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COMPARATIVE ECONOMETRIC INSIGHTS INTO THE INFLUENCE OF INFLATION ON ECONOMIC GROWTH IN ROMANIA AND EUROPEAN UNION

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Abstract
This paper provides a comparative analysis of the impact of inflation on economic growth, focusing specifically on the cases of Romania and the European Union. Using econometric methods, the study explores not only the interaction between inflation and economic growth, but also the variations of these dynamics in the two contexts. Comparative analysis allows a deeper understanding of the influence of inflation in different economic and political environments. Also, through the development and application of two econometric models, the paper clearly illustrates the relationship between inflation and economic growth, making an essential contribution to economic theory and the interpretation of the inflationary phenomenon. The results obtained are of importance for the formulation of effective economic policies, providing the necessary perspective for the adaptation and implementation of economic strategies at national and European level. The study also highlights the importance of policy adaptability in the face of economic diversity and provides recommendations for policy makers, thus contributing to more robust economic management in the face of inflationary fluctuations.

Keywords: *comparative; GDP; CPI; econometric models; inflation*

JEL Classification: E31

I. INTRODUCTION

Exploring the relationship between inflation and economic growth is a fundamental issue in modern economics, with significant implications for macroeconomic policy and economic stability (Kryeziu & Durguti, 2019). This paper aims to dissect this dynamic in the specific context of Romania and the European Union, highlighting the interactions between these two variables using empirical and econometric tools.

The concept of inflation, interpreted as a persistent increase in the price level, is hotly debated in the literature, with differing views on its effects on GDP. The relationship between inflation and economic growth depends on many other contextual variables and can vary from period to period, depending on transitory or structural shocks in the economy. Therefore, this study aims to analyze the dynamics of these indicators for Romania and the EU over the period 2005-2022 through historical developments and econometric models. The results will be explained by taking into account the specific macroeconomic context of each country.

The study also proposes a comparative perspective between Romania and the EU average in order to identify possible divergences and lessons to be learned. The analysis is based on quantitative data provided by institutions such as Eurostat, NBR and NSI, processed using SPSS scientific packages. The clarification of the relationship between inflation and economic growth can help to formulate monetary and fiscal policies appropriate to the Romanian and European context. The results can also provide useful insights for both academics and policy makers. Therefore, in order to achieve the proposed aim we have the following objectives: *Objective 1*: Examine and analyze inflation indicators and their evolution compared to economic growth in Romania and the European Union; *Objective 2*: Establish the links between inflation and economic growth using econometric methods; *Objective 3*: Develop two econometric models illustrating the relationships between inflation and economic growth in both the Romanian and the European Union contexts.

II. LITERATURE REVIEW

In terms of the theoretical framework, there are many economic theories with a multitude of often contradictory conclusions regarding the effect of inflation on a country's economic growth. This diversity is beneficial because they attempt to explain various inflation phenomena. Among the best known are:

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Issue 2 / June 2023 ISSN-L 2344-102X

Table 1. Perspectives on how inflation can affect economic growth

Theory	Author(s)	Description of the effect
Monetarist theory (Champ et al., 2022)	Milton Friedman	Monetarist theory suggests that inflation is the result of a quantitative increase in the money supply. In GDP terms, in the short run, an increase in money supply may boost output, but in the long run, it only leads to inflation, without affecting real output or unemployment.
Keynesian Theory (Cooper, 2019)	John Maynard Keynes	Keynesianism states that inflation and unemployment have an inverse relationship (Phillips Curve) and that moderate inflation can stimulate economic growth. Fiscal and monetary policies can be used to regulate economic demand, thereby influencing GDP and inflation.
Cost-Push Inflation Theory (Okon et al., 2023)	Various sources	The cost-push theory attributes inflation to increases in production costs, such as wages and commodity prices. This type of inflation can reduce corporate profit margins, thereby reducing investment and GDP growth.
Demand-Pull Inflation Theory (Jain et al., 2022)	Various sources	This theory sees inflation as the result of excessive aggregate demand in the economy. In the initial stages, higher demand can boost output and GDP, but as the economy approaches its full capacity, price increases become more pronounced.
Neoclassical Theory of Inflation (Laidler, 2019)	Milton Friedman, others	The neoclassical theory argues that inflation is always a monetary phenomenon. In the long run, inflation does not affect real variables such as GDP or unemployment. Monetary policies are essential to control inflation, and real economic growth is influenced by other factors.
The Tobin model (Zhang, 2019)	James Tobin	Tobin's model suggests that higher inflation may stimulate investment in physical capital because it reduces the real return on cash. This may lead to economic growth in the short run, but its long-term effect is contested.

