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Can the Phillips curve be applied in selected European countries today?

Да ли се Филипсова крива може применити у одабраним европским земљама данас?

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Abstract: The Phillips curve is one of the most important economic postulates, which indicates inversion between inflation rate and unemployment rate. Even though it has been empirically confirmed many times, in past research there has been evidence of rejecting it in some countries. The aim of this research is to analyse whether the Phillips curve exists in selected European countries: Bulgaria, Greece, Slovenia and Romania, during time period Q1 2009–Q3 2021 and to conclude if there are any differences between countries that are using Euro as national currency and those that are not. Panel analysis and choosing the appropriate model has led to the conclusion that there is a statistically significant inverse correlation between these two variables, which confirmed the presence of the Phillips curve. When analysing countries separately, results differ between them – the strongest inverse correlation is present in Greece and it is followed by Bulgaria. In Slovenia, correlation is slightly negative and in Romania slightly positive, pointing to the conclusion that correlation in these two countries is so weak, that it can be considered that it does not exist. Since obtained results differ between observed countries, this makes correlation between inflation rate and unemployment rate an important indicator for policy makers of individual countries to take into consideration when making decisions for future economic policy.
Keywords: the Phillips curve, inflation rate, unemployment rate
JEL classification: E00, E24, E52, E60, C33, J64

Сажетак: Филипсова крива је један од најзначајнијих економских постулата, који указује на инверзију између стопе инфлације и стопе незапослености. Иако је много пута била емпиријски потврђена, у спроведеним истраживањима се појављују и докази о њеном одбацивању у појединим земљама. Циљ овог истраживања је анализирати да ли Филипсова крива постоји у одабраним европским земљама: Бугарској, Грчкој, Словенији и Румунији, у периоду од К1 2009 до К3 2021 и утврдити да ли постоје значајне разлике између земаља које користе евро као националну валуту и оних које не користе. Панел анализа и избор одговарајућег модела су довели до закључка да постоји статистички значајан инверзан однос између ове две варијабле, што потврђује присуство Филипсове криве. Када се државе анализирају појединачно, резултати се разликују међу њима – најјача инверзна корелација је присутна у Грчкој, коју прати Бугарска. У Словенији је корелација једва негативна, док је у Румунији једва позитивна, што указује да је корелација у ове две државе толико слаба, да се може сматрати да не постоји. Пошто се добијени резултати разликују између посматраних земаља, корелација између стопе инфлације и стопе незапослености је важан индикатор за креаторе економске политике и мора се узети у обзир приликом доношења одлика о будућој економској политици појединачних земаља.
Кључне речи: Филипсова крива, стопа инфлације, стопа незапослености
ЈЕЛ класификација: E00, E24, E52, E60, C33, J64

Introduction

Inflation rate and unemployment rate are known to be important macroeconomic indicators, regardless of the development level of the country or observed time frame. They are strongly connected and influence one another; therefore, they should be considered seriously when making decisions for short-term or long-term economic policy directions.

The postulate which connects inflation rate and unemployment rate is known as the Phillips curve, which indicates negative correlation between these two variables. In the past, there has been numerous studies which have confirmed the existence of the Phillips curve, but on the other hand, it has been empirically rejected in some of them.

The aim of this research is to validate the existence of the Phillips curve in 4 selected European countries: Bulgaria, Greece, Slovenia and Romania during Q1 2009-Q3 2021. These four countries have been selected since all of them are members of the European Union and belong to Balkan countries. Greece and Slovenia use euro as national currency, whereas Romania and Bulgaria use Romanian lei and Bulgarian lev, so the aim is to determine whether there is a difference in correlation between inflation rate and unemployment rate between countries that are using euro as national currency and those that are not.

This paper is divided into 5 parts: the theoretical background of the Phillips curve and previously conducted research analysing the existence of Phillips curve or correlation between inflation rate and unemployment rate are presented in the first part. The second part of the paper presents the data source and methodology of this research. The third part presents empirical data for 4 analysed countries for 2 analysed macroeconomic variables, descriptive statistics and tests obtained for checking existence of normality, heteroscedasticity, autocorrelation and multicollinearity. Fourth part of the paper is panel analysis and choosing of the correct model from OLS, Fixed Effects Model and Random Effects Model. Discussion of results is presented in part 5 of this paper.

