

Inflation – Unemployment Dilemma. A Cross-Country Analysis

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Abstract

According to Phillips' study, there is an inverse link between inflation and unemployment. The major consequence of these imbalances lies in authorities' ability to correct one of them, usually the unemployment, by influencing the components of the aggregate demand. Phillips' opinion is later countered by Friedman's principle of currency neutrality. Together with Phelps, Friedman argues that, in the long run, the Phillips curve is vertical and any attempt to lower the unemployment below the natural rate leads to a simultaneous rise in unemployment and inflation. This paper aims to analyze the impact of the economic policy measures on the evolution of inflation and unemployment in the G7 countries, starting from the monetary criticism regarding the inefficiency of monetary impulses. In order to achieve this purpose, the developed econometric analysis tries to identify the existence and the direction of the nexus between variables, both in the short and long term, by using causality and cointegration methods, such as Granger, Granger-Wald and Johansen tests. Our findings support Phillips model on the short run, indicating that there is an inverse link between the inflation rate and the unemployment rate in the G7 states, during the analyzed period. However, on the long run, our results indicate that inflation and unemployment can coexist, fact that allows us to agree with the monetarist theories.

Keywords: unemployment-inflation relationship; Phillips; Friedman-Phelps; G7 countries.

JEL classification: E31; E24.

1. INTRODUCTION

For a certain period of time, economists considered that there is a functional relationship between the inflation rate and the unemployment rate, in the sense that full employment causes inflation. This negative relationship, known as the Phillips curve, led to many debates and dilemmas not only among scholars, but also between the policy-makers, starting from the 1970s', when high inflation coexisted with high unemployment.

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During time, unemployment was investigated from various perspectives, the researchers offering numerous explanations for its evolution and determinants. Despite this variety of approaches, it was agreed that the business cycles have a great influence on the variation of the unemployment rates: from a significant decrease during the expansion phase to a high increase in the recession period. [Smith and Zoega \(2007\)](#) offered, as examples, the energy crisis from the 1970's in USA and the oil price shocks of the early 1990's. [Canale and Liotti \(2015\)](#), referring to the last global financial and economic crisis, mentioned the high rates of unemployment in the euro area, especially in Spain and Greece. Moreover, [Guerrieri \(2013\)](#) underlined that, in the context of the latest global recession, the unemployment not only affected more the young population of the European Union than the other age groups, but it also made a segregation between Northern and Southern Europe, the last area confronting with higher rates of unemployment. Challenged by this large imbalance on the European Union labor market, many researches tried to offer policy recommendations for diminishing the unemployment in the Eurozone ([De Grauwe, 2016](#); [Verdugo, 2016](#)).

The aspects related to price increases and inflation also received a great attention from both researchers and practitioners. An unprecedented challenge occurred in the late 1970's and beginning of the 1980's, when the Western European countries faced serious problems in maintaining the price stability, employment security and a high level of wellbeing. At that moment, the increasing rates of inflation were considered to be the consequence of the wage explosion from the late 1960s' ([Boltho, 1982](#)). Other voices argued that the accelerating inflation in the European states was also influenced by the significant increase in the number of jobs and income security in the postwar period ([Schmidt, 1986](#)).

Several studies focused on the relation between inflation and unemployment in the case of the European states. [Musso, Stracca, and van Dijk \(2009\)](#) analyzed this relationship from the perspective of the time-varying mean of inflation in the Eurozone and concluded that there is no significant nonlinearity between this variable and the output gap. Meanwhile, [Önder \(2009\)](#) found that Phillips curve is nonlinear in the case of Turkey. The same conclusion, indicating the nonlinearity of Phillips curve in Australia and Sweden, was obtained by [Eliasson \(2001\)](#).

A few researches investigated the relationship between inflation and unemployment for the G7 states. However, not only the used research methods are different, but also the findings are dispersed and sometimes ambiguous. By using cointegration techniques, VAR estimation and Granger-causality tests, [Seyfried and Ewing \(2001\)](#) investigated this relation on G7 countries for the period 1980-1996. Their findings indicate that inflation had a significant short-run effect on the unemployment rate only in Canada, France, Italy and US. Meanwhile, on the long run, no tradeoff was noticed. [Thornton \(1988\)](#) mentioned that, from all the G7 countries, only in Germany and Italy inflation variability impacted the variability of the industrial production over the period 1955-1984. Developing a bivariate vector-autoregression model, [Weber \(1994\)](#) does not reject the hypotheses of a long-run vertical Phillips curve in the G7 states. Meanwhile, his results offer little support for the long-term currency neutrality. [Baxa, Plašil, and Vašíček \(2017\)](#) found that the nexus between the economic activity and the inflation is quite sturdy in the G7 states when the first one is assessed through a more complex set of variables. Thus, they indicate a flattening of the Phillips curve during the last decade, which is robust across countries.

