Is Okun's Law Valid in Romanian Economy? An Empirical Approach of Unemployment Rate and GDP Relation from 2000 to 2018

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Abstract

Economic growth and the level of employment are two key factors that economists should consider when analyzing different economic aspects. In this article, we focus on the relation between the growth of unemployment rate and the growth of real gross domestic product (both expressed as a percentage) in the case of Romania. In our research we answer at the following questions? Is Okun's rule valid in Romanian economy from 2000 to 2018? Does it hold over time? What is the relation between these variables?

The empirical analysis showed the inverse relationship between them, confirming Okun's findings, underlying that the rule is valid in the Romanian economy in the analyzed period, although the small value of R-squared made us interpret the results with caution, questioning somehow the sustainability of the law over time. Its validity can be seen more on short term analysis rather than on long term projections.

Key words: unemployment rate, GDP, Okun's law, economic growth
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1. Introduction

Important part of economic policy, monetary policy has always been careful in ensuring the balance between the four components of the "Magic Square". In this context, one of its scope is to impact all of them at once, although this can affect the others: price stability, economic growth, increase of employment rate and the equilibrium of balance of payments and the increase of reserves and means of international payments (Stoica *et al*, 2003, p.523-524).

Since economic growth and the level of employment are two important factors that economists should take into consideration in their analysis, in this article, we chose to remain inside this magic square and decide to check the relation between the growth of unemployment rate and the growth of real gross domestic product in the case of Romania, or in other words, what is known as a variation of Okun's law. Is Okun's rule valid in Romania? Does it hold over time? What is the relation between unemployment rate growth and real gross domestic growth in the analyzed period and how much correlated are these two variables?

In 1962, Yale's American economist, Arthur Melvin Okun, discovered two empirical indirect relationships between unemployment rate and gross domestic product (GDP) or output that has become real rules of thumb. Stating that in order to produce more goods, the economy needs more workers or more working hours, Okun introduced the unemployment rate to quantify the amount of labor from the economy. The "difference version" presents how the real output growth are influenced by the changes of unemployment rate quarterly data, while the "gap version" links the unemployment rate to the gap between potential and actual output, establishing that 1% increase in unemployment rate leads to a 2% decrease of real GDP (Okun, 1962).

In the first part of this article, we will present a short overview of the scientific literature regarding the relationship between unemployment rate and GDP and in the second part we will check the validity of Okun's law in Romanian economy from 2000 to the second quarter of 2018, using quarterly growth levels of unemployment rate and real GDP, expressed as a percentage.

2. Overview of scientific literature: in a nutshell

The subject is well debated in hundreds of articles throughout the world, many researchers checking the validity and stability of Okun's Law in their countries, using quarterly or annually data and analyzing only one or both versions of the law, studying not only the influence of unemployment rate over output, but the reverse relationship, too.

Most of the studies showed the existence of a relationship between unemployment and output. In checking the stability of the rule, many economists tried to determine the influence of GDP changes over the unemployment rate, while others searched for the reverse relationship. This means that depending on the research question asked, regressions of output on unemployment or vice versa play an important role in correct estimation (Barreto *et al*, 1993, p. 21).

In a nutshell, the relationship exists, while the coefficients may differ from one country to another.

Okun's law created a lot of controversies through researchers, studies showed how unstable and not trustful is this rule.

Using data since 1948 for the United States and since 1980 for no less than twenty advanced economies, Ball *et al* (2013, p. 1-2) explained short-run unemployment movements, concluding that Okun's low is a stable and a strong relationship in most countries.

On contrary, Knotek (2007, p. 81) believed that in long time series, there can be some changes in relationship, stating that on short term there is a considerable variation in the relation between changes in unemployment rate and real output growth. He concluded that not always there is a negative relation between those two variables, citing moments where growth reductions have not lead to increasing unemployment, but underlying that in time the relation is stable.

The stability of the law was tested by White *et al* (2013, pp. 25-26), showing that in USA case there is a two way causality between variables (out of a total of five influences between unemployment rate and GDP), with varying directions of effect, while in France and Japan case, they could not find any causality, due to variances in demographics, legal systems, states of business cycle, cultures. Using a regression with GARCH errors to show the volatility of the series, in United States, Nektarios (2016, p. 25) achieved a coefficient very close to the value of two, although it oscillated during the analyzed period. There is not a significant change in time of the relationship between the two variables.