1. Theoretical background

Unemployment is one of the most important issues that countries can face. Developed countries are affected by this problem the same way as emerging and poor countries. Unemployment can be defined as a state where the working age population has no job and they are actively searching for one (Chowdhury & Hossain, 2014).

According to McConell, Brue & Flynn (2009), inflation is a rise in general level of prices, which leads to decrease in purchasing power. The main measure of inflation is CPI (Consumer Price Index), which represents the market basket for typical consumers. According to Mishkin, CPI is calculated based on the group of prices of listed goods and services that are used by an average household (Mishkin, 2016).

Correlation between inflation rate and unemployment rate is explained by the Phillips curve. As a theoretical concept, Phillips curve was presented in 1958, when Alban Phillips published a paper in *Economica* where he pointed to indirect correlation between

unemployment rate and wages inflation in United Kingdom. He observed the following periods separately: 1861-1913, 1913-1948 and 1948-1957. The hypothesis that was tested and later confirmed indicated that in a year with high economic output and rising business activity, the demand for labour would increase and both employees and employers would bid on higher wages, compared to years with low unemployment rate, but with labour demand which is not increasing and *vice versa*. In other words, in years with increasing employment, since the demand for labour is high, wages would be defined on a higher level compared to periods with increasing unemployment rate, where labour force would even lower their wages expectations (Phillips, 1958).

Study performed by Phillips has faced some empirically based criticism, but nevertheless, this has remained one of the most important postulates in economics theory. However, after the 2008 financial crisis, the Phillips curve did not apply any longer in many countries, since unemployment rate increased, and this was not followed by expected inflation rate decrease. Even though it has been researched many times, the Phillips curve is not applicable to all countries and all time periods. Statistical relationship that appears strong during one decade or country, may be weak during the next one or in another country (Sovbetov & Kaplan, 2019).

Bulligan & Viviano (2017) presented correlation between unemployment rate and annual nominal wage growth in the euro area in the period Q1 1999–Q4 2015. The OLS model that corresponds points to the conclusion that coefficient on unemployment rate is statistically significant and -0.25 (analysed model was $\Delta w_t = c + \beta \Delta w_{t-1} + \gamma U_t + \varepsilon_t$, where Δw_t is y-o-y nominal hourly wage growth in private sector and U_t = unemployment rate). This model has been estimated first for the period Q1 1999-Q4 2007, and later, one by one observation has been added until Q4 2015. Results point to negative, but unstable correlation between unemployment rate and inflation rate. After the euro area analysis, authors referred to Italy, Germany, France and Spain, and concluded the following: pattern of unemployment and inflation rate correlation closely resembles to the one of Germany until 2012; the correlation became more negative in Italy and less negative in Germany during the time, in Spain it reached its peak in 2010, after which decline followed and in France, the correlation moved from being positive to negligible. The same conclusion was obtained by Hindrayanto, Samarina & Stanga (2019), who tested the existence of Phillips curve in the euro area and its five strongest economies (Germany, France, Italy, Spain and Netherlands) - negative correlation between unemployment rate and inflation rate was present in all five economies and the euro area during 1985-2017.

Shaari et al. (2018) used simple panel regression ($IR_t=\beta_1+\beta_2 UR_{t-1}+\varepsilon_t$) to test the existence of Phillips curve in 10 high-income countries during 1990-2014. FMOLS test was used and obtained results are statistically significant and point to negative correlation between unemployment rate and inflation rate. DiNardo & Moore (1999) tested the presence of the Phillips curve's presence in 9 OECD countries with simple OLS equation: $\pi_t^j = \alpha_j + \beta U^j_{t-1}$, where π stands for inflation, U unemployment rate, j represents the country and t the quarter. The following countries were examined: Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, the United Kingdom and the United States during

Q2 1970–Q1 1996. The OLS point estimate of the coefficient on unemployment is: -0.82 for the whole sample; -0.13 for period before 1983 and -0.42 for period after 1982. Coefficient of determination is 34%, 26% and 34% respectively.