Source: author's own processing

In the past, the phenomenon known today as persistent inflation was not present, which influenced the first theories on the relationship between inflation and economic growth. These theories were based on cyclical observations of inflation. Persistent inflation is thought to have emerged after the Second World War. In earlier periods, inflation was a relatively simple phenomenon, alternating between phases of inflation and deflation (deflation is a general decline in the prices of goods and services, usually associated with a contraction in the supply of money and credit in the economy), with no clear upward or downward trend, like the behavior of a "lazy dog", stabilizing at one level until a new disturbance. In this context, the positive correlation between inflation and economic growth has been sought to be understood (Binder & Kamdar, 2022). Aggregate supply and aggregate demand (AS-AD) theory has also suggested a positive relationship, where inflation follows the pace of economic growth (Goyal & Kumar, 2021). However, in the 1970s, the concept of stagflation began to be recognized in the literature (High and persistent inflation combined with high unemployment and stagnant demand in a country's economy.), calling into question the positive relationship between inflation and economic growth. During this period, the Phillips Curve, a hitherto widely accepted theory (Koch, 2023), began to be contradicted by new observations, such as periods of low or negative economic growth combined with historically high inflation rates in the context of sharp price increases and massive global unemployment (Gagnon & Collins, 2019; Macovei, 2020).

As regards the examination and analysis of inflation indicators and their evolution compared to economic growth In Romania and the European Union, Anghelache et al. (2022), carry out a descriptive analysis of the evolution of inflation and GDP indicators for comparable periods in the two areas. Both studies note a gradual convergence of Romania's inflation towards the EU average, but a continued gap in economic growth rates. To establish linkages using quantitative methods, Ekinci et al. (2020) model the inflation-growth relationship in Romania with a VAR model, identifying a negative influence of inflation on GDP. While Surugiu et al. (2021) apply a VECM model on EU data, revealing a negative correlation conditional on macroeconomic factors.

So, we see an acute lack in literature on inflation and its effect on economic growth. Thus, the present paper is distinguished by its comparative and systematic perspective on the inflation-growth relationship in Romania and the European Union, validated based on an extensive empirical base and the use of a complex set of econometric tools, thus contributing to the theory in the field.

III. METHODOLOGY OF THE WORK

Inflation data were collected from two main sources:

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Issue 2 / June 2023 ISSN-L 2344-102X

- Romanian inflation reports provided by the National Bank of Romania (NBR), publicly available via their online platform (see https://www.bnr.ro/Raportul-asupra-inflatiei-3342.aspx).
- European Union (EU) inflation data from the Eurostat database (see https://ec.europa.eu/eurostat/web/main/home).

After collecting, the data were processed and filtered using Microsoft Office to ensure compatibility with the requirements of the econometric analysis. The filtering process aimed to remove any anomalies and ensure data consistency. The econometric analysis was performed using Statistical Package for the Social Sciences (SPSS) software. This choice was based on SPSS's advanced capabilities in data processing and econometric modelling. In the analysis, Ordinary Least Squares (OLS) method was applied to establish correlations between the selected variables: Consumer Price Index (CPI) and Gross Domestic Product (GDP) for both Romania and the EU. The econometric models developed are as follows:

1. *The European Union (EU) model:*
   - Formula: EU GDP = 1.556E13 - 146587344102 * EU CPI
   - Interpretation: This model suggests an inverse relationship between inflation (EU CPI) and EU GDP, with CPI as the independent variable and GDP as the dependent variable.
2. *The Romanian model:*
   - Formula: GDP RO = 1.573E11 - 735375297 * CPI RO
   - Interpretation: Like the EU model, this model shows an inverse relationship between inflation (CPI RO) and GDP in Romania.

The results suggest that inflation, as represented by the CPI, plays a significant role as an independent variable in determining GDP, which functions as the dependent variable in both models. This inverse relationship highlights the potential negative impact of inflation on economic growth.

IV. DISCUSSIONS

In the first stage we will compare the evolution of inflation and economic growth between Romania and the European Union, then we will carry out the economic analysis and the related econometric models.

