Phillips Curve: An Empirical Research on Romania

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A B S T R A C T

This paper analyses the Phillips curve for Romania, eventually choosing the optimal type of model, while also analysing the implications on monetary policy. In order to create, test and analyse the Phillips curve, we utilised a backward-looking model. For empirical analysis we used the annual data obtained from the National Institute of Statistics for a period between 1991 and 2018.

1. Introduction

Inflation and unemployment are two macroeconomic factors that have been studied over the years by many economists, who followed the connection that exists between them. The analysis of the relationship between the two macroeconomic factors began in 1958, when William Phillips wrote "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957". The study conducted by W. Phillips led to the definition of the "Phillips curve", which shows the relationship between inflation and unemployment.

Throughout history, due to the large fluctuations of the two factors, economists have altered the idea formulated by W. Phillips, considering that the relationship between the unemployment rate and the inflation rate is no longer an inverse relationship, but a compensation between the two (Friedman, 1968). Based on M. Friedman's arguments, it was concluded that the Phillips curve should be analysed over two different time periods. Thus, there appeared the "short-term" Phillips curve, which looks like a normal one, and the "long-term" Phillips curve, in which only one unemployment rate is taken into account, which is consistent with a constant rate of inflation (Phelps, 2006).

2. Literature review

The unemployment rate is the ratio, expressed as a percentage, between the total number of unemployed people and the active population. Inflation can be defined as the decrease in the purchasing power of a monetary unit. Any economy faces this phenomenon over time, which can only be influenced, but not fully controlled. The two macroeconomic indicators are extremely important for any national economy, hence the interest of policy makers in regulating their levels.

The Phillips curve represents, in the literature, the inverse relationship between the inflation rate and the unemployment rate. Thus, in his approach, Phillips noticed that, during periods when the unemployment rate was high, salaries stagnated or increased slowly, and during periods of low unemployment, salaries increased rapidly. The logical explanation stems from the fact that, at a low unemployment rate and, consequently, at a low supply on the labour market, employers are forced to increase salaries in order to cover labour demand.

Although Phillips initially examined the relationship between salary inflation and unemployment, most subsequent studies have focused on the general level of inflation, since high salaries are automatically reflected in the market prices of goods and services.

The inverse influence between unemployment and inflation was explained in the 1960s by a chain of reactions, starting from an expansionary fiscal policy. Thus, an increase in aggregate demand leads to an increase in labour demand, which will lead to a decrease in the number of unemployed people. In order to attract workforce, employers are forced to increase salaries, and the increase in salary costs will ultimately be reflected in price levels.

At the same time, the American economists Paul Samuelson and Robert Solow determined the same negative correlation between the two indicators in the USA (1960 "Analytics of Anti-Inflation Policy" in the

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American Economic Review). They are the ones who proclaim the "Phillips curve" as a regulatory tool for decision-makers in politics, and not Phillips. This is exactly what happened in the following years, the relationship between the two indicators being used by decision-makers in politics to achieve the desired levels of inflation.

However, the stability of the pattern was interrupted in the 1970s, and economists Friedman and Phelps discovered that there were several short-term Phillips curves and one long-term Phillips curve for the natural unemployment rate (NUR). Thus, in his work "The Role of Monetary Policy", Freidman shows that, in the long run, unemployment cannot be reduced by increasing inflation, through an expansionary monetary policy, because the money supply is a nominal variable, which cannot influence a real variable such as unemployment. Those who set prices and salaries consider only salaries and relative prices, i.e. real levels of these variables, influenced by inflation expectations.

The long-term relationship between inflation and unemployment is illustrated by The Friedman-Phelps Phillips Curve, which highlights the existence of a level of unemployment corresponding to the concept of price stability (NUR). Thus, in the short term, the unemployment rate may fall below the NUR, putting pressure on salaries/prices, or it may increase, leading to a reduction in inflation, but over time it will tend to what Friedman calls the "Natural Rate of Unemployment" or Phelps' long-run equilibrium rate of unemployment.

