn would stimulate the economy. On the other side, conservative economists argue that austerity, by way of reducing debt and deficit, rather than borrowing and spending, would help the economy at the time of a recession. Excess debt may hurt the economy in the sense that it may reduce confidence of investors, especially foreign investors. Also, interest payment by a government on excessive debt may harm the economy and excess debt may lead to an economic policy of austerity, which can increase unemployment. For details on these economic concepts, the reader is referred to Krugman (2012).

It is known that GDP and unemployment are negatively correlated. This is referred to in the literature as Okun's law (Okun, 1962). The law gives a constant change in unemployment per unit change in GDP. What is called a law was in fact established empirically and no doubt is not

a constant, but could vary from country to country. In light of this, Burgen et al. (2012) suggest that Okun's law is essentially a simple rule of thumb that relates a change in the GDP to a change in the unemployment rate. It is useful to determine more accurately the relationship between GDP and unemployment rate in different economies. Also, it is important to determine the role of GDP on debt in studying the effect of debt on the unemployment rate.

Studies in the literature are mostly based on regression models. It is known that for time series data, where the errors could be highly auto correlated, regression may not be accurate and can be misleading in the sense that it gives a high R-square. It is more accurate to model time series data using time series modeling methodology, which accounts for the autocorrelation in the errors.

In this study, we investigate the relationship between GDP and unemployment and between unemployment and debt using time series methodology. We built time series models that relate unemployment to GDP and debt utilizing data from different countries. The countries chosen were Greece, Italy, Spain, Portugal, Ireland, England, France, Germany, and the USA. These countries have a mix of economies, from small to large, and some have their own central banks (United Kingdom and the USA) while the others do not (in the sense that they all have one central European bank). Also, these countries differ in their monetary and fiscal policies. For the European Union countries, the Maastricht Treaty of 1992 (The history of the European Union, 1990-1999) imposes control on government debt and government deficit. The ratio of government deficit to GDP must not exceed 3%. Also, government debt must not exceed 60% of the GDP. As pointed out by Nenovski and Stevanovska (2014), many of the member states, and in particular Greece, Portugal, Ireland, Spain, Cyprus, and Italy, fail to meet the Maastricht criteria. The Maastrict treaty, with regard to government spending and debt, is a matter of fiscal policy which may call for austerity measures at times of recessions or economic downturns.

## REVIEW OF RELEVANT LITERATURE

There is agreement in the literature that there is a negative relationship between unemployment rate and the GDP. This relationship was in fact established empirically by Okun (1962). Although this negative relationship is robust and holds for different economies, its exact form is complicated and can vary over different economies or different phases of an economy over time (Burgen et al. 2012; Vojtovich, 2011; Khan et al., 2013; Andrei et. al., 2009). Kitov et. al. (2011) showed that unemployment rate since 1970 in different countries is highly linearly dependent on the logarithm of real GDP per capita with R-squares varying between 0.84 and 0.95.

Layard (1985) argued that cutting the budget or reducing the deficit reduced jobs. He presented empirical evidence for the US, UK, and the EEC over the years 1979 to 1984, supporting this argument. Koechlin (2011) makes the same argument that cutting spending to reduce the deficit, when the economy is stagnant, will increase unemployment. Sawtelle (2007) presented empirical evidence using regression analysis on data in the US between 1991 and 2001 showing that controlling for macro variables and considering unemployment by industrial sector is important when determining the relationship between GDP and unemployment. Nicola et. al. (2007) confirmed the negative relationship between GDP and unemployment for six European

countries, Canada and the US, based on the Okun's law concept. However, in variant with the Okun's regression equation, the authors used GDP as the dependent variable and unemployment as the independent variable. Aamir et. al. (2013), in an empirical study to verify Okun's law, using data from 1976 to 2010 in Pakistan, showed that an increase of 1% in unemployment reduced real GDP growth by 0.36 percentage points.

Aliabadi et. al. (2011), using a multiple regression model on macroeconomic data for the US from 1964-2010, showed that there was no association between change in unemployment rate and change in government spending after controlling for change in deficit, percentage change in GDP, and recession. As a result, authors argued for a cut in government spending to reduce debt and budget deficit.

Fedeli et. al. (2015), using a cointegration vector analysis on data from 22 OECD countries, showed that net lending of governments as a percentage of potential GDP and general government total receipts as a percentage of GDP, controlling for other variables, were positively related to the unemployment rate.

Vojtovich (2011), in an empirical study, concluded that the GDP growth before the recent economic crisis reduced the unemployment rate, but this relationship was not as clearly manifested after the crisis. This may point to other factors playing a role like industry confidence in the economy that could lead to a wait and see attitude before hiring again. Bethune (2013) developed a debt index based on the following equation:

$$\text{Debt Index} = \text{Deficit/Spending} + \text{Debt/GDP}$$

He showed for different countries that, in general, the debt index was negatively correlated with private investment and that the correlation was larger for the index than for any of its components. Also, the debt index was positively correlated with the unemployment rate. In a further study, Bethune (2014), using the Pearson correlation, showed that the debt index was positively correlated with the unemployment rate for most countries investigated. Also, using least square regression, he showed that the debt index as the independent variable had a considerable explanatory power on unemployment, as the dependent variable, for some countries, namely the US, Japan, the UK, and Spain.