By analyzing quarterly data from 1971 to 2013 in United Kingdom, Stober (2015, p. 10, 14-15) assessed the validity of Okun's law, suggesting the negative correlation between unemployment and economic growth rate (if output increases by 1 point, the unemployment rate will diminish by 0.074 points).

Okun's law seems to be valid and useful in unemployment and output forecasts in Japan, Germany and Italy, since this is possible due to small magnitudes of the Okun coefficient (Ball *et al*, 2014, p. 12).

The Okun's law negative relationship is valid for Nigeria, during 1970 – 2013. A decrease of 1% of unemployment rate leads to an increase of 1.75% of GDP, a coefficient which is lesser than 3% original Okun coefficient, emphasizing that the coefficient can be used to explain the situation in Nigeria (Oluyomi *et al*, 2016, p. 1422).

Estimating Okun coefficient in four Mediterranean countries (Spain, Portugal, Italy and Greece), Dritsaki *et al* (2009, p. 18) found out, using Hodrick and Prescott filter, that unemployment cost (from real GDP loss perspective) is greater in Italy (-0.024) and smaller in Greece (-0.007).

The validity of Okun's law was tested in Romania, too (Gheorghe, 2010, p. 95). The approach to model reciprocal and unique two-way relation between the growth of GDP and the growth of unemployment rate as described by Okun in 1962 is not applying in Romania during the period 1992-2004 (Turturean, 2008, p. 7). An empirical work in Romania studied the impact of economic

crisis on the unemployment time varying NAIRU and output gaps (Andrei, 2014, p. 6). The "gap version" of Okun's law was studied by Curea-Pitorac (2015, p. 50) using data after the integration in the European Union. The model was considered valid, expressing the inverse relationship between unemployment gap and output gap. The study also showed that beside fiscal and monetary policies, some other policies had to be implemented.

3. Methodology

For this analysis, we will use the original Okun's relationship between the growth rate of GDP and unemployment rate, expressed as percentage. Both are seasonally adjusted series and cover the period from the the first quarter of 2000 (2000 Q1) until the second quarter of 2018 (2018 Q2). All the 74 observations for each series are to be found in *Table no. 1*.

The growth of unemployment rate, expressed as a percentage (*U_growth*) is the dependent variable and is calculated as a percentage change of unemployment rate from a quarter to another. Data from the series are from the Eurostat database.

The growth of GDP, expressed as a percentage (*GDP_growth*) is the independent variable and is calculated as a percentage change of GDP from a quarter to another. In this case, the data is from the National Institute of Statistics in Romania.

Knowing the Okun's indirect relationship between unemployment and GDP growth, the research will use the Least Squares method to analyse *U_growth* as a function of *GDP_growth*.

In this case, *U_growth* = f (*GDP_growth*).

Table no. 1. GDP growth and U growth in Romania expressed as a percentage (2000 – 2018)

Period	GDP growth (%)	U growth (%)	Period	GDP growth (%)	U growth (%)	Period	GDP growth (%)	U growth (%)
2000 Q1	10,717	-1,333	2006 Q2	3,995	-1,408	2012 Q3	0,689	0,000
2000 Q2	8,050	2,703	2006 Q3	4,211	7,143	2012 Q4	1,714	-2,941
2000 Q3	10,158	2,632	2006 Q4	6,284	-6,667	2013 Q1	1,361	4,545
2000 Q4	10,480	-1,282	2007 Q1	4,364	-5,714	2013 Q2	2,102	7,246
2001 Q1	12,326	-3,896	2007 Q2	5,689	0,000	2013 Q3	2,040	-5,405
2001 Q2	8,184	-2,703	2007 Q3	5,181	-6,061	2013 Q4	2,149	0,000
2001 Q3	8,007	1,389	2007 Q4	7,291	-4,839	2014 Q1	-0,074	-1,429
2001 Q4	7,638	6,849	2008 Q1	7,307	-3,390	2014 Q2	2,212	0,000
2002 Q1	3,795	10,256	2008 Q2	5,565	0,000	2014 Q3	0,760	-1,449
2002 Q2	8,859	1,163	2008 Q3	6,152	-5,263	2014 Q4	1,193	-1,471
2002 Q3	5,411	-2,299	2008 Q4	2,138	3,704	2015 Q1	3,039	4,478
2002 Q4	6,446	-10,588	2009 Q1	-11,776	8,929	2015 Q2	-0,769	-1,429
2003 Q1	8,024	0,000	2009 Q2	3,905	0,000	2015 Q3	3,750	-1,449
2003 Q2	6,161	1,316	2009 Q3	1,898	11,475	2015 Q4	1,013	-2,941
2003 Q3	6,435	-1,299	2009 Q4	5,335	4,412	2016 Q1	1,276	-4,545
2003 Q4	6,311	6,579	2010 Q1	-9,902	2,817	2016 Q2	3,740	-4,762
2004 Q1	5,064	0,000	2010 Q2	3,668	-8,219	2016 Q3	-0,034	-1,667
2004 Q2	5,758	-3,704	2010 Q3	2,233	2,985	2016 Q4	3,616	-8,475
2004 Q3	6,179	2,564	2010 Q4	1,626	0,000	2017 Q1	3,662	-3,704
2004 Q4	4,932	-1,250	2011 Q1	1,770	0,000	2017 Q2	2,123	-5,769
2005 Q1	2,063	0,000	2011 Q2	-0,581	2,899	2017 Q3	3,350	0,000
2005 Q2	3,962	-7,595	2011 Q3	2,721	2,817	2017 Q4	2,477	-4,082
2005 Q3	4,632	-10,959	2011 Q4	0,287	1,370	2018 Q1	2,121	-4,255
2005 Q4	3,638	1,538	2012 Q1	1,607	-6,757	2018 Q2	2,948	-6,667
2006 Q1	5,443	7,576	2012 Q2	2,691	-1,449			