Friedman's model, was, in its turn, criticized. He considered that employees make decisions according to an expected level of prices, which is adjusted only late, as compared to the actual level. During the development period, employers increase salaries to attract workforce, but prices also increase, which actually leads to a decrease in real salaries, by decreasing the purchasing power. However, employees pay attention only to the nominal level of the salary, confusing it with the real salary. In his 1968 paper, Phelps considers that not only employees are deceived, but also employers. Together they enjoy the increase in prices in their field and the increase in production, in fact ignoring the other price increases in the economy. In such periods there is a type of unemployment determined by leaving the job, in search of a better salary. Given that all employers increase salaries, this type of unemployment has not been recorded. Therefore, in the short term, the inverse correlation between unemployment and inflation was checked, but only as long as price expectations were erroneous. Critics of the two models believe that both employees and employers have learned to shape their expectations correctly, since in all past periods, characterized by an increase in production and a decline in unemployment, there has also been an increase in inflation. (Gordon, R.J., 2018)
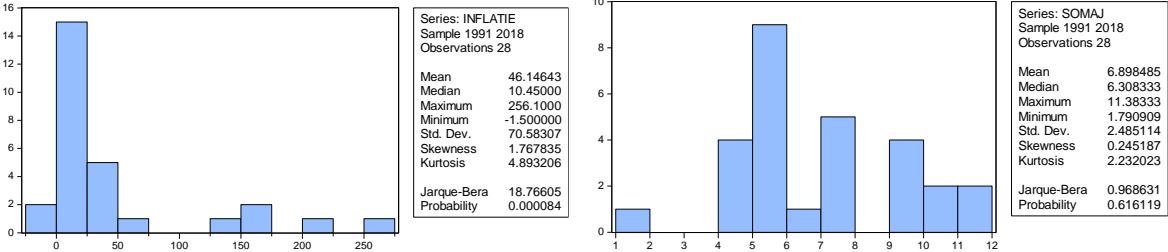
Some authors, including Robert Lucas, Thomas Sargent, and Neil Wallace, have denied the relationship described by the Phillips curve, some even considering it as being unproductive research. The statistical data from the 1970s, which revealed a positive correlation of the two macroeconomic indicators, supported this criticism.

3. Methodology
3.1. Statistical tests

Statistical tests are used in order to formulate statistical inferences, using the data series given by the selected population. The foundation of the statistical tests is the formulation of the two statistical hypotheses: the null hypothesis, which must not be rejected and the alternative hypothesis, which may indicate certain problems of the data series. Among the most important statistical indicators that should be analysed are: primary indicators: mean, median, minimum and maximum data series, indicators of variation and asymmetry: standard deviation, asymmetry index, excess or flattening, the Jarque-Bera test to verify the normal residue distribution.

Table 3. Descriptive statistics of the inflation rate and of the unemployment rate

Series: INFLATIE	
Sample 1991 2018	
Observations 28	
Mean	46.14643
Median	10.45000
Maximum	256.1000
Minimum	-1.500000
Std. Dev.	70.58307
Skewness	1.767835
Kurtosis	4.893206
Jarque-Bera	18.76605
Probability	0.000084

Series: SOMAJ	
Sample 1991 2018	
Observations 28	
Mean	6.898485
Median	6.308333
Maximum	11.38333
Minimum	1.790909
Std. Dev.	2.485114
Skewness	0.245187
Kurtosis	2.232023
Jarque-Bera	0.968631
Probability	0.616119

Source: Author's calculations

After analysing the information provided by descriptive statistics, we may assert that inflation had an average evolution of 46.14% in the period 1991-2018, being in the range of -1.5% (recorded in 2016), and 256.1% (recorded in 1993), while unemployment had an average value of 6.89%, in a range of 1.79% (1991) and 11.38% (1999). One may also notice that both inflation and the unemployment rate had a deviation from the average of 70.58%, in the case of the inflation rate and of 2.49% in the case of the unemployment rate.

The Pearson asymmetry coefficient for the inflation rate data series is 0.66 and shows that there is a positive asymmetry, i.e. low values are prevalent. For the unemployment rate data series, the Pearson asymmetry coefficient is 0.65, which indicates a prevalence of lower values. The same information is provided by the Fisher asymmetry coefficient.

The Jarque-Berra test shows the normal distribution of errors and formulates two hypotheses: the null hypothesis in which the residues have a normal distribution and the alternative hypothesis in which the residues do not have a normal distribution. After analysing the data provided by the statistical test, we can conclude that in the case of inflation we do not have a normal distribution, because the probability associated with JB statistics is lower than the significance level (α = 5%), while the unemployment rate series has a normal distribution.

3.2. Models

To analyse the relationship between the inflation rate and the unemployment rate we will use different multifactorial models, all starting from the shape of the Phillips curve. We used the standard Phillips curve with an earlier component of inflation:

$$\pi_t = c + \sum_{i=1}^{n} a_i \pi_{t-i} + \sum_{i=1}^{n} b_i u_t^i + \varepsilon_t \tag{E1}$$

where:
π_t – represents the inflation rate;
u_t – represents the unemployment rate;
ε_t – represents the random variable or model error.