Inflation and growth developments in Romania and the European Union

We will start this part by looking at the evolution of inflation (CPI) and the monetary policy interest rate. The latter variable, the monetary policy interest rate, stands out as an essential instrument in the portfolio of monetary policies adopted by central banks, with the primary objective of regulating inflationary levels and ensuring sustainable economic stability within the national framework. This rate, in short, is the threshold at which commercial banking institutions access funding from the central bank. By strategically adjusting this rate, the central bank exerts a direct influence on the cost of credit, which is reflected in spending and investment trends in the economy, generating immediate impacts on the inflation rate and economic growth. A graphical representation of the monthly evolution of these two important indicators over the period 2017-2023 is provided in the figure below.

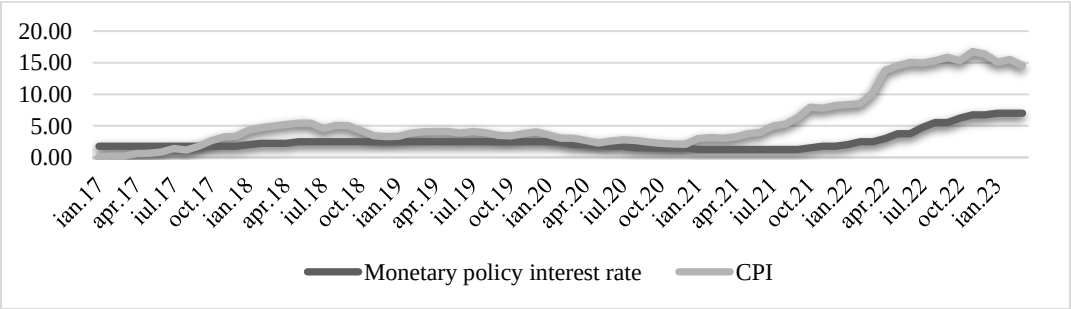

Figure 1. Monetary policy interest rate vs CPI
Source: author's own processing

Analysis of the previous graph reveals important developments in the two main economic indicators, which we will examine below. Over the January-December 2017 period, we see that the monetary policy interest rate has stabilized at 1.75%, while the consumer price index (CPI), a barometer of inflation, has seen a gradual increase from 0.05% to 3.32%. This increase in inflation suggests predominantly extrinsic economic factors, such as increased government spending or increased demand for goods and services, rather than interest rate movements. The period

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Issue 2 / **June** 2023 ISSN-L 2344-102X

June 2018 to February 2021 marks a steady interest rate at 2.5%, with inflation stabilizing around 4%. Interestingly, the impact of the COVID-19 pandemic on monetary policy is observable with a cut in the interest rate to 2% in March 2020, followed by further adjustments to 1.75% in June 2020 and 1.50% in August 2020 in an effort to stimulate the economy. In response to these measures and in the context of the pandemic, the CPI has seen accelerated growth, peaking at 6.29% in September 2021 and peaking at 16.76% in November 2022. In response to this escalation, the National Bank of Romania raised the interest rate to 7%, a measure that appears to have contributed to the recent fall in inflation to 14.54% in March 2023. In the following, we will extend the analysis by comparing inflation (CPI) in Romania with that in the European Union, in order to assess the concordances or discrepancies and to provide insight into potential structural discrepancies in the Romanian economy. This comparison is essential to understand Romania's positioning in the European economic context. The graphical presentation of this comparative analysis is included in the following figure, focusing on the period 2005-2022, considering significant economic variations prior to 2005.

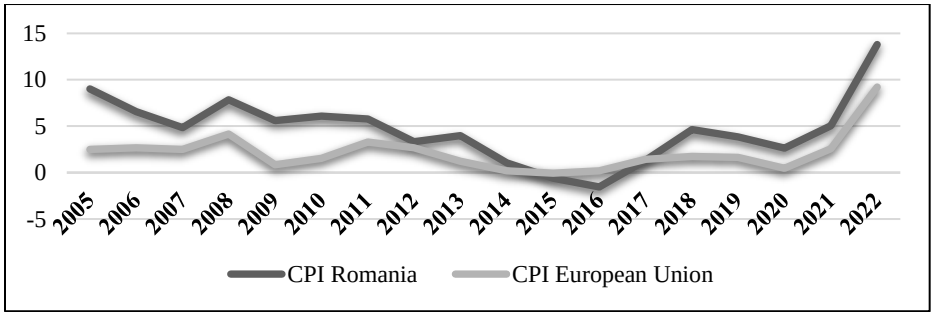

Figure 2. Inflation evolution Romania vs EU 2005-2022
Source: author's own processing