Kooros (2008), using a step-wise multiple regression analysis on data from the Federal Reserve Bank of Saint Louis for the period 1950-2003, showed that GDP, discount rate, budget deficit, inflation, and hourly wage were related significantly to the unemployment rate. Unemployment was inversely related to GDP, discount rate, and inflation. However, unemployment was directly related to the wage rate.

Seccareccia (2013), analyzing the macroeconomic condition in Canada and the United States in the era after World War II, concluded that growing unemployment was due to government not stimulating demand through fiscal policies.

Leao (2013), using a mathematical argument, showed that below full employment and with fixed interest rate by the Central Bank, an increase in government spending nay reduce the ratio of debt to GDP. The author attributed this to the argument that an increase in government spending will, through the Keynesian multiplier, increase the GDP proportionately more than it does the debt.

## METHODS

### Time Series Model

A time series model relating an output series y to k input series $x_i$ (i = 1, 2, …,k) can be expressed in general as

$$y_t = \sum_i^k c(B)_i \, x_{it} + a_t \quad (1)$$

Here, $c(B) = \sum c_j B^j$, where B is the backshift operator, $Bx = x_{t-1}$.
The function $c(B)_i$ with its lags is determined from the cross correlations between $x_{it}$ and $y_t$, (i = 1,2,'''k), namely the significance at a given lag and the pattern of the cross correlations over lags (Wei, 2006).

The sample cross correlation between two time series y and x is expressed as follows:

$$r_{xy} = \frac{\sum_{t=1}^{n-k}(x_t - \bar{x})(y_{t+k} - \bar{y})}{n\, S_x\, S_y} \quad k \geq 0,$$

$$= \frac{\sum_{t=1-k}^{n}(x_t - \bar{x})(y_{t+k} - \bar{y})}{n S_x\ S_y} \qquad k < 0,$$

where, $S_x$ and $S_y$ are the standard deviations for x and y, $\bar{x}$ and $\bar{y}$ are the sample means and n is the sample size.

Once $c(B)_i$ is identified, one can express $a_t$ in Eq. (1) as

$$a_t = y_t - \sum_i^k c(B)_i \, x_{it} \quad (2)$$

and identify the appropriate time series model for Eq. (2). With $a_t$ known, one can determine the final model in Eq. (1). The model in (1) implies that there is no feedback between y and x. Feedback is identified by significant cross correlations between y and x at negative lags. In this analysis there was no significance of the cross correlations at negative lags.

An alternative to the cross correlation function for identifying feedback between two time series is the Granger causality test (Granger, 1980; Eichler, 2012). To test the hypothesis that x does not Granger-cause y, one considers the auto-regression of y augmented by lagged values for x.

$$y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \ldots + a_n y_{t-n} + b_0 x_t + b_1 x_{t-1} + \ldots + b_p x_{t-p} + e$$

The variable x does not Granger-cause y if none of the coefficients for x in the above regression is retained as being significant. Granger causality does not necessarily mean that x causes y. X may affect y because of a third common variable to both.

The Granger test is applicable to two series. A more general method to test for feedback is the vector auto-regression (VAR) for two or more time series. The variables are assumed to be stationary and all of the same order of integration.

As an example, the vector auto-regression for one lag, VAR(1), in the case of two variables may be written as:

$$y_{1,t} = a_1 + b_{1,1} y_{1,t-1} + b_{1,2} y_{2,t-1} + e_{1,t}$$
$$y_{2,t} = a_2 + b_{2,1} y_{1,t-1} + b_{2,2} y_{2,t-1} + e_{2,t}$$

If $b_{1,2}$ and $b_{2,1}$ are significant, one can assert that there is feedback between $y_1$ and $y_2$.

**Data**

Time series data on GDP, percent debt, and percent deficit were obtained from the database online using the link Gecodia.com. Percent deficit was analyzed as a positive quantity. Countries chosen were Greece (1977-2012), Italy (1981-2012), Spain (1981-2012), Portugal (1981-2012), Ireland (1981-2012), United Kingdom (1971-2011), France (1970-2011), Germany (1970-2011), and the US (1970-2011). GDP was in billions of Euros. For the UK it was in billions of GBP and the US in billions of dollars.

**RESULTS OF THE TIME SERIES ANALYSIS**

**USA**

The cross correlation between two series indicated that there was a negative significant correlation between GDP and unemployment rate (U) at lag 0 and lag 1 ($r_0$ = -0.40, $r_1$=-0.68), a positive significant correlation between unemployment rate and percent debt (PDT) at lags 0 and 1 ($r_0$ =0.67, $r_1$=0.55), and a negative significant correlation between GDP and percent debt at lags 0 and 1 ($r_0$ = -0.63, $r_1$= -.41)