The method used for predicting the parameters will be the least squares method, and the choice of the "best" prediction model will be made using the Akaike coefficient.

4. Result analysis

The analysis was performed by using annual data for a period of 28 years, starting with 1991 until 2018. Further on, we shall present the four models we analysed, in order to finally choose the model that could best predict the relationship between the two factors.

4.1. Model 1 - analysis of the relationship between the inflation rate and the value of past inflation and the unemployment rate

The first model we shall analyse is the following:

$$\pi_t = a_1 \pi_{t-1} + b_1 u_t + \varepsilon_t \tag{E2}$$

For this model, after testing all the statistical hypotheses necessary to validate the model, the following results were obtained:

Table 2. The results obtained for equation E2

Dependent Variable: INFLATION
Method: Least Squares
Sample (adjusted): 1992 2019
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFLATION(-1)	0.836332	0.134298	6.227420	0.0000
UNEMPLOYMENT	-4.138382	3.997238	-1.035310	0.3101

R-squared	0.650439	Mean dependent var	-4.482635
Adjusted R-squared	0.636995	S.D. dependent var	66.64673
S.E. of regression	40.15460	Akaike info criterion	10.29210
Sum squared resid	41922.19	Schwarz criterion	10.38726
Log likelihood	-142.0894	Hannan-Quinn criter.	10.32119
Durbin-Watson stat	1.990658		

Source: Author's calculations

Based on the information in Table 2, regarding the regression equation, we may assert the following:
- the term a_1 is 0.836332, so that at an increase in previous inflation by one unit, the current inflation would increase by 0.84 percent, with a standard error of 0.13;

- the term b1 is -4.138382, so that when the unemployment rate increases by one unit, the current inflation will decrease by 4.14 percent, with a standard error of 3.99.

At first glance, the probability that the model is correct is about 65%, this being deduced with the help of the determination coefficient (R-squared = 0.650439), so the model is plausible, i.e. inflation is explained in a percentage of 65% by the variables that are independent of the previous inflation rate (inflation at time t = -1) and the unemployment rate.

The Durbin-Watson statistical test, which shows the correlation between errors, is passed, because its calculated value is in the range in which the errors are independent and it is approximately 2 (Durbin, 1951).

Regarding the obtained parameters, they are also significant in predicting the equation. The significant variable is the previous inflation, because the calculated value of the t-Student test is higher than the tabulated one, which means that the previous inflation has an influence on the current inflation rate, while the unemployment rate does not have a very high influence on inflation.

The value of the Aikaike coefficient, which will be taken into account in choosing the best model that could be used in the forecast, is 10.29.

4.2. Model 2 – analysis of the relationship between the inflation rate and the squared unemployment rate

The second model we shall analyse is the following:

$$\pi_t = a_1 \pi_{t-1} + b_1 u_t + b_2 u_t^2 + \varepsilon_t \tag{E3}$$

For this model, after testing all the statistical hypotheses necessary to validate the model, the following results were obtained:

Table 3. The results obtained for equation E3

Dependent Variable: INFLATON
Method: Least Squares
Sample (adjusted): 1992 2019
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFLATON(-1)	0.851038	0.134241	6.339629	0.0000
UNEMPLOYMENT	5.792084	3.988043	1.452363	0.1588
SQUARE_UNEM.	-0.718557	0.487220	-1.474812	0.1527

R-squared	0.665765	Mean dependent var	40.20357
Adjusted R-squared	0.639026	S.D. dependent var	66.64673
S.E. of regression	40.04207	Akaike info criterion	10.31870
Sum squared resid	40084.19	Schwarz criterion	10.46143
Log likelihood	-141.4617	Hannan-Quinn criter.	10.36233
Durbin-Watson stat	2.050101		

Source: Author's calculations

Using the information provided by the least squares method it can be said that:
- the three parameters are statistically significant, and can be used in future model analysis;
- the model is approximately 67% significant and, given that the adjusted value of the determination coefficient is also close to the value of the determination coefficient, it can be said that the equation is representative for rendering of reality;
- the errors are independent, because the value of the Durbin Watson coefficient is close to 2;
- the Akaike coefficient has the value 10.32.