Examination of the data presented in the previous graph for the period 2005-2022 reveals a trend of convergence in the inflation rate between Romania and the European Union. We note that Romania has experienced a consistent reduction in inflation from 9.01% to 4.84% over the period 2005-2007, while the inflation rate in the EU has shown minor variations. Notable is the year 2008, marked by the global financial crisis, when both inflation rates increased, with Romania reaching 7.85%, compared to 4.16% in the EU. Between 2013 and 2016, Romania experienced a steep decline in inflation, reaching deflationary levels in 2015 and 2016, while the EU maintained an inflation rate, albeit moderate, indicating a relatively more stable economy. In the context of multiple crises in 2021 and 2022 - war, pandemic, energy crisis - both inflation rates have increased significantly, with a more pronounced rise in Romania (from 5.05% to 13.80%), in contrast to the EU (from 2.55% to 9.22%). This suggests a higher vulnerability of Romania's economy to external economic shocks and a reduced capacity to absorb these impacts compared to the EU average. An alternative approach to measuring inflation is the GDP deflator. This index, as developed in the theoretical section, reflects the price level for an extensive basket of goods and services representative of the economy as a whole, including investment goods, exports, government services, and consumer goods and services. The path of the GDP deflator over the period 2005-2021 for Romania and the European Union is illustrated in the figure 3.

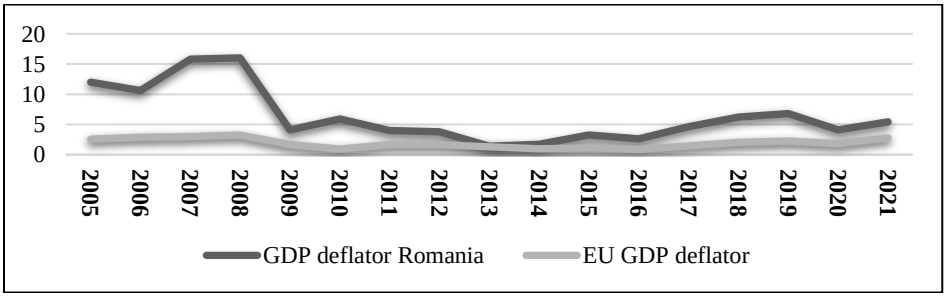

Figure 3. Evolution of GDP deflator Romania vs EU 2005-2021
Source: author's own processing

The analysis of the GDP deflator rate reveals that in 2005 Romania recorded a value of 12.01% for this indicator, significantly higher than the average of 2.54% recorded by the European Union. This discrepancy suggests a prevalence of inflation in the Romanian economy above the average level observed in the EU, a phenomenon

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Issue 2 / **June** 2023 ISSN-L 2344-102X

frequently correlated with the general increase in prices in the economy. Contributing factors may include accelerating changes in the structure of national consumption and exponential increases in production costs. After 2005, Romania's GDP deflator showed a downward trend, but remained above the EU average until 2008, when it peaked at 16.02%, compared to 3.24% in the EU, in the context of the global economic crisis. This indicates a significantly more severe impact of the crisis on Romania compared to the EU. In 2009, both GDP deflator rates fell sharply, but the decline was much more pronounced in Romania (4.09%) compared to the EU (1.68%). In the period 2010-2014, Romania's GDP deflator continued to be higher than that of the EU, signaling relatively higher inflation, but showed relative stability, suggesting a phase of economic stabilization. This trend continued until 2021, with Romania's GDP deflator rates exceeding EU averages.

In view of these observations, the next stage of our analysis focuses on the evolution of Gross Domestic Product (GDP) in Romania, as well as on the average recorded in the European Union, as this indicator is widely recognized for assessing the size of an economy. It is assumed that an increase in GDP indicates an overall expansion of the economy and vice versa. The purpose of this analysis is to determine whether periods of economic growth correspond to times when inflation has reached high levels. To illustrate this point, we will use indicators of percentage change in GDP. Thus, the trends in GDP in Romania and the European Union can be seen in the figure below.