Based on the cross correlations above, the functional relationships using time series analysis for unemployment rate as the dependent variable and percent debt and GDP as the independent variables, used together and each alone, gave the following expressions:

$$U_t = U_{t-1} + 0.14\ PDT(1)_t - 0.046\ PDT(1)_{t-1} - 0.094\ PDT(1)_{t-2} - 0.002\ GDP\ (1)_t$$

$$- 0.0007\ GDP\ (1)_{t-1} + 0.0015\ GDP\ (1)_{t-2} + 0.0012\ GDP\ (1)_{t-3} + e_t, \quad (3)$$

Where $PDT\ (1)_t = 0.71\ PDT(1)_{t-1}$
and $GDP\ (1)_t = 0.30\ GDP\ (1)_{t-1}$

The $GDP\ (1)_t$ and $PDT(1)_t$ equations are needed when predicting $U_t$ from Equation (3)
Here, PDT(1) and GDP (1) indicate first difference to make the series stationary.

$$U_t = U_{t-1} - 0.003\ GDP(1)_t - 0.0013\ GDP(1)_{t-1} + 0.0025\ GDP(1)_{t-2} + 0.0018\ GDP(1)_{t-3} + e_t \quad (4)$$

$$U_t = U_{t-1} + 0.244\ PDT(1)_t - 0.08\ PDT(1)_{t-1} - 0.164\ PDT(1)_{t-2} + e_t \quad (5)$$

It is seen form Eq. (3) that both percent debt and GDP have a significant effect on the unemployment rate. The relationship between unemployment and percent debt and GDP involves two lags and three lags, respectively.

Equation (4) showed that GDP has an effect on unemployment up to three lags, similar to Equation (3). Also, similar to Equation (3), the effect of percent deficit on unemployment rate involves two lags.

**FRANCE**

The cross correlation analysis showed that Percent debt was positively correlated with unemployment at lags 0, 1 and 2 ($r_0 = 0.25$, $r_1 = 0.25$, $r_3 = 0.24$). However, these correlations were not significant. GDP was negatively correlated to unemployment at lag 1 ($r_1 = -0.22$), but was not significant. On the other hand, percent debt was significantly negatively correlated with GDP at lags 0 and 1 ($r_0 = - 0.39$, $r_1 = -.56$).

Percent debt had no significant effect on unemployment in the presence of GDP. Hence, we present the functional relationships between unemployment rate (U) and GDP and unemployment rate and percent debt (PDT) separately.

$$U(1)_t = 0.866\ U(1)_{t-1} - 0.096\ GDP(1)_{t-1} + 0.082\ GDP(1)_{t-2} + e_t \quad (6)$$

Also,

$$U(1)_t = 0.29\ U(!)_{t-1} + 0.093\ PDT(1)_t - 0.026\ PDT(1)_{t-1} + e_t \quad (7)$$

where $PDT(1)_t = 0.59\ PDT(1)_{t-1}$

**Germany**

The cross correlation analysis revealed that unemployment rate was significantly negatively correlated with GDP at lags 0 and 1 ($r_0 = -0.49$, $r_1 = -0.31$) and significantly positively correlated with percent debt (PDT) at lag 0 ($r_0 = 0.45$). Also, GDP and percent debt were significantly negatively correlated at lag 0 ($r_0 = -0.49$).

The functional relationships between unemployment and GDP and percent debt, in combination (Eq. 8) and each separately (Eqs. 9 and 10), are as follows:

$$U(1)_t = 1.1\ U(1)_{t-1} - 0.75\ U(1)_{t-2} + 0.21\ U(1)_{t-3} + 0.097\ PDT(1)_t - 0.107\ PDT(1)_{t-1} + 0.007\ PDT(1)_{t-2} - .02\ Pdf(1)_{t-3} - 0.025\ GDP(1)_t + 0.011\ GDP(1)_{t-1} + e_t - 0.46\ e_{t-1} + 0.46\ e_{t-2} \quad (8)$$

where $PDT(1)_t = 0.24\ PDT(1)_{t-1}$

and $GDP(1)_t = 0.27\ GDP(1)_{t-1} - 0.50\ GDP(1)_{t-2}$

$$U(1)_t = 0.41\ U(1)_{t-1} + 0.15\ PDT(1)_t - 0.62\ PDT(1)_{t-1} + e_t \quad (9)$$

$$U(1)_t = 0.33\ U(1)_{t-1} + 0.32\ U(1)_{t-2} - 0.028\ GDP(1)_t - 0.042\ GDP(1)_{t-1} + 0.048\ GDP(1)_{t-2} + e_t + 0.42\ e_{t-1} \quad (10)$$

Equation (8) shows that unemployment rate is a function of its lags and of GDP and percent debt and their own lags.

Equation (9) shows that unemployment rate is a function of its own lag and of PDT and its lag.

Also, Equation (10) shows that unemployment is a function of its own lags as well as the GDP and its lags.

**United Kingdom**

The cross correlation between series revealed that there was a significant positive correlation between unemployment rate and percent debt at lag 0 ($r_0 = 0.28$). Percent debt was significantly negatively correlated with GDP at lags 0 and 1 ($r_0 = -0.28$, $r_1 = -0.31$). Also, GDP and unemployment rate were significantly negatively correlated ($r_0 = -0.38$, $r_1 = -0.65$).

