APPLICATION OF THE PHILLIPS CURVE TO STUDY THE RELATIONSHIP BETWEEN UNEMPLOYMENT AND WAGE GROWTH IN BULGARIA

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Abstract: Phillips's study of wage inflation and unemployment in the United Kingdom from 1861 to 1957 is a milestone in the development of macroeconomics. Phillips found a consistent inverse relationship: when unemployment was high, wages increased slowly; when unemployment was low, wages rose rapidly. In this work the relationship between unemployment and wage growth in Bulgaria is studied. For this purpose, a quarterly data from the period 2016-2020 from the National Statistical Institute (NSI) is used. The data is analysed using the Phillips curve, which represents the average relationship between unemployment and wage behaviour over the business cycle. A correlation analysis is made. A reciprocal model was built, which is analysed for adequacy, significance of the coefficients and normality of the residuals.

Keywords: Phillips curve, Reciprocal Model, Inverse Model, Unemployment Analysis, Wage Growth

INTRODUCTION

Unemployment rate and wage growth rate are important elements of the economic in one country, because the taxes deducted from the salaries are the main income in the country's budget. As high are the incomes from the salaries as stable and strong is the management of one country. Big salaries bring big incomes as taxes to the country. In another hand the unemployment is expense because the country must benefit the unemployed citizens until they signed contract. As much unemployed individuals there are as many expenses there are for the country. Therefore, in the economy it is important to regulate the level of unemployment and the level of wage growth, and for this purpose it is good to study the relationship between them with the help of a mathematical instruments.

Such an instrument is offered by A. U. H. Phillips. He studied a curve that represents the relationship between the level of inflation / change in wages and the level of unemployment. Although it had predecessors, Phillips' study of the relationship between wage growth and unemployment in the United Kingdom from 1861-1957 was an important moment in the development of macroeconomics. The analysis of the British economy, made by Philips, shows that when the price level rises by 1 percentage point, the unemployment rate decreases by 2 percentage points. This conclusion led economists to believe that the reduction of unemployment could be achieved at a relatively low rate of inflation - a situation that is called inflationary compromise theory [1].

In his research, Phillips found a constant inverse relationship: when unemployment is high, wages rise slowly, and conversely, when unemployment is low, wages rise dramatically. Phillips suggests that the lower the unemployment rate, the fewer unemployed there are in the labor market, and hence the faster companies need to raise wages to attract scarce free labor. With high unemployment levels, tensions decrease. The Phillips curve represents the average relationship between unemployment and wage behavior in the business cycle. It indicates the level of salary

increase that will occur if a certain level of unemployment is maintained for a certain time. Price inflation is more closely linked to unemployment than wage increases. Of course, the prices a company pays are directly related to the salaries it pays.

The data in this study is from the National Statistical Institute (NSI). It includes the quarterly change in percentages of the average gross monthly wage of employees (by employment and service) and the total unemployment rate (at 15 and over years of age) by quarters in percentages in Bulgaria for the period 2016-2020.

EXPOSITION

In the third quarter of 2020, the number of employees decreased by 3.8% on an annual basis [2]. The relative share of employed persons in the population aged 15 and over is 53.5%, as for men this share is 59.9%, and for women - 47.6%. The total number of employed persons aged 15 and over is 3.173 million (1.70 million men and 1.47 million women), according to the NSI.

Unemployment in Bulgaria in the third quarter rose to 4.8% (5.3% for men and 4.2% for women, respectively). In one year, the unemployment rate increased by 1.1 percentage points, while the growth of men and women was 1.5 and 0.8 percentage points, respectively. In the third quarter of 2020 the number of unemployed in Bulgaria reached 160.4 thousand, of which 95.4 thousand (59.5%) were men and 65.0 thousand (40.5%) - women.

The indicator growth is due to the increased number of unemployed with a duration of unemployment of up to one year. During this period, it increased by 41.6 thousand and reached 88.6 thousand - more than half of the total number of unemployed [2]. Long-term unemployed (for one or more years) are 71.7 thousand, or 44.7% of all unemployed persons. The long-term unemployment rate decreased by 0.1 percentage points to 2.2% (2.4% for men and 1.9% for women). Of the total number of unemployed, 31.1 thousand, or 19.4%, are looking for their first job.