Considering all the above mentioned aspects, this paper aims to analyze the impact of the economic policy measures on the evolution of inflation and unemployment in the G7 countries for the period 1971-2020. In order to achieve this purpose, the rest of the study is organized as

follows: a brief presentation of the previous debates regarding the unemployment-inflation nexus is included in [Section 2](#), [Section 3](#) shows the methodological framework, the results and discussions are presented in [Section 4](#) and the [last Section](#) concludes.

2. LITERATURE REVIEW

In the literature, there are many perspectives regarding the inflation-unemployment dilemma. One of first approaches can be identified in Irving Fischer's study, from 1926 ([Fischer, 1926](#)). By investigating the case of the United States, he found out a high correlation between the rate of price changes and the employment.

Some studies, deeply rooted in the Keynesian theory, consider that the policy makers should cope with inflation in order to reduce the workplace conflict and to properly determine the wage, for avoiding the unemployment ([Dunlop & Zack, 1997](#)). This perspective was largely promoted in the 1960s' during the Nixon administration ([Piore, 2017](#)), and materialized in Phillips U shaped-curve ([Phillips, 1958](#)). Focusing his research on the United Kingdom's labor market between 1861 and 1957, Phillips regresses the rate of wage inflation against the unemployment rate and concludes that there is a negative relation between wage inflation and unemployment. Similar relationship was found by [Samuelson and Solow \(1960\)](#) in the case of the United States economy.

[Lipsey \(1969\)](#) extended Phillips' approach, by using standard statistical techniques meant to eliminate the econometric minuses of the methods used by his predecessor. Lipsey's findings are in line with the results obtained by Phillips, but he mentions that the negative relationship between inflation and unemployment seems unstable in time, indicating the possibility of omitted variables. Therefore, the Phillips' curve is nonlinear ([Lipsey, 1969](#)). This conclusion was the starting point of further researches. While [Perry \(1964\)](#) supports the nonlinear model, [France \(1962\)](#) argues a linear relationship between inflation and unemployment. A linear model is also advocated by [Bowen and Berry \(1963\)](#) on the case of United States which, according to them, rarely faced low unemployment rates.

Other studies analyzed the nonlinearity of the Phillips curve starting from microeconomics theories. Based on the capacity constraint model, [Yates \(1998\)](#) showed that it is expensive for a firm to raise the number of jobs as a result of a surplus of demand, when the production capacity is fixed on short period of time and the marginal costs are increasing. According to him, the Phillips curve is convex in the short run. The nonlinearity of the Phillips curve has also been argued through the asymmetries in price adjustment. In this view, [Fisher \(1989\)](#) underlined that people are more willing to accept a decrease in the real wages than in their nominal wages due to the money illusion. As a consequence, the excess of demand will put a higher pressure on inflation than the excess of supply, which will lead to asymmetries.

Another significant debate was related to the comparability of data across countries. As mentioned by [Flanagan \(1973\)](#), the United Kingdom did not have many unemployed immigrants, while the United States did. Therefore, United Kingdom had a lower U-shaped curve, thus a more favorable trade-off. An important issue was also raised by [Simler and Tella \(1968\)](#), who claimed for inadequate statistics. They referred to the fact that the measure for the unemployment rate does not take into account the hidden unemployment – those workers that were discouraged from participating on the labor market. A solution for this problem was found by [Moore \(1983\)](#), who proposed the ratio of the employment to working age population instead of the unemployment rate. By introducing this variable into the analysis, he found out

a close relationship between the movements in the employment-population ratio and the wage rate in the postwar period. Moore (1983) explained the persistence of both inflation and unemployment during the 1973-1975 recession through the fact that the percentage of persons employed held up relatively well, which provided support for increasing the income and the consumers' demand. Thus, by underlying high employment ratio, he completed the labor market's statistics that showed a value for the unemployment rate of 8.5% in 1975, higher than in any other year after 1941. All these results led him to the conclusion that high unemployment rate can coexist with both high employment rate and inflation.