The time series analysis showed that percent debt had no significant effect on unemployment in the presence of GDP in the model. Hence, the relationships between unemployment rate and GDP and unemployment rate and percent debt are given by the following expressions:

$$U(1)_t = 0.936\ U(1)_{t-1} - 1.06\ U(1)_{t-2} + 0.57\ U(1)_{t-3} + 0.076\ PDT(1)_t - 0.05\ PDT(1)_{t-1} + e_t - 0.29\ e_{t-1} + 0.87\ e_{t-2} \quad (11)$$

where $PDT(1)_t = 0.52\ PDT(1)_{t-1}$

$$U(1)_t = 0.85\ U(1)_{t-1} - 0.049\ GDP(1)_t - 0.035\ GDP(1)_{t-1} + 0.065\ GDP(1)_{t-2} + e_t \quad (12)$$

where $GDP(1)_t = 0.22GDP(1)_{t-1}$

Equation (11) gives the relationship between unemployment and its own two lags as well as PDT and its own lags.

Equation (12) gives the relationship of unemployment to its own lag and to GDP and its lags.

**Portugal**

The cross correlation analysis indicated that there was a significant negative correlation between unemployment and GDP ($r_0$ = -0.55) and a significant positive correlation between unemployment rate and percent deficit ($r_0$ = 0.47). A negative correlation was shown between percent deficit and GDP ($r_0$ = -0.47). However, this was not significant—due, perhaps, to the small sample size. The time series analysis did not show any significant effect of GDP on unemployment. The effect was negative, but not significant. This may be due to the small sample size of 16. As a result, quarterly data was used to express unemployment rate as a function of GDP. The negative relationship was significant with the larger sample size. The functional relationship between unemployment rate and GDP and unemployment rate and percent deficit are given as:

$$U(1)_t = 0.54\ U(1)_{t-1} - 0.31\ GDP(1)_t - 0.163\ GDP(1)_{t-1} + 0.18\ GDP(1)_{t-2} + e_t \quad (13)$$

$$U(1)_t = 0.598\ U(1)_{t-1} + 0.132\ Pdef_t - 0.079\ Pdef_{t-1} + e_t \quad (14)$$

For prediction purposes, $GDP(1)_t$ and $pdef(1)_t$ may be replaced by $0.21\ GDP(1)_{t-1}$ and $0.066\ pdef(1)_{t-1}$, respectively.

**Spain**

Cross correlation between series showed that there was a negative correlation between GDP and percent debt ($r_0$ = -0.28, $r_1$ = -0.46, $r_2$ = -0.55). Only $r_2$ was significant. Also, GDP was significantly negatively correlated with unemployment rate at lag 2 only ($r_2$ = -0.83). Percent debt was significantly positively correlated with unemployment rate ($r_0$ = 0.4). Because of the small sample size (n=17), quarterly data was used to determine the functional relationship between GDP and unemployment rate.

The following time series equations relate unemployment rate to GDP:

$$U(1)_t = 0.82\ U(1)_{t-1} - 0.145\ GDP(1)_t - 0.01\ GDP(1)_{t-1} + 0.106\ GDP(1)_{t-2} + e_t \quad (15)$$

Where for prediction purposes:

$$GDP(1)_t = 0.806\ GDP(1)_{t-1} \quad (16)$$

It is seen from Equation (15) that unemployment relates to its own lag as well as to GDP and its lags.

**Italy**

GDP was significantly negatively correlated with percent debt ($r_0 = -0.43$) and with the unemployment rate ($r_0 = -0.44$). Percent debt was significantly positively correlated with unemployment rate ($r_0 = 0.67$).

Due to the relatively small sample size of 18, we were able to fit only the following models:

$$U(1)_t = 0.675\ U(1)_{t-1} - 0.03\ GDP(1)_t + 0.02\ GDP(1)_{t-1} + e_t \quad (17)$$

$$U(1)_t = 0.5\ U(1)_{t-1} + 0.063\ PDT(1)_t - 0.031\ PDT()_{t-1} + e_t \quad (18)$$

For prediction purposes, $PDT(1)_t$ and $GDP(1)_t$ can be replaced by $0.195\ PDT(1)_{t-1}$ and $0.31\ GDP(1)_{t-1}$.

It is seen for equations (17) and (18) that unemployment is related to its own lag and to GDP and PDT and their own lags. Although the models are based on a relatively small sample size, they do conform to expectation where unemployment is positively related to debt and negatively related to GDP. Also, the models fit the observed data rather well.

**Greece**

The cross correlation analysis between series showed that unemployment rate was significantly negatively correlated with GDP ($r_0 = -0.65$). However, there was no significant correlation between percent deficit and unemployment rate or percent deficit and GDP. The lack of a significant negative correlation between percent deficit and GDP could be due to the relatively small sample size of 18, or perhaps due to austerity measures. The time series model relating unemployment rate to percent deficit showed a positive effect of percent deficit on unemployment rate. However, this was not significant ($p=0.28$).

The time series model relating unemployment rate to GDP using quarterly data gave the following expression:

$$U(1)_t = 0.578\ U(1)_{t-1} - 0.14\ GDP(1)_t + 0.08\ GDP(1)_{t-1} + e_t \quad (19)$$

For prediction purpose, $GDP(1)_t$ can be set to zero,, which means that $GDP_t = GDP_{t-1}$. It is seen from equation (19) that unemployment relates to its own lag and to GDP and its lag.