In the third quarter of 2020, the economically inactive persons (persons outside the labor force) aged 15 - 64 years were 1.183 million, of which 496 thousand (41.9%) were men and 686.7 thousand %) women [3]. The share of economically inactive people in this age group is 26.8%, respectively 22.2% of men and 31.5% of women.
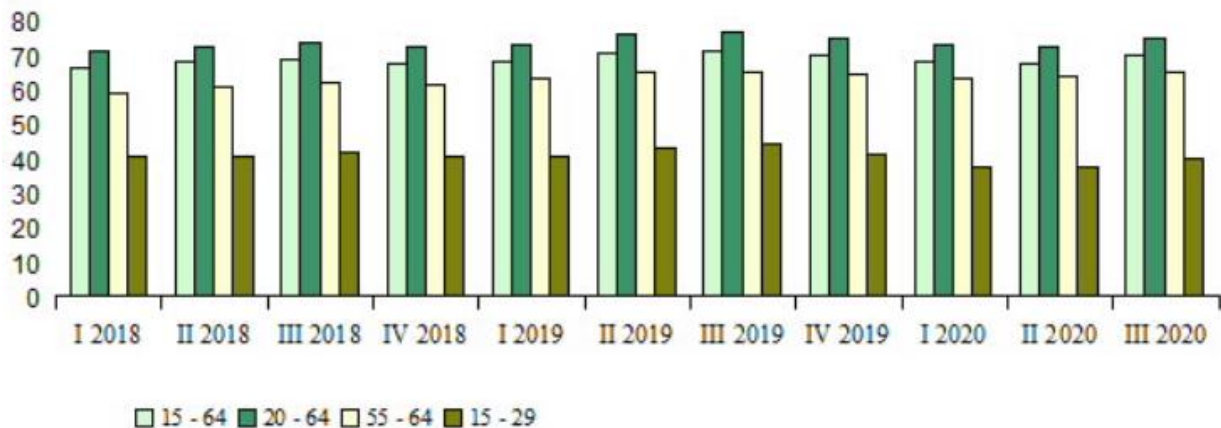

Figure1. Employment rates by age groups and quarters, NSI

Figure 1 shows how the employment rates in Bulgaria change, calculated by age groups on a quarterly basis for the period 2018-2020.

Phillips curve

Phillips curve essentially represents the reciprocal regression model:

$$Y_i = \beta_1 + \beta_2 \left(\frac{1}{X_i}\right) + u_i$$

This model has the following property: when X tends to infinity, then $\beta_2(1/X)$ will tend to zero, and Y will tend to its asymptotic value β_1 [4]. Therefore, with the help of reciprocal models we can obtain the asymptotic value of the dependent variable Y with unlimited increase of the independent variable X.
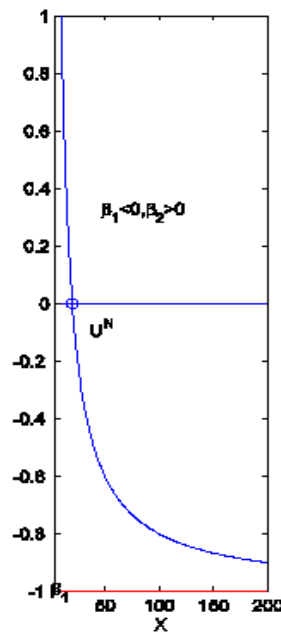

Figure 2. Phillips curve for United Kingdom (1950-1966)

Figure 2 shows the Phillips curve where the dependent variable Y is the percentage increase in wage growth and the factor variable X is the percentage unemployment rate. The figure shows that the left side of the Phillips curve is characterized by low unemployment and high wage growth. Small changes in unemployment lead to significant changes in the growth rate of wages. The right part of the curve is characterized by high unemployment and low wage growth.