Another aspect that should be considered when analyzing Phillips curve is the composition of the labor force. As noticed by Perry, Schultze, Solow, and Gordon (1970) on the case of the United States, two groups of population with higher than the average employment rates increased their share in the labor market: women and teenagers.

In the end of the 1960s', Milton Friedman, the founder of the monetarist theory, offered a different perspective by introducing a new concept: a natural rate of unemployment. He considered that this natural rate, determined by real factors, can be achieved when expectations are on average met (Friedman, 1968). Moreover, this rate of unemployment can be maintained at any absolute level of prices or of price change. The natural rate hypothesis offers support for a far broader range of situations compared to Phillips curve, including the phenomenon of stagflation. Yet, it cannot explain the slumpflation. According to Friedman, the association of higher inflation with higher unemployment may occur when external and independent factors lead to an upward trend of both phenomena, such as oil crisis. Another cause of high inflation-high unemployment situation can be the transition from one political regime to another. In this case, the institutions that are unprepared for a new monetary environment may induce high and volatile inflation, accompanied by government intervention into price setting. However, this situation cannot last. It will either transform into hyperinflation and radical change or the policy makers will implement such measures that will lead to a lower rate of inflation and less government intervention (Friedman, 1977). Agreeing to Friedman's theory, Phelps (1968) argued that no policy can permanently lower unemployment below its natural rate because this will lead to a simultaneous rise in unemployment and inflation. Moreover, Phelps concludes that the Phillips curve is vertical in the long run (Phelps, 1968).

A few years later, Lucas (1976) also argued that Keynes' approach did not take into account the fact that the relationship between the two variables can change when individuals' behavior modifies, as a result of the changes in the economic policies. In other words, he stated that models designed for policy evaluation should also involve a detailed description of the changes in the behavior of economic agents as a reaction to changes in economic policy rules (Goutsmedt, Pinzón-Fuchs, Renault, & Sergi, 2019). Lucas' argument, also associated with the rational expectations hypothesis, was widespread among the macroeconomists' studies from the end of the last century. Sargent (1980) stated that people adapt their behavior in order to benefit from the changes in the rules. Consequently, the policy variables are influential in changing the trade-off between the unemployment rate and inflation. However, despite the fact that Lucas' approach set the principle of a new macroeconomic modeling that took into account the human behavior, another opposite 'empirical interpretation' of the Lucas' Critique has been advocated by Keynesians, in the late 1980's and, subsequently, in the early 2000's. For Keynesians, the parameters defined by Lucas represented only a theoretical argument which should be tested for the practical relevance for the economic policy, through econometric analysis (Klamer, 1984). In line with this idea, Malinvaud (1998)

mentioned that the economic agents are interested in the changes of economic policy only when these have a direct impact on them. Among those who conducted an empirical research regarding Lucas' approach was [Blanchard \(1984\)](#). He analyzed two traditional macroeconomic relationships – the Phillips curve and the term structure of interest rates – on the case of United States, in the context in which the Federal Reserve changed its approach to monetary policy in the late 1970's. This change materialized in tightening the monetary policy and in the switch to public money supply targeting ([Sergi, 2018](#)). His findings highlighted instability in parameters' for the term structure, but not for the Phillips curve. Therefore, Lucas' Critique is empirical relevant only for the term structure of interest rates and not for the Phillips curve, conclusion that opened a wide research field for the so-called 'new Keynesian economics' ([Mankiw & Romer, 1991](#)). By using theories that incorporate frictions, other studies investigated either the unemployment ([Andolfatto, 1996](#); [Diamond, 1982](#); [Hall, 2005](#)) or the inflation ([Molico, 2006](#); [Shi, 1995](#)). [Berentsen, Menzio, and Wright \(2008\)](#) integrated some of these models in order to analyze unemployment and inflation together. Their conclusion was that the two phenomena can follow the same trend, in the same time. Actually, many postwar economists denied the existence of a durable Phillips tradeoff. Some of them, following the logic of Friedman's analysis, considered that there is only one rate of unemployment compatible with steady inflation: the 'natural rate'. Therefore, as [Tobin \(1972\)](#) underlined, a natural rate of unemployment should be a policy target in the sense that the policy makers should let the economy gravitate to this equilibrium. Other economists, criticizing the 'new economic policy' implemented by Nixon administration that failed to solve the problems of both inflation and unemployment, consider that the solutions to deal with these two phenomena could consist in international monetary reforms and exchange rate interventions ([Triffin, 2014](#)).