Source: National Institute of Statistics in Romania, Eurostat, own processing

4. An empirical application of Okun's law in Romanian economy between 2000 and 2018

We will begin our analysis by firstly testing the stationary of the variables, *U_growth* and *GDP_growth*, expressed as a percentage. A time series is stationary only if its mean and variance are constant over time. We will therefore perform Augmented Dickey – Fuller (ADF) and Phillips – Perron (PP) tests to check the presence of a unit root that can cause stationarity.

Figure no. 1. ADF and PP tests for GDP_growth time series

Null Hypothesis: GDP_GROWTH has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.459169	0.0000
Test critical values:	1% level	-4.088713	
	5% level	-3.472558	
	10% level	-3.163450	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: GDP_GROWTH has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.558617	0.0000
Test critical values:	1% level	-4.088713	
	5% level	-3.472558	
	10% level	-3.163450	

*MacKinnon (1996) one-sided p-values.

Source: EViews outputs, own processing

As it is seen in *Figure no. 1*, t-Statistic values (ADF = - 7.459169 and PP = - 7.558617) are smaller than any critical values of the tests at 1%, 5 % and 10% level, so the null hypothesis that *GDP_growth* time series has a unit root, is rejected with a probability higher than 99%, and in consequence, is stationary at level. The order of integration is 0, meaning the series is I(0).

U_growth time series is also stationary at level, the null hypothesis being accepted with a probability less than 1%, because both t-Statistic values for ADF test and PP test are smaller than tests critical values at different levels (ADF = PP = - 6.678796). *U_growth* is integrated by order 0, I(0), as it is seen in *Figure no. 2*.

Figure no. 2. ADF and PP tests for U_growth time series

Null Hypothesis: U_GROWTH has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.678796	0.0000
Test critical values:	1% level	-3.522887	
	5% level	-2.901779	
	10% level	-2.588280	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: U_GROWTH has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.678796	0.0000
Test critical values:	1% level	-3.522887	
	5% level	-2.901779	
	10% level	-2.588280	

*MacKinnon (1996) one-sided p-values.

Source: EViews outputs, own processing

Since both series are order one integrated, I(0), it is not necessary to check if between them there is a stable long term relationship (level of cointegration).

Using Least Squares method, we can estimate the regression model, how unemployment growth rate varies when there is a change in GDP growth rate (see *Figure no. 3*).

The estimated equation is:

U_GROWTH = C(1) * *GDP_GROWTH* + C(2), or

U_GROWTH = - 0.217603 * *GDP_GROWTH* + 0.147779.

We found an inverse relationship between GDP growth rate and unemployment growth rate, validating the indirect influence as stated by Okun's law. If GDP growth rate increases by 1% from a quarter to another, the unemployment growth rate decreases by 0.217%. R-squared is 0.03 and means that only 3% of the variation of unemployment growth rate can be explained by the GDP growth rate.