**Ireland**

The cross correlation between GDP and unemployment rate was negative and significant at lags 1 and 2 (r1 = -0.62, r2 = -0.5) and that between percent deficit and unemployment was positive and significant at lag 1 (r1 = 0.43). The correlation between GDP and percent deficit was negative and significant (r0 = - 0.72). Because of the small sample size, only quarterly data was used to develop a model. For this case, the time series equation relating GDP to unemployment rate is

$$U_t = - 0.205\ U_{t-1} – 0.30\ GDP(1)_t\ - 0.06\ GDP(1)_{t-1} + e_t \quad (20)$$

For prediction purpose, $GDP(1)_t = 0.29\ GDP(1)_{t-1} + 0.31\ GDP(1)_{t-2}$.

It is seen from the above equation that unemployment is related to its own lag and to GDP lags.

**MODELS' FIT TO DATA**

Table 1 presents for each country the R-square for a time series model with unemployment rate as the dependent variable and percent debt (or deficit) and/or GDP as independent variables. It is seen that all models presented above gave low residuals as a fraction of the total sum of squares of observed values. GDP alone in the model gave residual ratios less than 0.1 except for the US and Germany, which were 13 and 15 percent, respectively. Plots in Figures 1-9 are presented for observed and expected from the models. It is seen from the low residual ratios in Table 1 and the plots that there was good fit between models and observed data.

**Table 1**
**RATIOS OF RESIDUAL SUM OF SQUARES TO TOTAL SUM OF SQUARES FOR THE DIFFERENT TIME SERIES MODEL**

| **Country** | **Independent Variables** | | |
|---|---|---|---|
| | **(GDP, percent debt or deficit)** | **GDP** | **percent debt or deficit** |
| USA | 0.10 | 0.13 | 0.14 |
| UK | ---- | 0.04 | 0.38 |
| France | ---- | 0.06 | 0.09 |
| Germany | 0.09 | 0.15 | 0.06 |
| Greece | ---- | 0.06 | ---- |
| Italy | ---- | 0.07 | 0.05 |
| Spain | ---- | 0.01 | ----- |
| Portugal | ---- | 0.02 | 0.15 |
| Ireland | ---- | 0.06 | ---- |

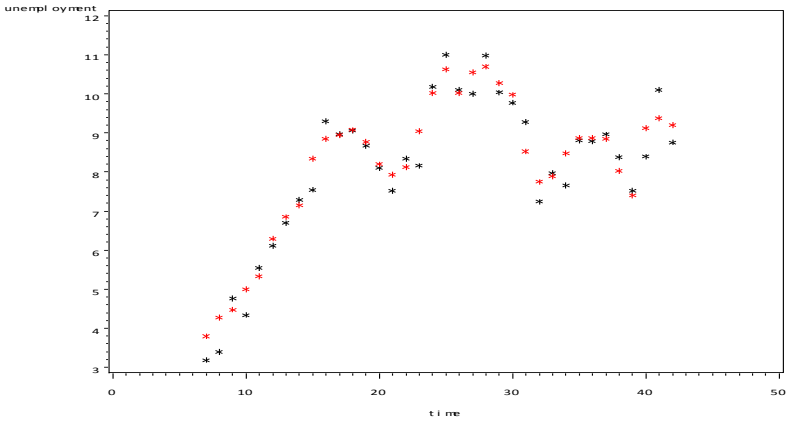


**FIGURE 1. FRANCE. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN YEARS, STARTING IN 1977. EXPECTED VALUES ARE BASED ON THE GDP MODEL IN EQ. (6).**

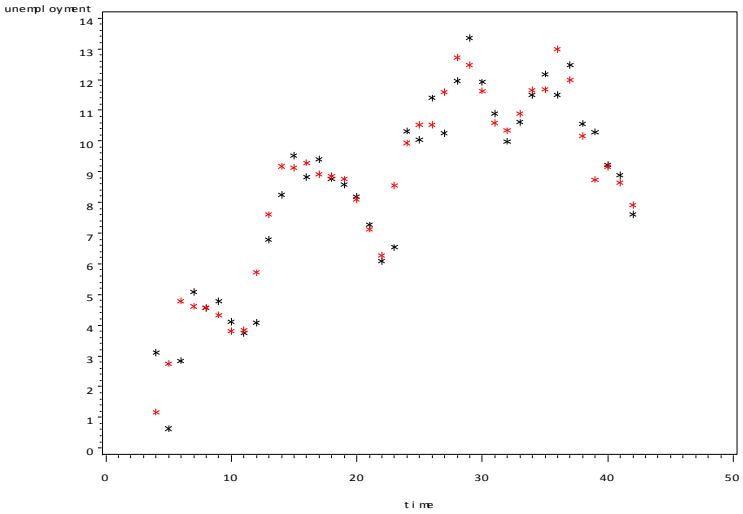


**FIGURE 2. GERMANY. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN YEARS, STARTING IN 1974. EXPECTED VALUES ARE BASED ON THE GDP AND PERCENT DEBT MODEL IN EQ. (8).**