Recent studies explained the instability of the Phillips curve with the help of the business cycles and the structural changes of the inflation's dynamics. [King, Stock, and Watson \(1995\)](#) underlined, on the case of United States, that the relation between inflation and unemployment is positive during the normal periods, but negative during the phases of the business cycle. Meanwhile, [Angeloni, Aucremanne, and Ciccarelli \(2006\)](#) noticed a permanent decline in the inflation in the late 1990s', explained through a structural change in the inflation dynamics, in the Euro zone.

Considering the results of this large amount of the studies, we may argue that the relationship between inflation and unemployment might be unstable and nonlinear. However, this is only one of the uncertainties faced by the empirical researches investigating the inflation–real activity relation. Other uncertainties are related to finding the appropriate variable for tracking the economic activity or to determining if the inflation – economic activity relation is permanently varying because of the structural changes from the economy and monetary policy ([Mavroeidis, Plagborg-Møller, & Stock, 2014](#)).

3. RESEARCH METHODOLOGY

The purpose of our study is to identify the nature of the link between inflation and unemployment in order to test the two controversial theories, namely the Keynesian and the monetarist theories. We will use data taken from OECD database, for the period 1971-2020. The year 1971 was chosen as the beginning of the period because, in that moment, the inflationary outbreaks started to appear, triggered by the application of the Keynesian

measures aimed at stimulating the effective demand. The analysis will try to identify the existence and the direction of the nexus between variables both in the short and long term, by using causality and cointegration techniques.

3.1 Augmented Dickey-Fuller (ADF) Test

If the results of a specific test (Dickey-Fuller) for time series show that they are non-stationary at level 0, then they must be stationarized at level I (1) or higher. To avoid the problem of autocorrelation between data, Augmented Dickey-Fuller test can be used, by adding various lagged dependent variables.

The general form of the regression function used in the ADF test can be expressed with the help of the [equation \(1\)](#):

$$\Delta RUnempl_t = \mu + \gamma RUnempl_{t-1} + \sum_{j=1}^p \alpha_j \Delta RUnempl_{t-j} + \beta t + \omega_t \quad (1)$$

To show the inverse dependence, we developed a second equation:

$$\Delta Infl_t = \mu + \gamma Infl_{t-1} + \sum_{j=1}^p \alpha_j \Delta Infl_{t-j} + \beta t + \omega_t \quad (2)$$

In our case, $RUnempl$ represents the unemployment rate, in adjusted series calculated as the number of registered unemployed persons over the civilian active population and $Infl$ represents the growth rate of consumer prices compared to the previous period, measured through the Consumer Price Index. Meanwhile, μ is the drift term, t denotes the time trend and p is the largest lag length used. The equation has both intercept and trend. The value for p (number of lags) can be determined by making reference to a commonly produced information criteria such as the Akaike criteria (AIC), Schwarz-Bayesian (SBIC) criteria or Hannan and Quinn information criteria (HQIC). The most stable method is AIC.

Talking about variation indices compared to a previous period, we cannot mention a drift effect, so that $\mu = 0$. The trend effect, which can be easily observed from the graphical analysis of the two data series, is still present.

3.2 Granger causality

Granger causality can be used to analyze the direction of the short-term link between variables. We say that a variable x Granger causes y if y can be better predicted using the histories of both x and y than it can do by using only the history of y .

The most common method for testing Granger causality is to perform the regression analysis of y on its own lagged values and on lagged values of x and to test the null hypothesis that the estimated coefficients on the lagged values of x are jointly zero. The acceptance of the null hypothesis means that x has no Granger causality compared to y (x does not Granger-cause y) ([Granger, 1969](#)).

Therefore, having two variables x and y , we first regress y on y lags without x lags, meaning that we construct the restricted model:

$$y_t = \alpha_1 + \sum_{j=1}^m \gamma_j y_{t-j} + e_t$$

Afterwards, we add the x lags and we regress again, which represents the unrestricted model:

$$y_t = \alpha_1 + \sum_{i=1}^n \beta_i x_{t-i} + \sum_{j=1}^m \gamma_j y_{t-j} + e_t$$

Finally, we test the null hypothesis that $\beta_i = 0 \forall i$, by using a Wald test.