Ho & Njindan Iyke (2018) tested the existence of Phillips curve in 11 Eurozone countries from January 1999 to February 2017 (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxemburg, Netherlands, Portugal and Spain). Obtained results pointed to different conclusions depending on unemployment rate – correlation between inflation and unemployment rate is negative when unemployment rate is lower than 5%. When the unemployment rate is within the range 5-6.54%, correlation becomes positive. Once the unemployment rate exceeds 6.54%, there is no correlation between inflation and unemployment rate. Sovbetov & Kaplan (2019) researched the existence of the Phillips curve in 41 countries for period 1980-2016, and they have confirmed that relationship between these two variables differs over time: the Phillips curve is more present in developed countries than in emerging countries; but the Phillips curve relationship is not applicable during periods of recession, even for developed countries.

McLeay & Tenreyro (2020) analysed US CPI inflation and unemployment gap (provided by Congressional Budget Office estimate) during Q1 1957-Q2 2018. The OLS model which was analysed points to slightly negative correlation between these two variables. Data was divided into 6 periods which were analysed separately: (1) Q1 1957-Q2 1971: negative correlation; (2) Q3 1971-Q4 1980: slightly positive correlation, affected by large cost shocks due to the oil disruption; (3) Q1 1981-Q4 1983: negative correlation; (4) Q1 1984-Q4 1988: correlation between inflation rate and unemployment gap was close to zero; (5) Q1 1989-Q2 2007: slightly positive correlation; (6) Q3 2007-Q2 2018: slightly negative correlation.

Hooper, Mishkin & Sufi (2019) tested correlation between inflation rate (nominal wage inflation) and unemployment rate in all 50 US states and the District of Columbia, from 1981 to 2017. The estimated coefficient on the unemployment rate is negative and it is -0.41. Results point to the conclusion that a state with a negative deviation from its normal unemployment rate has a larger than average increase of nominal wage inflation. Osadcha (2014) examined the existence of Phillips curve in the US based on state-level data during 1976-2007. Time series models which were conducted are OLS Model, Fixed and Random Effects Models. Majority of states showed a negative relationship between current unemployment rate and the future inflation rate (28 states out of 50) and on national level, existence of the Phillips curve has been empirically confirmed with high level of significance.

Milenković et al. (2020) researched impact that independent variables gross domestic product, government expenditures, unemployment, real interest rate, savings and value-added tax have on inflation rate in following Balkan countries: Albania, Bosnia and Herzegovina, Croatia, Montenegro, North Macedonia, Serbia and Slovenia from 2008-2016. Results showed that GDP and government expenditure have a positive impact on inflation rate, whereas unemployment, real interest rate, savings and VAT have negative effects on inflation. Impact of GDP, unemployment rate and VAT is statistically significant,

which is not the case with other variables. Furtula, Durkalić & Simionescu (2018) confirmed low and positive correlation between inflation rate and unemployment rate in Serbia and Romania by using Bayesian linear regression models.

Positive, but insignificant relationship between inflation and unemployment rate was confirmed in Romania during the period 1990-2009 (Herman, 2010), which has pointed out that the Phillips curve cannot be applied in Romania in the long run (20 years as subject of analysis). The same conclusion has been reached by Melian (2021) during 1991-2013.

Ciupac-Ulici & Beju (2014) tested the existence of the Phillips curve in some Eastern European countries during the period January 1998–May 2013 and negative correlation was present in the Czech Republic, Poland, Romania and Slovakia, which was not the case with Hungary and Slovenia. For two countries which showed positive correlation, the authors introduced a dummy variable to present the appearance of financial crisis and these results showed that the correlation before the crisis was negative, whereas and after the crisis it is positive.

Karahan, Çolak & Bölükbaşı (2012) confirmed negative correlation between unemployment rate and inflation rate when investigating impact unemployment rate has on inflation rate in Turkey (data analysed on monthly basis from January 2006-October 2011) - ARDL results point to negative relationship between these variables in the short run and absence of causation in the long run.

2. Data and methodology

The analysis in this research was conducted in order to validate inverse correlation between inflation rate and unemployment rate in Bulgaria, Greece, Slovenia and Romania. These two macroeconomic variables were analysed on a quarterly level during Q1 2009–Q3 2021. The number of observations was 51 for each country and 204 in total.

Data source for inflation rate was Bank for International Settlements (BIS bank) and analysed inflation rate was measured by Consumer Price Index (CPI). Unemployment rate was analysed in percentages and calculated based on unemployment between 15 and 74 years. Unemployment rate data was obtained by Eurostat.