Figure no. 3. U_growth time series – equation estimation

Dependent Variable: U_GROWTH
Method: Least Squares
Date: 02/03/19 Time: 15:42
Sample: 1 74
Included observations: 74

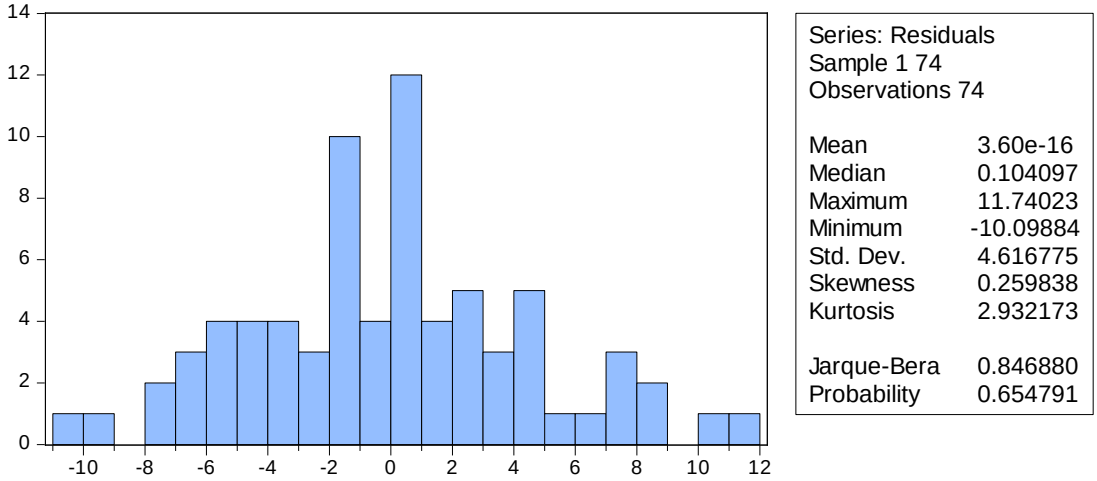
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_GROWTH	-0.217603	0.145466	-1.495910	0.1390
C	0.147779	0.769659	0.192006	0.8483

R-squared	0.030143	Mean dependent var	-0.672027
Adjusted R-squared	0.016673	S.D. dependent var	4.687970
S.E. of regression	4.648725	Akaike info criterion	5.937718
Sum squared resid	1555.966	Schwarz criterion	5.999990
Log likelihood	-217.6956	Hannan-Quinn criter.	5.962559
F-statistic	2.237746	Durbin-Watson stat	1.491854
Prob(F-statistic)	0.139048		

Source: EViews output, own processing

In the end, for a valid model, we need to test the errors (residuals). The normality test (histogram) shows the residuals distribution (see *Figure no. 4*). The value of Jarque-Bera 0.846880 confirms the normal distribution of errors with a 65% probability (more than 5% standard level). Moreover, the Skewness coefficient very close to zero (0.25) explains the symmetrical distribution around the mean, while Kurtosis coefficient 2.932173 confirms the normal distribution of residuals.

Figure no. 4. Histogram – residuals distribution normality



Source: EViews output, own processing

Breusch-Godfrey serial correlation LM test rejects the null hypothesis of errors correlation with 10.75% probability. At the same time a Durbin-Watson test's value of 1.982904 confirms there is no correlation between errors.

We used ARCH test to verify the heteroskedasticity of residuals. With 86.84% the null hypothesis is rejected, meaning that residuals are not heteroscedastic, they have constant variance over time.

5. Conclusions

The empirical analysis of quarterly values of unemployment growth rate and GDP growth rate in Romania from the 2000 to 2018 showed the inverse relationship between these two variables, confirming Okun's findings and from this point of view, underlying that the rule is valid in the Romanian economy in the analyzed period.

A small coefficient of 0.217 suggests that if GDP growth rate increases by 1% from a quarter to another, the unemployment growth rate decreases by 0.217%. Knowing that these values can differ

from country to country and from a period to another, using historical inputs (see all the scientific approaches that have been made), we must interpret with caution the results. R-squared has a small value, meaning that the variation of unemployment rate is explained by other variables.

As a result, we can conclude that its validity can be seen more on short term analysis (for instance, in discussions about economic growth) and forecasts, rather than on long term projections, because of continuous market changing conditions that influence Okun's coefficient.

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