3.3 Johansen Cointegration

We can say that the two series are cointegrated when the linear combination of two I(t) processes becomes an I(t-1) process. As [Johansen \(1988, 1995\)](#) said, cointegration implies common stochastic trend and the existence of long-run equilibrium. [Granger \(1983\)](#) defines cointegration as a phenomenon that nonstationary processes can have linear combinations that are stationary.

If we have p lags and the variables are y – GDP growth rate (gdp) and z – public spending growth rate (exgov), then the VEC system should be:

$$\begin{bmatrix} RUnempl \\ Infl \end{bmatrix} = a_0 + A_1 \begin{bmatrix} RUnempl_{t-1} \\ Infl_{t-1} \end{bmatrix} + \dots + A_p \begin{bmatrix} RUnempl_{t-p} \\ Infl_{t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix},$$

where a_0 is a vector of intercept terms and A_i represents the matrix of coefficients.

4. EMPIRICAL RESULTS AND DISCUSSIONS

4.1 Descriptive analysis of data

The database consists of annual data provided by the OECD for the period 1971-2020. The variables taken into account are the unemployment rate (RUnempl), calculated as the number of unemployed persons relative to the civilian active population and the inflation indicator (Infl), expressed with the help of Consumer price indices, as a percentage change over the same period of the previous year. For the unemployment rate, the standard deviation from the average is 1.16 and the Kurtosis distribution is platykurtic and negative, while the Skewness distribution is negative, which shows an elongated distribution on the left side.

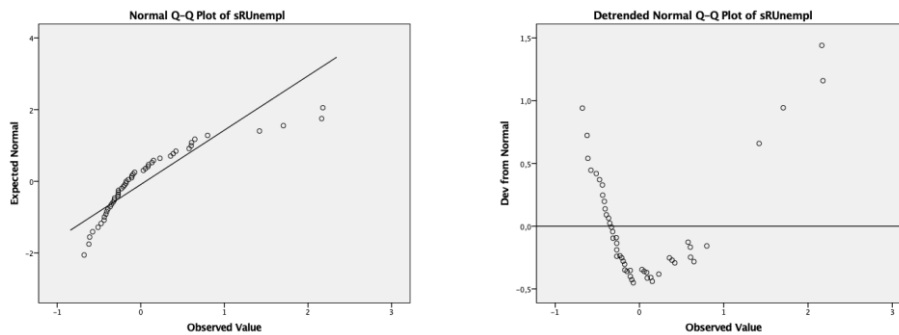
Table no. 1 – Statistics

N	Valid	RUnempl	Infl
	Missing	50	50
		0	0
Mean		6,09224481	3,87124496
Median		6,25902350	2,42366650
Std. Deviation		1,164298053	3,208908782
Skewness		-,466	1,432
Std. Error of Skewness		,337	,337
Kurtosis		-,030	1,342
Std. Error of Kurtosis		,662	,662
Minimum		3,334102	-,125469
Maximum		8,120625	13,234610

Table no. 2 – Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RUnempl	,083	50	,200*	,970	50	,222
Infl	,213	50	,000	,829	50	,000

Note: *. This is a lower bound of the true significance. a. Lilliefors Significance Correction

**Figure no. 1 – The distribution for the unemployment rate variable**

The normality tests (Table no. 2) show that the distribution is not normal in the case of the unemployment rate, the value of significance being higher than 0.05 in both tests. For the Infl variable the distribution is normal.

Therefore, for the RUnempl variable we will normalize the data in the first difference. For the unemployment rate variable, the applied tests on the stationary series show that the distribution is normal. But, because the other series is normal only in the first difference, we will work with both stationary series. The distribution of the stationary series for inflation is also a normal one. Both tests show the normality of the data with 95% significance but we consider more relevant the Shapiro-Wilk test, which is generally applied for smaller series, up to 50 periods, as our series are. In this case, the significance is 0.008.