Methodology of this research contains presenting and comparing empirical data for analysed 4 countries, descriptive statistics, testing existence of normality, heteroscedasticity, autocorrelation and multicollinearity, panel analysis and graphic presentation of correlation between these 2 variables. Panel analysis consists of Ordinary Least Squares Model (OLS Model), Fixed Effects Model (FE Model) and Random Effects Model (RE Model). For conducting econometric analysis, software that was used is STATA and data was analysed on significance level of 5%.

The analysed model can be defined as:

$$Yit = \alpha + \beta xit + \mu it$$

Where Y stands for dependent variable inflation rate, α is constant, β is coefficient of independent variable unemployment rate, μ is residual, i represents the number of countries which were part of the analysis (i=4), t=time frame of analysis (Q1 2009–Q3 2021).

Two hypotheses are defined and tested in this paper:

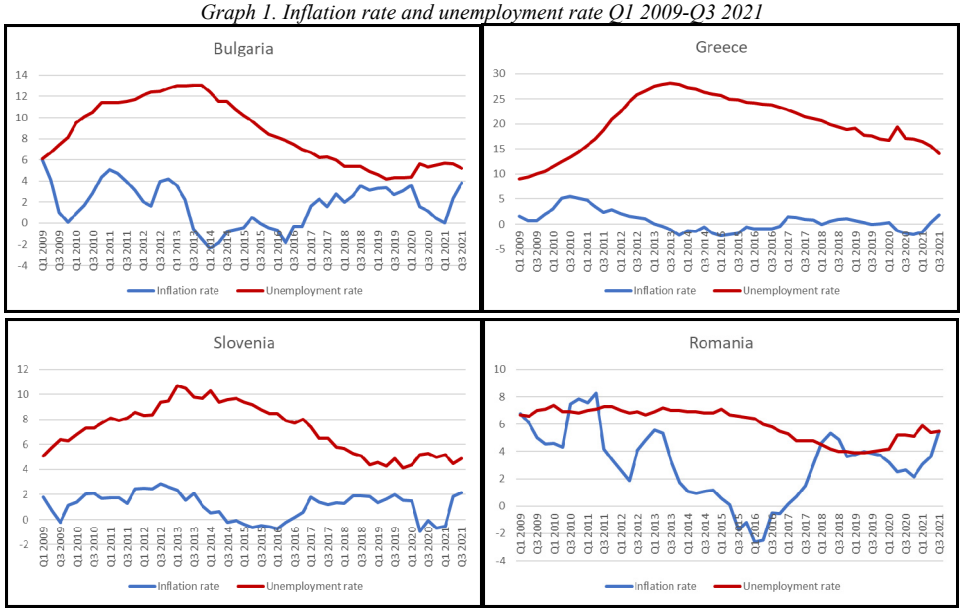
Hypothesis 1: Phillips curve, which points to inverse correlation between inflation rate and unemployment rate, can be applied in Bulgaria, Greece, Slovenia and Romania during the period Q1 2009-Q3 2021.

Hypothesis 2: Existence of the Phillips curve differs between countries that are using Euro and other currencies as national currency.

3. Inflation rate and unemployment rate in selected countries – empirical data

In order to determine the existence of Phillips curve in selected Balkan countries, unemployment rate and inflation rate were analysed quarterly, in order to get more insight on movement of these macroeconomics variables during a year. Inflation rate and unemployment rate for Bulgaria, Greece, Slovenia and Romania from Q1 2009-Q3 2021 are presented in Graph 1.

Graph 1. Inflation rate and unemployment rate Q1 2009-Q3 2021



Source: the author's calculation based on BIS bank and Eurostat data

When analysing empirical data for inflation and unemployment rate, results point to highest (8.27% in Q2 2011) and lowest recorded inflation rate in Romania (-2.62% in Q1 2016), which means that Romania had the largest deviations when it comes to inflation rate during the observed period. For the unemployment rate, the highest rate was recorded in Greece (28.10% in Q3 2013), whereas the lowest was noted in Romania (3.9% in Q1 2019 and Q2 2019). When it comes to comparing average data for all 4 countries for both inflation and unemployment rate, the highest average inflation rate was in Romania (3.08%) and the lowest in Greece (0.54%), whereas Greece (20.2%) noted the highest average unemployment rate and Romania (6.01%) the lowest.

Another thing which can be noticed is the rise in inflation rate in the last 3 quarters of 2021, which is a product of consequences corona virus has left on the world economy – rise in prices of energy sources, oil, higher demand, delayed cross-border transport etc.