Figure 2 shows the asymmetry between wage growth and unemployment. Wages rise faster than the change in unemployment if the unemployment rate is below $U^N = \beta_2/\beta_1$ [4]. This level is called by economists the natural rate of unemployment. When the unemployment rate exceeds the natural rate, then wages fall more or less at the same rate of rising unemployment.
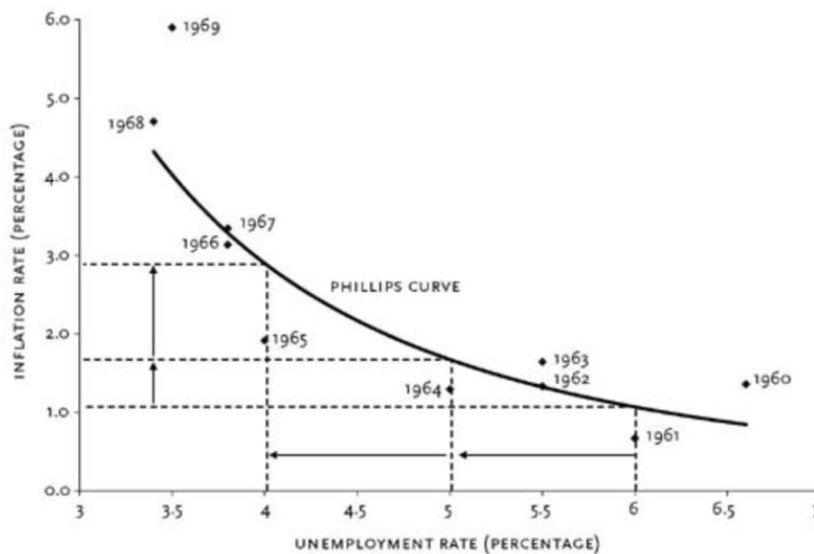

Figure 3. Phillips curve for United States (1961-1969)

Figure 3 shows the most common Phillips curve described by data for the United States from 1961 to 1969 [5]. The Phillips curve can be treated as a menu of policy options. For example, if we have unemployment at 6%, the government can stimulate the economy to reduce these rates to 5. Figure 2 shows in conditions of higher inflation that this would be at the expense of less than half a percent. But if the government initially faces lower unemployment rates, reducing it would be at a much higher cost: reducing unemployment from 5 to 4 percent would cause more than a double increase in inflation to about 1.25%.

At the point where the Phillips curve intersects the abscissa, the expected inflation is always zero. Phillips analysed Britain's national economy in the 1950s, then concluded that when the unemployment rate was 2.5%, inflation at that time was zero.

Empirical Research

For the purposes of the study, the quarterly percentage increase of the average gross monthly salary of employees in Bulgaria for the period 2016-2020 (Y) was calculated, based on the average gross monthly salary from the first quarter of 2016. For this purpose, NSI data on the average gross monthly wages and salaries of employees in the country for the period under review were used. The connection of this growth with the total unemployment rate (at 15 and over years of age) by quarters in percentages in Bulgaria for the period 2016-2020 (X) is considered. Using SPSS, a correlation analysis was performed based on the data from the sample, on the basis of which a reciprocal model was built. The model was checked for adequacy and significance of the coefficients, as well as for normality of the residuals.

A check for the normality of the variables was made, which showed that the empirical distribution of X and Y in the sample follows the theoretical normal distribution.

Table 1. Correlation matrix

		X – Unemployment (%)	Y - Wage Growth (%)
X - Unemployment (%)	Pearson Correlation	1	-0.782
	Sig. (2-tailed)		0.000
	N	20	20
Y - Wage Growth (%)	Pearson Correlation	-0.782	1
	Sig. (2-tailed)	0.00	
	N	20	20

Table 1 shows that Pearson's correlation coefficient for the relationship between the unemployment rate (X) and the quarterly wage growth (Y) is -0.782. It is significant at a significance level of 0.05. The sign of the correlation coefficient is negative. This means that as unemployment increases, the percentage increase in wages can be expected to decrease.

Table 2. Common statistics for the model

R	R Square	Adjusted R Square	Std. Error of the Estimates
0.746	0.556	0.531	11.818

Table 2 shows that the coefficient of determination for the model (Adjusted R Square) is 0.531, which shows that 53.1% of the change in wage growth (Y) is determined by a change in the unemployment rate (X).

Table 3. ANOVA Table

	Sum of Squares	df	Mean Square	F	Sig
Regression	3148.317	1	3148.317	22.541	0.000
Residual	2514.085	18	139.671		
Total	5662.402	19			

The adequacy of the regression model can be checked from Table 3. Sig. = 0.000 < α = 0.05, which means that the null hypothesis is rejected, i.e. the reciprocal model is adequate to the existing significant relationship between the unemployment rate (X) and the percentage quarterly increase in gross wages (Y).