Table no. 3 – Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
sRUnempl	,191	49	,000	,799	49	,000
sInfl	,134	49	,027	,933	49	,008

Note: a. Lilliefors Significance Correction

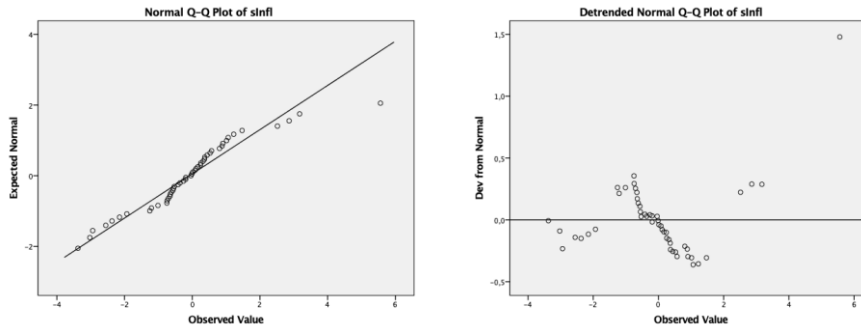


Figure no. 2 – The distribution for the inflation variable

The time variable is y , annual series ranging between 1971 and 2020. The series for the analysis are RUnempl (unemployment rate) and Infl (consumer price index).

4.2 Unit root test

To assess the level of stationarity, the Augmented Dickey-Fuller test for unit root is applied, taking into account a default number of 4 lags.

Table no. 4 – Augmented Dickey-Fuller test for unit root unemployment rate (45 observations)

Augmented Dickey-Fuller test for unit root RUnempl Number of obs = 45				
----- Interpolated Dickey-Fuller -----				
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-2.592	-3.614	-2.944	-2.606
MacKinnon approximate p-value for Z(t) = 0.0947				

Table no. 5 – Augmented Dickey-Fuller test for unit root growth rate of consumer prices (45 observations)

Augmented Dickey-Fuller test for unit root Infl Number of obs = 45				
----- Interpolated Dickey-Fuller -----				
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-1.640	-3.614	-2.944	-2.606
MacKinnon approximate p-value for Z(t) = 0.4624				

Since for both analyzed variables the p -value is higher than 0.05, the null hypothesis is accepted: the series are not stationary at the level. As such, we will move on to stationarity testing at level 1. Therefore, we stationary the series and then we apply the ADF test again.

Table no. 6 – Augmented Dickey-Fuller test for unit root unemployment rate (44 observations)

Augmented Dickey-Fuller test for unit root RUNempl Number of obs = 44				
----- Interpolated Dickey-Fuller -----				
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-3.488	-3.621	-2.947	-2.607
MacKinnon approximate p-value for Z(t) = 0.0083				

Table no. 7 – Augmented Dickey-Fuller test for unit root growth rate of consumer prices (44 observations)

Augmented Dickey-Fuller test for unit root Infl Number of obs = 44				
----- Interpolated Dickey-Fuller -----				
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-3.782	-3.621	-2.947	-2.607
MacKinnon approximate p-value for Z(t) = 0.0031				

This time we observe that for all analyzed series the p -value is less than 0.05 and even less than 0.01 (or, for $Z(t)$ in module, the critical value is less than the statistical value). This shows that the null hypothesis is rejected and the series are stationary at level 1, which shows that there is a cointegration equation.

Table no. 8 – Calculation of the number of lags for the variables

Selection-order criteria RUNempl									
Sample: 1975 - 2020									
Number of obs = 46									
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC	
0	-61.729				-.895365	2.72735	2.74224	2.7671	
1	-41.7811	39.896	1	0.000	.392862	1.90352	1.93331	1.98303	
2	-35.9068	11.749*	1	0.001	.317877*	1.6916*	1.73628*	1.81086*	
3	-35.5796	.65442	1	0.419	.327396	1.72085	1.78042	1.87986	
4	-35.3852	.38888	1	0.533	.339209	1.75588	1.83034	1.95464	

Note: Endogenous: RUNempl; Exogenous: _cons

It is observed that, for the *unemployment rate*, the number of lags that can be taken into account is 2, all the tests applied indicating the same value.

Table no. 9 – Selection-order criteria growth rate of consumer prices

Selection-order criteria Infl									
Sample: 1975 - 2020									
Number of obs = 46									
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC	
0	-114.774				8.98696	5.03364	5.04854	5.0734	
1	-73.1058	83.336	1	0.000	1.53364	3.26547	3.29525*	3.34498*	
2	-72.8918	.4279	1	0.513	1.58717	3.29965	3.34432	3.4189	
3	-70.8495	4.0847*	1	0.043	1.51723*	3.25433*	3.31389	3.41334	
4	-70.663	.37303	1	0.541	1.57252	3.28969	3.36415	3.48846	

Note: Endogenous: Infl; Exogenous: _cons

For the inflation variable, the FPE and AIC tests indicate 3 lags and the HQIC and SBIC tests indicate a single lag. According to Leppink (2019), AIC is considered the strongest criterion. Since we also have 3 lags for the other variable, then we will consider in our analysis a lag equal to 3.