When European Zone (EZ) countries are divided into the core and the periphery countries, they can be observed as developed European countries, older EZ countries which joined the monetary union during 1999/2001 (EZ12) and newer members which have joined after 2007 (EZ19). The unemployment rate during 2007-2018 has been the highest in EZ12 countries and is followed by EZ19 and core EZ countries (Beker-Pucar & Glavaški, 2020). These results are in accordance with analysed data in this paper, since Greece is part of the EZ12 countries and has the highest unemployment rate and Slovenia is part of EZ19 and unemployment rate is on a lower level.

The inverse movement of these two indicators can be noticed in the graphic overview – when inflation rate increases, unemployment rate decreases and *vice versa*. Depending on the country, this regularity is more or less noticeable, but the Phillips curve cannot be confirmed or rejected just by looking at graphic overview – econometric analysis is conducted, which will lead to confirmation or rejection of Hypothesis 1.

Table 1 and Table 2 present descriptive statistics (both basic and more detailed) for analysed 4 variables: Countries, Quarters, Inflation rate (dependent variable) and Unemployment rate (independent variable). Besides the total number of observations, which is 204 (51 observed quarters for 4 countries), the basic descriptive statistics presents mean, standard deviation, minimum and maximum for each of these variables. Apart from these indicators, dependent and independent variables are analysed *"overall"* (considering all data), *"between"* (considering data between different countries) and *"within"* (considering data for analysed period, not considering different countries). For inflation rate, *"within"* standard deviation is higher than *"between"*, meaning that differences are more significant within the analysed period, which is not the case with unemployment rate, where higher importance is given to differences between countries. In Table 2, results for the number of observations, analysed countries and analysed time frame (number of observed quarters) are presented in absolute numbers, whereas the remaining data is presented in percentage.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Country	204	2,5	1,120784	1	4
Quarter	204	26	14,75581	1	51
Inflation rate	204	1.616765	2.20183	-2.62	8.27
Unemployment rate	204	10.47598	6.574444	3.9	28.1

Source: the author's calculation in STATA

Table 2. Detailed descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
Inflation rate	Overall	1.616765	2.20183	-2.62	8.27	N=204
	Between		1.0935	.5376471	3.080784	n=4
	Within		1.986664	-4.08402	6.80598	T=51
Unemployment rate	Overall	10.47598	6.574444	3.9	28.1	N=204
	Between		6.561063	6.007843	20.2	n=4
	Within		3.283079	-.6240196	18.37598	T=51

Source: the author's calculation in STATA

Before starting the panel analysis, the following tests were completed to determine presence or absence of:

1. normality – Skewness/Kurtosis test
2. heteroscedasticity – White's test
3. multicollinearity – VIF test
4. autocorrelation – Durbin-Watson test

The observed data is not normally distributed, since Skewness/Kurtosis test indicates p=0.0000 (Table 3).

Table 3. Skewness/Kurtosis test – testing normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	ajd chi2(2)	Prob>chi2
residuals	204	0.0000	0.1135	32.04	0.0000

Source: the author's calculation in STATA

When it comes to testing heteroscedasticity, using White's test has proven the presence of heteroscedasticity – p-value is lower than 0.05 (Table 4).

Table 4. White's test – testing heteroscedasticity

White's test for Ho: homoskedasticity			
Against Ha: unrestricted heteroskedasticity			
Chi(2) = 7.57			
Prob > chi2 = 0.0227			
Cameron & Trivedi's decomposition of IM-test			
Source	**Chi2**	**df**	**p**
Heteroskedasticity	7.57	2	0.0227
Skewness	7.22	1	0.0072
Kurtosis	0.45	1	0.5046
Total	15.24	4	0.0042

Source: the author's calculation in STATA

Absence of multicollinearity is proven with VIF test (Table 5), since results from STATA point to: VIF=1.00<10.

Table 5. VIF test – testing multicollinearity

Variable	VIF	1/VIF
Unemployment rate	1.00	1.000000
Mean VIF	1,00	

Source: the author's calculation in STATA

For testing the presence of autocorrelation, Durbin-Watson test was used. Obtained results from STATA are: *Durbin-Watson d-statistic (2.204)=0.2643769*. This result was compared with results from the Durbin-Watson significance table and observed specifications were: number of observations (200); k=1; range dU (1.664)-dL(1.684). Since d=0.2643769 is lower than dL in the Durbin-Watson significance table, null hypothesis is rejected and autocorrelation is present.