4.3. Model 3 – analysis of the relationship between the inflation rate and the previous values of the inflation rate and the unemployment rate

The third model we shall analyse is the following:

$$\pi_t = a_1 \pi_{t-1} + a_2 \pi_{t-2} + b_1 u_t + \varepsilon_t \tag{E4}$$

For this model, after testing all the statistical hypotheses necessary to validate the model, the following results were obtained:

Table 4. The results obtained for equation E4

Dependent Variable: INFLATIE
Method: Least Squares
Sample (adjusted): 1993 2019
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INFLATION(-1)	0.735584	0.188143	3.909699	0.0007
INFLATION(-2)	-0.103440	0.183210	-0.564601	0.5776
UNEMPLOYMENT	1.138026	1.475911	0.771067	0.4482

R-squared	0.600957	Mean dependent var	33.90000
Adjusted R-squared	0.567703	S.D. dependent var	58.79840
S.E. of regression	38.65952	Akaike info criterion	10.25190
Sum squared resid	35869.41	Schwarz criterion	10.39588
Log likelihood	-135.4007	Hannan-Quinn criter.	10.29472
Durbin-Watson stat	2.131123		

Source: Author's calculations

Analysing the data obtained by applying the least squares method, the following conclusion can be drawn:
- at an increase by one unit of previous inflation, the inflation rate will increase by 0.74 percent, while an increase by one unit of inflation from two years ago will cause a decrease of 0.10 percent of current inflation. An increase in unemployment will lead to an increase in inflation by 1.16 percent;
- the model is significant in a percentage of almost 60% and the parameters are significant;
- the errors are independent, this being demonstrated by the Durbin Watson coefficient;
- the Akaike coefficient has the value 10.25.

4.4. Model 4 – analysis of the relationship between the inflation rate and the previous values of the inflation rate and the squared unemployment rate

The fourth model we shall analyse is the following::

$$\pi_t = a_1\pi_{t-1} + a_2\pi_{t-2} + b_1u_t + b_2u_t^2 + \varepsilon_t \qquad (E5)$$

For this model, after testing all the statistical hypotheses necessary to validate the model, the following results were obtained:

Table 5. The results obtained for equation E5

Dependent Variable: INFLATION
Method: Least Squares
Sample (adjusted): 1993 2019
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RI	0.752212	0.193820	3.880987	0.0008
R_I	-0.066565	0.199454	-0.333738	0.7416
UNEMPLOYMENT	3.175906	4.241309	0.748803	0.4616
UNEMPLOYM.D	-0.288146	0.560992	-0.513637	0.6124

R-squared	0.605482	Mean dependent var	33.90000
Adjusted R-squared	0.554023	S.D. dependent var	58.79840
S.E. of regression	39.26644	Akaike info criterion	10.31457
Sum squared resid	35462.63	Schwarz criterion	10.50655
Log likelihood	-135.2467	Hannan-Quinn criter.	10.37166
Durbin-Watson stat	2.130992		

Source: Author's calculations

After verifying the statistical hypotheses and fulfilling them, the last model presented can be accepted in a percentage of 61%, and all the predicted parameters are significant. The Akakike coefficient has the value 10.31.

After verifying the four models proposed by us, we will centralize the data in order to choose the model that would best present the relationship between the current inflation rate and the previous inflation and unemployment, using the Phillips curve.

Table 6. Centralization of results for the four equations

Criterion / Equation	Equation 1	Equation 2	Equation 3	Equation 4
Coefficient of determination	65.04%	66.57%	60.09%	60.54%
The Akaike coefficient	10.29	10.31	10.25	10.31

By analysing table 6, we notice that all the predicted models have a probability of acceptance of over 60%, but by analysing the Akaike coefficient, its lowest value is that of the E3 equation, although the differences between the coefficients of the other models are not very large.

In conclusion, the equation we can use in predicting the relationship between inflation and unemployment, with the help of the Phillips curve, is equation E3, of the form:

$$\pi_t = a_1 \pi_{t-1} + a_2 \pi_{t-2} + b_1 u_t + \varepsilon_t$$

5. Conclusions

Economists' views on the importance of the Phillips curve, expressed over time, have been divided. Although controversial, the Phillips curve continues to be an important macroeconomic tool and, in particular, the subject of many empirical studies: "The Phillips curve is the connective tissue between the Federal Reserve's dual mandate goals of maximum employment and price stability. Despite regular declarations of its demise, the Phillips curve has endured. It is useful, both as an empirical basis for forecasting and for monetary policy analysis".(Williams J.C., 2019)

Jerome H. Powell în his speech from 2018, at the 60th Annual Meeting of the National Association for Business Economics, Boston, Massachusetts had a more reserved approach: "At the risk of spoiling the surprise, I do not see it as likely that the Phillips curve is dead, or that it will soon exact revenge. What is more likely, in my view, is that many factors, including better conduct of monetary policy over the past few decades, have greatly reduced, but not eliminated, the effects that tight labor markets have on inflation."

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