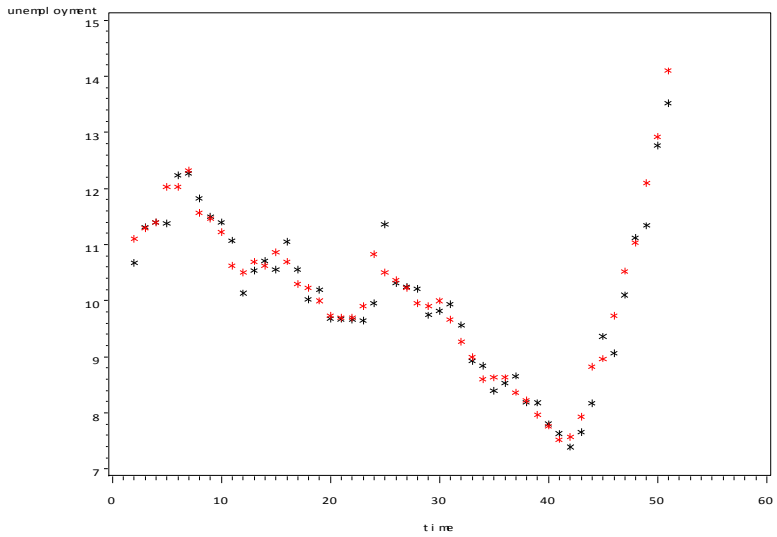


**FIGURE 3. GREECE. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN QUARTERS, STARTING IN 1998. EXPECTED VALUES ARE BASED ON THE GDP MODEL IN EQ. (19).**

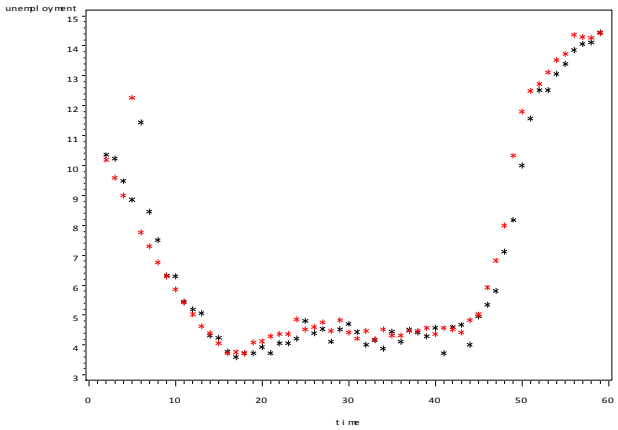


**FIGURE 4. IRELAND. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN QUARTERS, STARTING IN 1997. EXPECTED VALUES ARE BASED ON THE GDP MODEL IN EQ. (20).**

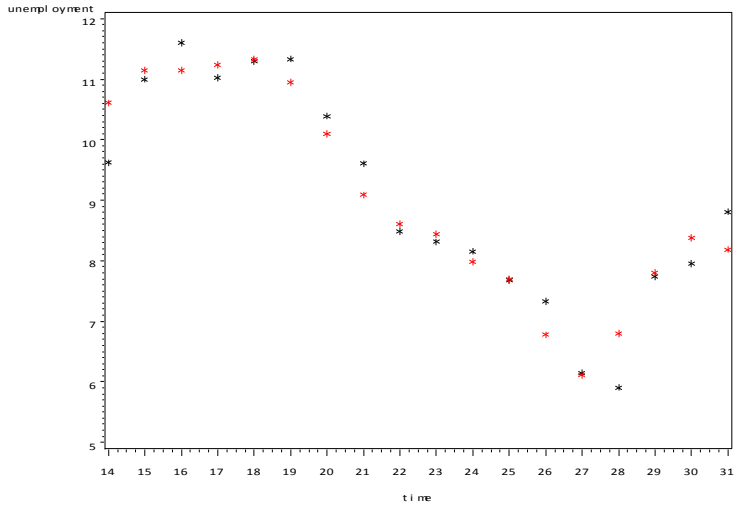


**FIGURE 5. ITALY. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN YEARS, STARTING IN 1994. EXPECTED VALUES ARE BASED ON THE GDP MODEL IN EQ. (17).**

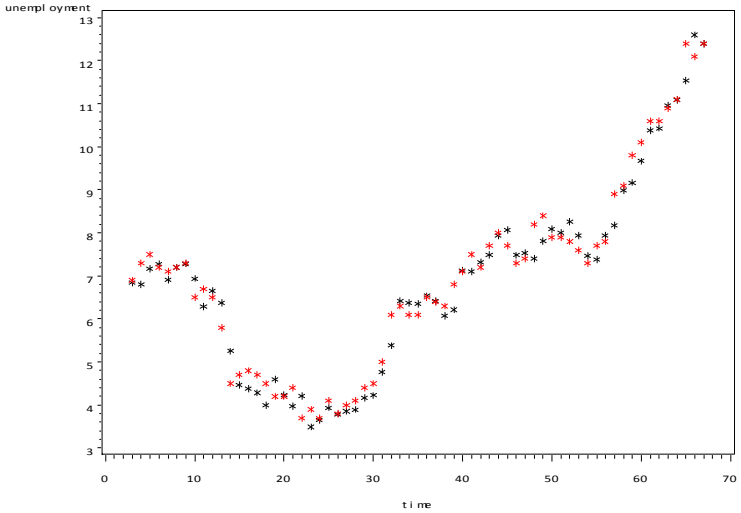


**FIGURE 6. PORTUGAL. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN QUARTERS, STARTING IN 1995. EXPECTED VALUES ARE BASED ON THE GDP MODEL IN EQ. (13).**