4. Panel analysis of interdependence of unemployment rate and inflation rate

In order to determine interdependence of unemployment rate and inflation rate in selected countries, panel data was created and the following models were analysed: OLS (Ordinary Least Squares Model), Fixed Effects Model and Random Effects Model. Results of the OLS Model are presented in Table 6.

Table 6. OLS model

Source	**SS**	**df**	**MS**	**Number of obs = 204**		
Model	147.449071	1	147.449071	**F(1.202) = 35.60**		
Residual	836.706594	202	4.14211185	**Prob > F = 0.0000**		
Total	984.155665	203	4.84805746	**R-squared = 0.1498**		
				Adj R-squared = 0.1456		
				Root MSE = 2.0352		
Inflation rate	**Coef.**	**Std. Err.**	**t**	**P > | t |**	**[95% Conf. Interval]**	
Unemployment	-.1296325	.0217272	-5.97	0.000	-.1724737	-.0867913

rate						
_cons	2.974792	.2685377	11.08	0.000	2.445296	3.504289

Source: the author's calculation in STATA

The OLS Model is statistically significant (p-value=0.0000<0.05) and 14,98% of inflation rate movements are explained by unemployment rate changes. P-values that correspond to constant and independent variable (unemployment rate) are statistically significant (0.0000<0.05) which makes OLS model corresponding and that increase of unemployment rate for 1% leads to decrease of inflation rate by 0.1296325% (OLS Model: *Inflation rate=2.974792-0.1296325*Unemployment rate*). Negative coefficient next to the independent variable points to indirect correlation between unemployment and inflation rate.

The second model that was analysed was the Fixed Effects Model (Table 7). As for the OLS model, it was proven to be statistically significant (model p-value is 0.0002<0.05; p-values for constant and dependent variable are 0.0000<0.05) and indirect correlation variable is confirmed. This model is corresponding and it reads: *Inflation rate=3.249615-0.1558661*Unemployment rate*.

Table 7. Fixed effects model

Fixed-effects (within) regression					**Number of obs = 204**	
Group variable: Country					**Number of groups = 4**	
R-sq: within = 0.0663					**Obs per group: min = 51**	
Between = 0.5264					**Avg = 51.0**	
Overall = 0.1498					**Max = 51**	
Corr(u_i, Xb) = -0.2525					**F (1,199) = 14.14**	
					Prob > F = 0.0002	
Inflation rate	**Coef.**	**Std. Err.**	**t**	**p>|t|**	**[95% Conf. Interval]**	
Unemployment rate	-.1558661	.0414486	-3.76	0.000	-.2376008	-.0741313
_cons	3.249615	.4549382	7.14	0.000	2.352496	4.146733
Sigma_u	.78671604					
Sigma_e	1.9388257					
Rho	.14137203	(fraction of variance due to u_i)				
F test that all u_i=0:		F(3,199) = 7,86		Prob > F = 0,0001		

Source: the author's calculation in STATA

Last Model that was analysed as part of the panel analysis is the Random Effects Model (Table 8). Conclusion is the same as for two previous models: statistically significant model (p=0.0001<0.05) with indirect correlation between inflation rate and unemployment rate. Random Effects Model can be presented as: *Inflation rate=3.173797-0.1486288*Unemployment rate.*

Table 8. Random effects model

Random-effects GLS regression					Number of obs = 204	
Group variable: Country					Number of groups = 4	
R-sq: within = 0.0663					Obs per group: min = 51	
Between = 0.5264					Avg = 51.0	
Overall = 0.1498					Max = 51	
Corr(u_i, X) = -0 (assumed)					Wald chi2(1) = 16.29	
Theta = .70544379					Prob > chi2 = 0.0001	
Inflation rate	**Coef.**	**Std. Err.**	**z**	**p>|z|**	**[95% Conf. Interval]**	
Unemployment rate	-.1486288	.0368302	-4.04	0.000	-.2208147	-.0764428
_cons	3.173797	.6002909	5.29	0.000	1.997248	4.350345
Sigma_u	.88079972					
Sigma_e	1.9388257					
Rho	.17107679 (fraction of variance due to u_i)					

Source: the author's calculation in STATA

In order to choose between Fixed Effects and Random Effects Model, Hausman test was performed and obtained results point to p=0.7035 (p>0.05), which means that Null Hypothesis is confirmed and that corresponding Model is Random Effects Model (Table 9).