4.3 Granger-Wald causality tests

Since the series are stationary at level 1, we will apply the causality tests to show the short-term link between the variables. For this, it is necessary to generate the VAR model:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = B_0 + B_1 \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} \tilde{u}_{xt} \\ \tilde{u}_{yt} \end{bmatrix},$$

where B_0 is vector of constants and B_1 is the matrix of lags coefficients, y is (RUnempl) and x is (Infl).

Table no. 10 – Vector autoregression

Sample: 1974 - 2020		Number of obs = 47			
Log likelihood =	-108.709	AIC =	5.221661		
FPE =	.6378651	HQIC =	5.429047		
Det(Sigma_ml) =	.3499946	SBIC =	5.772769		
Equation	Parms	RMSE	R-sq	chi2	P>chi2
RUnempl	7	.553234	0.7347	130.1395	0.0000
Infl	7	1.37077	0.8459	257.9586	0.0000

Since the value of p is 0 and the degree of determination between variables is high, the model is valid and it allows the application of the causality test.

Table no. 11 – Granger-Wald causality tests

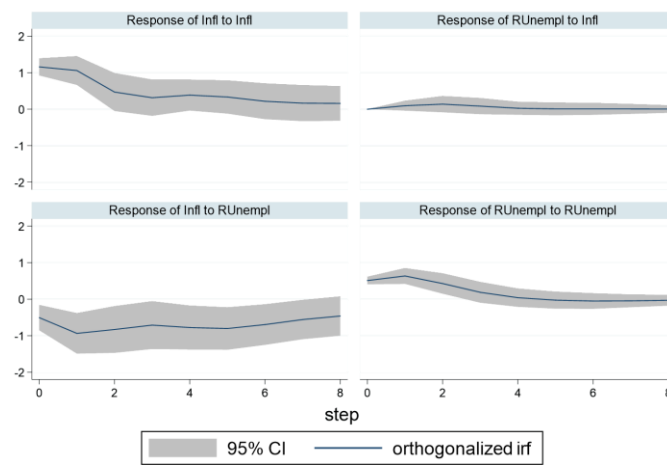
Equation	Excluded	chi2	df	Prob > chi2
RUnempl	Infl	2.0955	3	0.553
RUnempl	ALL	2.0955	3	0.553
Infl	RUnempl	8.9292	3	0.030
Infl	ALL	8.9292	3	0.030

It can be observed that, in the case of the influence of unemployment on inflation, the null hypothesis is rejected (p value = 0.03), which means that, on the short term, unemployment has a Granger causality with the respect to inflation and not vice versa. The fact that we have identified unidirectional Granger-causality from unemployment to inflation shows that, on the short term, Phelps's critique is not justified. In terms of public policy, this conclusion is very important because it shows that there is a response from inflation when acting on the level of employment.

4.4 Impulse response factor

To see the response of the variables to impulses, the Var basic model (statistics/ Multivariate time series/Basic Var) is constructed and the impulse graphs are generated.

The bellow graphs show the response of one variable to the shock applied by another variable. For example, in the top right graph we see the response of the unemployment rate when a very short shock is applied through the consumer price index. Therefore, Infl is the shock variable and RUnempl is the response variable. There is a very weak response. Instead, the lower right graph shows a stronger response from the Infl variable when a shock is applied in RUnempl. Therefore, it can be deduced that inflation responds more quickly in the short term to measures aimed at stimulating the demand and increasing the employment. It is observed that for the first period the response is negative, meaning that there is an inverse link between the inflation rate and the unemployment rate, as Philips claims. Instead, from the second period onwards, the trend is positive, which leads us to an acceptance of the criticism of the monetarist school, which assumes that, in the long run, the currency is neutral and the two blockages, unemployment and inflation, evolve together.