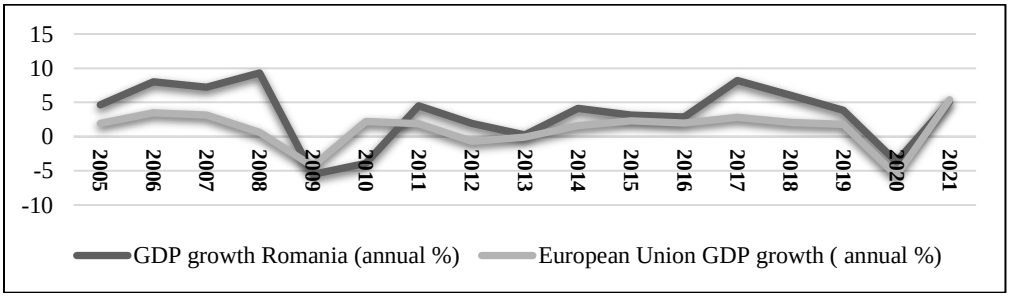
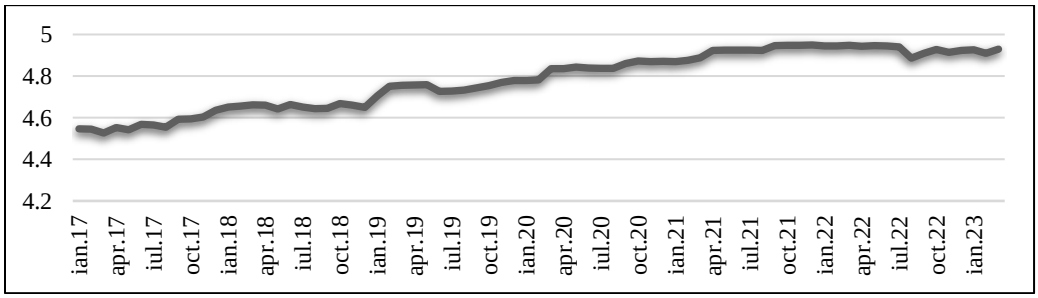


Figure 4. GDP growth (in % per year) Romania vs European Union
Source: author's own processing

According to the data illustrated in the previous figure, it can be seen that in 2005 and 2006, Romania's economy experienced a Gross Domestic Product (GDP) expansion of 4.67% and 8.03% respectively, while the Consumer Price Index (CPI) and the GDP deflator recorded high values (9.01% and 6.56% for the CPI, respectively 12.01% and 10.61% for the GDP deflator). This trend indicates that inflationary pressures remained significant during periods of economic expansion. In the 2007-2008 period, we observe accelerating GDP growth in Romania, with inflation rates remaining high, peaking at 16.02% for the GDP deflator in 2008. This correlates with economic theory which postulates that rapid economic growth can lead to inflation when demand exceeds supply.

In 2009 and 2010, both Romania and the European Union suffered a contraction in GDP as a direct result of the global economic crisis. During this period, inflation rates fell significantly, indicating a slowdown in economic activity and an easing of inflationary pressures. The period 2011-2014 marked signs of economic recovery in Romania, with moderate GDP growth and low inflation rates, suggesting economic stabilization and effective management of inflationary pressures. Between 2015 and 2021, apart from 2020 marked by the Covid-19 pandemic, Romania has seen steady GDP growth. The data indicate that the European Union has managed to maintain a more effective balance between economic growth and inflation control compared to Romania.

The next stage of our analysis focuses on the assessment of the strength of the national currency, the Romanian Leu (RON), against the Euro (EUR). In order to get a perspective on past developments, we will focus on the evolution of the RON/EUR exchange rate, which will be presented in the following figure:



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Issue 2 / June 2023 ISSN-L 2344-102X

Figure 5. RON/EUR exchange rate evolution

Source: author's own processing

The analysis of the figure 5 presented above highlights a general depreciation trend of the Romanian leu against the euro during the period under review. This depreciation trend can be attributed to a higher inflation rate in Romania compared to the European Union. Another relevant factor in this dynamic is an increased current account deficit, requiring financing through the sale of local currency and the purchase of euro. There is also a steady increase in the exchange rate from the end of 2018 to 2021, with minimal fluctuations. This period coincides with a climate of economic and political uncertainty, both in the European Union and in Romania, factors that could have led to a risk-averse trend and increasing pressure on the domestic currency. We see, from August 2022 onwards, a steep fall in the exchange rate, followed by a period of stabilization and then a slight rise. These developments may point to an improvement in Romania's economic situation and/or an easing of inflation, thus supporting the appreciation of the leu against the euro.

Considering the elements discussed, we identify a trend of convergence between the inflation rate in Romania and that in the European Union, based on both the Consumer Price Index (CPI) and the GDP deflator. However, in most of the periods analyzed, inflation in Romania has remained consistently above the European Union average. Paradoxically, in terms of economic growth, Romania's Gross Domestic Product has shown an evolution consistently above the European Union average, with domestic consumption being the main driver of growth, as shown in Table 8. It is worth noting that some periods of economic growth seem to correspond to times of high inflation. Consequently, the following sub-chapter aims to deepen the analysis of the relationship between inflation and economic growth in Romania and the European Union. For this purpose, we processed data using SPSS statistical software and developed two econometric models - one specific to Romania and one to the European Union - to elucidate this relationship.