Table 9. Hausman test

Coefficients				
	(b) fixed	**(B) random**	**(b-B) Difference**	**Sqrt (diag(V_b-V_B)) S.E.**
Unemployment rate	-.1558661	-.1486288	-.0072373	.0190136
b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg Test: Ho: difference in coefficients not systematic chi2 (1) = (b-B) '[(V_b-V_B) ^ (-1)] (b-B) = 0.14 Prob>chi2 = 0.7035				

Source: the author's calculation in STATA

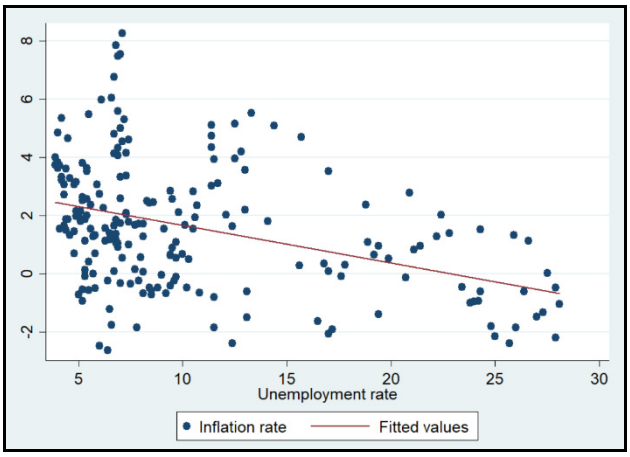
5. Discussion of results

Panel analysis has led to the conclusion of indirect correlation between inflation rate and unemployment rate. The most appropriate model is Random Effects Model:

*Inflation rate = 3.173797 – 0.1486288 * Unemployment rate*

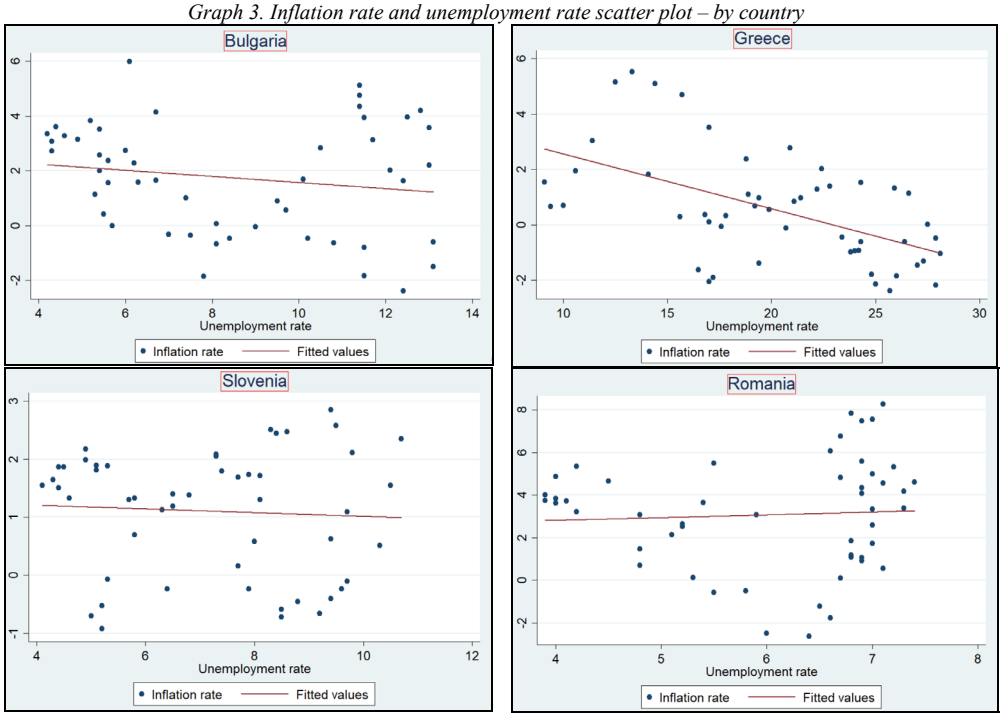
This model indicates that an increase of unemployment rate for 1% leads to decrease of inflation rate for 0.1486288%. If unemployment rate was 0%, inflation rate would be 3.173797%. Graph 2 presents a scatter plot of unemployment rate and inflation rate, which can graphically confirm negative correlation between these two variables in observed 4 countries, whereas Graph 3 presents separate scatter plots for each of the analysed countries.