Graphs by irfname, impulse variable, and response variable

Figure no. 3 – The response of one variable to the shock applied by the other variable (Infl and RUnempl)

4.5 Cointegration

Since the series are stationary at level 1, we can assume a long run relationship in the model. The VEC model is generated, which allows the analysis of the relationships between long-term variables.

Table no. 12 – The cointegration test

Johansen tests for cointegration						
Trend: constant			Number of obs = 47			
Sample: 1974 - 2020			Lags = 3			
maximum rank	parms	LL	eigenvalue	trace statistic	max statistic	5% critical value
0	10	-119.08984	.	20.7616	17.7249	15.41
1	13	-110.22741	0.31417	3.0367*	3.0367	3.76
2	14	-108.70904	0.06257			

We reject the null hypothesis (H_0 : No integration equation) if the Trace and Max statistics $> 5\%$ critical value. Since Trace statistics and Max statistics are lower than the critical value for $r=1$, then there is a cointegration vector. Therefore, the analyzed series are cointegrated at level 1, which shows that there is a link between the inflation rate and the unemployment, noticeable with a gap of a period (in our case 1 year). This gap supports the Keynesian model according to which stimulating the increase of the employment level by enhancing the actual demand does not implicitly lead to the increase of prices.

5. CONCLUSIONS

The aim of this paper was to provide additional empirical support for the inflation-unemployment nexus through the lens of the cointegration methods and causality analysis. Our findings support Phillips model on the short run, indicating that there is an inverse link between the inflation rate and the unemployment rate in the G7 states, during the analyzed period. These results are in line with the conclusions of other studies which showed that the Phillips curve relationship is present on short term (Seyfried & Ewing, 2001), foreign factors playing an important role in influencing the inflation even in relatively large economies, such as the G7 countries (Baxa et al., 2017). However, on the long run, our results indicate that inflation and unemployment can coexist, fact that allows us to agree with the monetarist theories.

All these findings obtained through the analysis of the evolution of inflation and unemployment for a 50-years period on the G7 group of states can provide some useful information in conceiving the public policy measures. The existence of a causality that shows that the unemployment rate has an influence on the short-term inflation rate suggests that the measures taken to reduce the unemployment lead to an increase in the money supply that can trigger the immediate inflationary outbreaks.

The fact that there is a cointegration relationship between the two analyzed variables leads us to the conclusion that a long-term link exists between the evolutions of the two phenomena, inflation and unemployment. It is reasonable to believe that the anti-unemployment measures should be designed in such a manner that would not generate an immediate increase in the money supply (we are referring here to lower interest rates, subsidies, social assistance etc.). Moreover, we do agree with the fact that the measures conceived to stimulate the demand or the supply, in order to increase the level of production and, thus, the employment, lead to increases in prices.

One important policy recommendation meant to reduce the unemployment and, meanwhile, not to lead to inflation is related to the destination of the money supply that may result from an expansionary policy. Instead of being used for increasing the social assistance, through unemployment insurances, that money could be directed towards improving job opportunities in the labor market. While the former may increase the unemployment, and even its duration because individuals are not motivated to find a job, the latter one may increase the employment rate.

Based on the results of our study, another recommendation for the policymakers is to take into account the employment elasticity with respect to the economic output and focus on those sectors which have more absorptive capacity in engaging the young labor market entrants.

Further discussion could be possible if we take into account that the changes in the economic policy approach occurred in the 1980's in some OECD countries, starting with USA and UK, have influenced the evolution of the relationship between inflation and unemployment. An analysis conducted on shorter periods of time could highlight some deviations from the

results obtained on the entire period, especially if we take into account the fact that the evolution of the economies depends, to a great extent, on the nature of the applied economic policies.

A limitation of our study is that the findings are representative only for G7 countries. Therefore, in future researches, we intend to test Phillips curve on an extended sample that might include, for instance, the G20 states or the Eurozone countries. Meanwhile, in future studies, we also intend to test the importance of the threshold effects at both individual country level and group of states.

The period we analyzed includes many moments of change in all the aspects, from the monetary and fiscal nature of the macroeconomic policies to the major restructuring of the global order: the emergence of the EU, rethinking some principles of global governance, the transformation of corporations into economic global powers etc. Some events are difficult to quantify and, therefore, difficult to be included into a model. However, a possible development of the analysis will have to take into account a number of additional variables regarding the short-term influences of the oil crisis, the cessation of the convertibility of gold into dollar, the increase of the economic openness of the countries, the relocation of production etc.

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