Table 4. Coefiecients of the model

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
1/X-Unemployment (%)	320.542	67.515	0.746	4.748	0.000
(constant)	-33.923	12.760		-2.659	0.016

From Table 4 we can see:

$\widehat{\beta_2} = 320.542 \; and \; \widehat{\beta_1} = -33.923$

$\sigma_{\widehat{\beta}_2} = 67.515 \; and \; \sigma_{\widehat{\beta}_1} = 12.760$

$t_{\widehat{\beta}_2} = 4.748 \; and \; t_{\widehat{\beta}_1} = -2.659$

From Table 4 we can form the line of regression:

$$\hat{Y}_i = \hat{\beta}_1 + \hat{\beta}_2 \frac{1}{X_i} = -33.923 + 320.542 \frac{1}{X_i}$$

From Table 4 the significance of the regression coefficients can be checked. For β1 we have that Sig. = 0.000 < α = 0.05, which means that the null hypothesis is rejected, ie. β1 is statistically significant. For β2 we have that Sig. = 0.016 < α = 0.05, which means that the null hypothesis is rejected, ie. β2 is statistically significant.
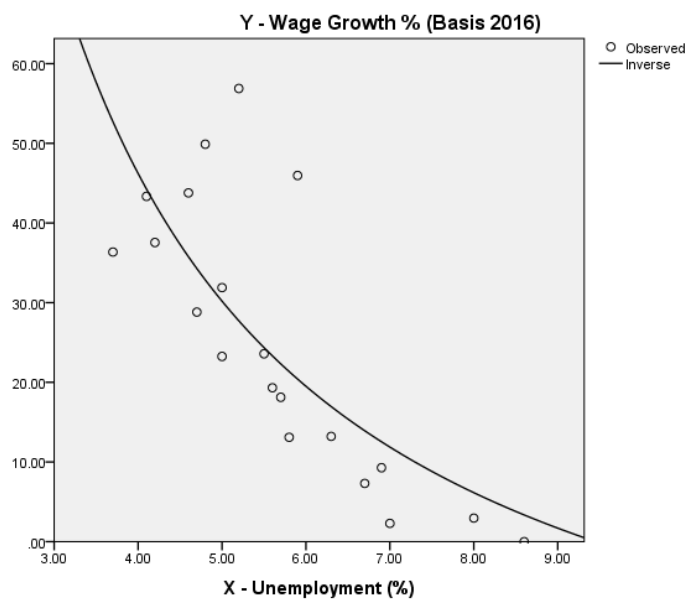

Figure 4. Reciprocial model

Figure 4 shows that the reciprocal model describes the data quite well.

A check was made for normal distribution of residuals. It shows that the empirical distribution of errors does not follow the theoretical normal distribution (with P>99%). It follows that one of the conditions of the Classical Normal Linear Regression Model is violated and in small samples the obtained model should be considered with some dose of doubt.

Note: Initially, a reciprocal model for wage growth on a dynamic basis was considered. However, the correlation of this growth with the unemployment rate for the sample is insignificant, the model is not adequate and this necessitated the use of a static basis (as of the first quarter of 2016).

The natural rate of unemployment in wage growth, calculated on a dynamic basis, is calculated as follows:

$$U^N = -\frac{\beta_2}{\beta_1}$$

In this case on a static basis was calculated as follow:

$$-\frac{\beta_2}{\beta_1} = \frac{320.542}{33.923} = 9.45\% -$$

This shows that on a static basis, the average gross wage grows faster than the change in total unemployment if the unemployment rate is below 9.45%. When the unemployment rate exceeds 9.45%, then the average gross wage decreases at about the same rate of increase in total unemployment. In the sample, the unemployment rate for the quarters of 2016-2020 is below 9%, which shows that the average gross wage is growing faster than the change in unemployment.

CONCLUSION

This paper studies the Phillips curve and its application in examining the relationship between the total unemployment rate (at 15 and older) by quarters in percentages and the quarterly change in percentages of the average gross monthly salary of employees (by employment and service). in Bulgaria for the period 2016-2020.

1. A correlation analysis is made on the basis of which a reciprocal regression model is built, which is adequate and describes the data well. The regression coefficients are statistically significant at a significance level of 5%.
2. A check was made for the normality of the residuals and it was found that they were not normally distributed. It follows that in small samples the resulting model must be considered with some dose of doubt.
3. Based on the obtained model, it was found that the average gross wage grows faster than the change in total unemployment if the unemployment rate is below 9.45%. When the unemployment rate exceeds 9.45%, then the average gross wage decreases at about the same rate of increase in total unemployment.
4. In the sample, the unemployment rate for the quarters of 2016-2020 is below 9%, which shows that the average gross wage is growing faster than the change in unemployment.

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