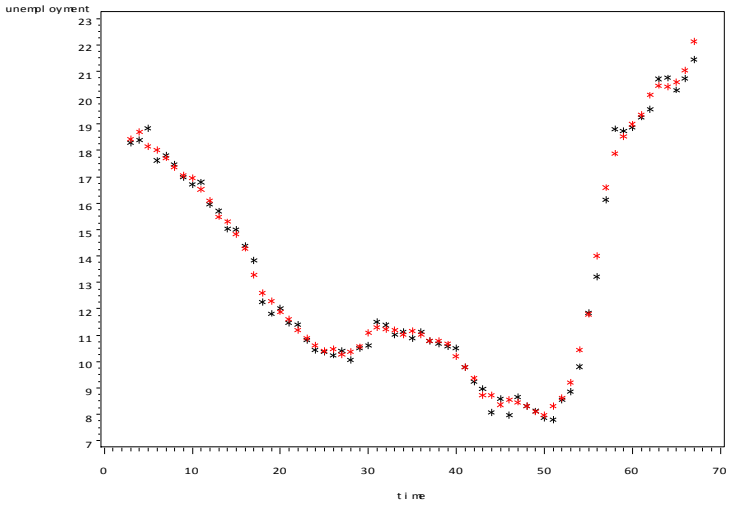


**FIGURE 7. SPAIN. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN YEARS, STARTING IN 1983. EXPECTED VALUES ARE BASED ON THE GDP MODEL IN EQ. (15).**

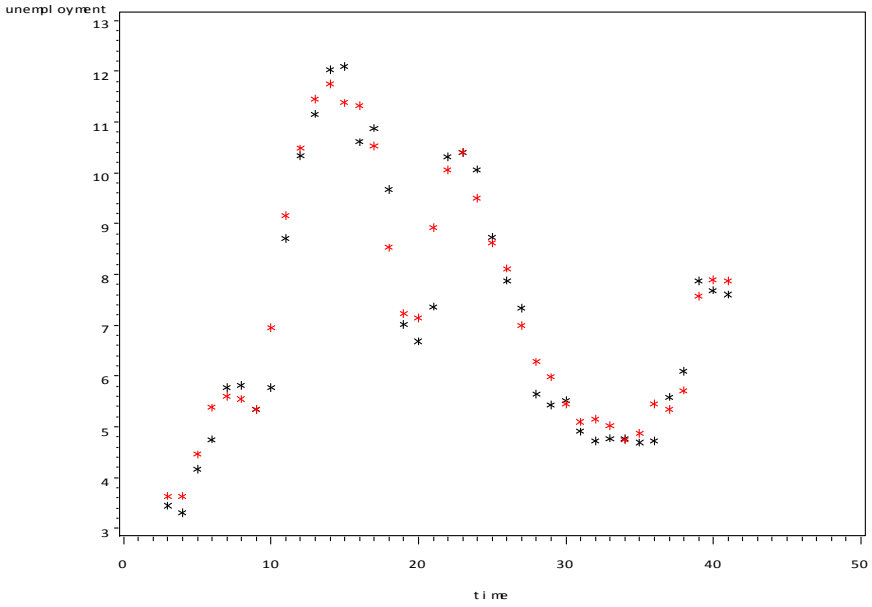


**FIGURE 8. UK. PLOT OF EXPECTED AND OBSERVED (IN RED) UNEMPLOYMENT RATE OVER TIME IN YEARS, STARTING IN 1973. EXPECTED VALUES ARE BASED ON THE GDP MODEL IN EQ. (12).**