Graph 2. Inflation rate and unemployment rate scatter plot



Source: the author's calculation in STATA

Graph 3. Inflation rate and unemployment rate scatter plot – by country



Source: the author's calculation in STATA

The negative correlation is the strongest in Greece, and is followed by Bulgaria, where the inverse relationship between inflation and unemployment rate is significantly

lower. In Slovenia, the correlation is barely negative and in Romania correlation is slightly positive. By separating these four countries as those that use euro as national currency (Greece and Slovenia) and those that do not (Bulgaria and Romania), a unique conclusion cannot be drawn. Negative correlation is present in Greece and Slovenia, but negative impact of unemployment rate on inflation rate in Slovenia is close to zero. For countries which are not using euro as national currency, the results are opposite: slightly negative correlation in Bulgaria compared to slightly positive correlation in Romania. Since differences are present between correlations of these two countries, but in both of them correlation is close to zero, the conclusion which can be drawn is that in countries that do not use euro as national currency, correlation between inflation rate and unemployment rate is so weak, that it can be considered that it does not exist.

What can be observed is that Greece, as a country with the highest negative correlation between inflation rate and unemployment rate, had the lowest average inflation rate and the highest average unemployment rate during the analysed period, and Romania, which marked highest average inflation rate and lowest unemployment rate, had slightly positive correlation between the two observed variables.

Results obtained in this paper are in accordance with findings of Bulligan & Viviano (2017), Hindrayanto, Samarina & Stanga (2019), Shaari et al. (2018), DiNardo & Moore (1999), Hooper, Mishkin & Sufi (2019), who have confirmed the existence of the Phillips curve in developed countries. When it comes to Balkan countries, negative correlation between inflation rate and unemployment rate was confirmed by Milenković et al. (2020), whereas low and positive correlation in Romania was confirmed by Furtula, Durkalić & Simionescu (2018), Herman (2010) and Melian (2021).

When analysed countries as observed as panel data, the existence of the Phillips curve during period Q1 2009–Q3 2021 is empirically confirmed. But these results differ between countries and some of them present higher, some lower negative correlation, whereas positive correlation is present in Romania. These results represent important guidelines and directions for policy makers and should be taken into account when deciding on the course of economic policy. If the aim is to increase employment rate and encourage economic growth, what needs to be considered is the impact this will have on inflation rate and *vice versa.*

Conclusion

Low and stable inflation rate and unemployment rate are some of the main goals for every economic policy – keeping the rise of prices on low level, but also unemployment rate on as close to natural unemployment rate – but as theoretically confirmed by Phillips curve, which points to inverse movement of these two variables, often this cannot be the case. Lowering the unemployment would lead to higher production, GDP growth, wages, purchasing power, which will eventually lead to price increase and inflation rate rise.

Even though Phillips curve is highly appreciated in economics theory, it is empirically confirmed that it cannot be applied in all countries, so the aim of this research

was to test existence of Phillips curve in 4 European countries: Bulgaria, Greece, Slovenia and Romania, during the period Q1 2009–Q3 2021.

After conducting panel analysis, the most adequate model was chosen, which is Random Effects Model: *Inflation rate=3.173797-0.1486288*Unemployment rate.* These results confirm inverse correlation between inflation rate and unemployment rate, which confirmed the existence of Phillips curve and accepted Hypothesis 1 of this research.

However, results differ between countries. Differences between countries that use euro as national currency and those that do not are not pointing to unique conclusion – Greece and Slovenia have negative correlation, but for countries that are not using euro as national currency, results suggest both positive and negative correlation, but it is so weak that is can be considered as it does not exist – so Hypothesis 2 cannot be rejected.

As this research analyses only 4 European countries, within a period of almost 13 years, suggestions for further econometrics analysis would include all European countries and a broader time frame, in order to determine the existence of the Phillips curve. Since the model in this research is simple, and it analyses only the impact of unemployment rate on inflation rate, further research should include more macroeconomic variables, in order to analyse the influence of all independent variables on inflation rate.

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