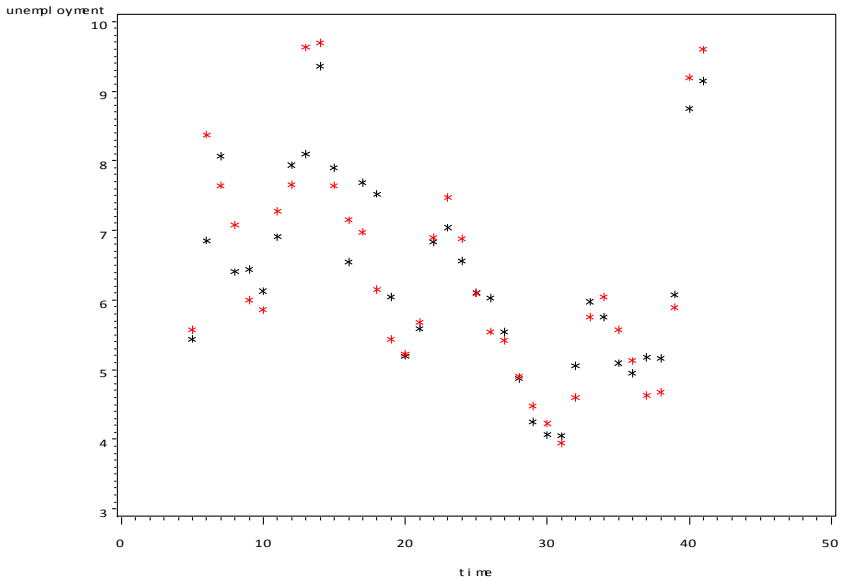


**Figure 9. USA. Plot of expected and observed (in red) unemployment rate over time in years, starting in 1974. Expected values are based on the GDP model in Eq. (4).**

## DISCUSSION

Results of this investigation showed that GDP was negatively correlated with the unemployment rate and with the percent debt or percent deficit. Also, percent debt or percent deficit was positively correlated with the unemployment rate. It could be argued that the positive correlation between debt or deficit and unemployment is due to the fact that they are negatively correlated with GDP. As GDP decreases, unemployment increases and percent debt or percent deficit increases at the same time. In other words, the positive effect of debt or deficit on unemployment is due to GDP and not to a direct cause and effect. If deficit or debt were to have a negative effect on GDP, then one may argue that they will in turn directly contribute to higher unemployment. However, while GDP affects debt or deficit, there is no indication (except perhaps in the case of Germany and Spain) from the present study that the reverse is true. The cross correlation data did not show any significant correlation for negative lags, but only for positive lags. This is an indication that there was no feedback between debt or deficit and GDP.

Indications are that GDP affects deficit or debt, but debt or deficit does not affect the GDP. Debt may have an influence on the GDP in cases where the ratio of debt to GDP is so high that it causes an erosion of confidence on the part of investors and a strain on the economy as a result of interest payment on the debt. Also, high debt may lead to an economic policy of severe austerity, which can increase unemployment. In general, this does not seem to be the case. However, in the case of Germany and perhaps Spain, there may be evidence that debt has an effect on the economy and unemployment. The Granger test shows a significant feedback from pdebt to GDP ($p = 0.041$) in the sense that percent debt had an effect on the GDP. Also, the residual ratio for the model where debt is the only independent variable is lower than that for the

model where GDP is the independent variable. This result was confirmed by the analysis using a vector AR(1) Model. In this analysis $GDP(1)_{t-1}$ had a significant effect ($p=0.0151$) on $pdebt(1)_t$ and $pdebt(1)_{t-1}$ had a significant effect ($p=0.048$) on $GDP(1)_t$. The case for Spain was similar except that the feedback effect from pdebt to GDP(1) was significant at the 0.0558 level and in the vector AR(1) model, the effect of $Pdebt_{t-1}$ on $GDP(1)_t$ was significant at the 0.08 level. The evidence here is not as strong as that for Germany.

Germany may be a unique situation because of the re-unification between East and West Germany and the massive spending by the West German government for the building of the infrastructure and the economy of East Germany from the bottom up. This event could be the cause for the observed effect of debt on the GDP. The results for Spain may be explained by high debt coupled with severe austerity measures.

In two cases, France and the United Kingdom, debt had no significant effect on unemployment when GDP was present in the model. This argues for the fact that the effect of debt on unemployment is indirect and is due to the GDP effect on unemployment.

Greece did not show any significant correlation between percent deficit and GDP. This could be attributed to the severe austerity measures, which prevented borrowing, by the government in the face of a decrease in GDP. Also, there was no correlation between deficit and unemployment. While GDP and unemployment are negatively related, GDP and deficit as well as deficit and unemployment are not related.

In general, one may conclude from these results that the effect on unemployment is to a large extent due to GDP and that the contribution of deficit or debt to unemployment is less important. Debt or deficit coupled with austerity may have an effect on increasing unemployment.

It is also important to note from this study that the functional relationship between GDP and unemployment rate is more complex than that given by the regression equation of Okun (1962) and while there is a negative relationship between unemployment and GDP, the magnitude of this relationship is not a constant as stated in Okun's work, but could vary from one country to another. This is to be expected since the relationship due to Okun was empirically determined.

## CONCLUSION

Time series data on unemployment rate, GDP, percent deficit or percent debt for nine countries was analyzed using time series cross correlation and time series modeling procedures. Results indicated that the unemployment rate was negatively related to GDP and positively related to percent debt or percent deficit. Of importance is the fact that GDP was found to be negatively related to percent debt or percent deficit. It was concluded that the effect of debt or deficit on unemployment was largely a result of the GDP effect on both, debt (deficit) and unemployment. Only in the case of Germany, and perhaps Spain, there may have been an effect of percent debt on the GDP and on the unemployment rate. This could be attributed to debt coupled with austerity.

Also, the negative relationship between GDP and unemployment is in accord with the literature and the earlier results of Okun (1962). However, the functional relation between GDP and unemployment is more complex than initially stated by Okun and is not a universal law as referred to, but can vary over different economies.

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