Analysis of the relationship between inflation and economic growth in Romania and the European Union

As mentioned in the methodology section, the econometric models were run in SPSS software. Following the data processing, the best models resulted by developing simple linear regression models, whose representation is given by the following equation for the CPI:

$$GDP = \alpha + \beta 1 * CPI + \varepsilon \qquad (1)$$

Inflation, represented by the CPI indicator, is the independent variable in our models, while GDP is the dependent variable. Thus, after running the models, according to the Summary table, we show that between the independent variable CPI (inflation) and the dependent variable GDP there is a significant correlation of 71.8% in the case of the EU and 72.1% in the case of Romania.

Table 2. Summary of models

Model	R	R Square	R Square Adjusted	Standard Error of Estimation	Durbin-Watson
European Union	0,718 [a]	0,489	0,361	2.94172E+12	2,124
Romania	0,721[a]	0,485	0,364	6.8592E+10	2,423
a. Dependent variable: GDP **b. Predictors: CPI**					

Source: Own processing in SPSS 25

The coefficient of determination (adjusted R-squared) shows the proportion of the variance of the dependent variable (CPI - Inflation) that can be explained by the independent variable (GDP). In this case, GDP explains approximately 48.9% of the variation in the CPI for the European Union and 48.5% for Romania. The following table, referred to as ANOVA, aims to test the model developed to ensure that it can be accepted and used. Thus, the results of the following table can be seen below:

Table 3. ANOVA

Model		Sum of Squares	df	Mean Square	F	Mr
European Union	Regression	1.555E+26	1	1.555E+26	17,964	0,000[b]
	Residual	2.51E+26	29	8.654E+24		
	Total	4.064E+26	30			
Romania	Regression	8.559E+22	1	8.559E+22	18,191	0,000[b]
	Residual	1.364E+23	29	4.705E+21		
	Total	2.220E+23	30			
a. Dependent variable: GDP **b. Predictors: CPI**						

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Issue 2 / June 2023 ISSN-L 2344-102X

Source: Own processing in SPSS 25

According to the ANOVA table, the econometric models developed for the two regions are validated with a probability of more than 95%, given that Sig. is lower than the statistical significance threshold of 0.05. Thus, the linear regression models are significant and can be used to explain the link between CPI (inflation) and GDP (economic growth) for the two regions. The following table, provides the valuable information on the strength of influence of the independent variable on the dependent variable thus:

Table 4. Model coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Mr
		B	Std. Error	Beta		
European Union - 1	(Constant)	1.556E+13	1.035E+12		15.027	0,000
	CPI EU	**-14658732102**	3.459E+11	-0,558	-4,238	0,000
Romania -2	(Constant)	1.573E+11	1.447E+10		10.871	0,000
	IPC Romania	**-735375297**	172417116	-0,621	-4,265	0,000
Dependent variable: GDP EU (1); GDP Romania (2)						

Source: Own processing in SPSS 25

Based on the data in the above table we can develop the equations of the two simple linear regression models. The equations are as follows:

The EU model:

$$GDP\ UE = 1.556E13 - 1465873102 * CPI\ UE \quad (2)$$

The Romanian Model

$$GDP\ RO = 1{,}573E11 - 735375297 * CPI\ RO \quad (3)$$

Analysis of the econometric model results shows that CPI (inflation) has a negative coefficient in both models, indicating an inverse relationship between CPI (inflation) and GDP. This finding logically aligns with the assumption that higher inflation has adverse consequences for economic growth. This negative correlation can be attributed to various factors, as discussed in the theoretical section of the paper, including the erosion of consumer purchasing power, rising business costs, economic uncertainty and instability that can negatively influence investment. In an inflationary environment, reduced consumer purchasing power can lead to a decline in demand for goods and services, thus negatively affecting output. Periods of inflation are also often associated with rising production costs, which can discourage investment and therefore lead to a decline in economic dynamism. Regarding the difference between the coefficients of the two models, we note that the coefficient for CPI (inflation) in the EU model is significantly higher (in absolute value terms) than in the Romanian model. This indicates that in the European Union, a unit increase in CPI (inflation) has a more pronounced impact on GDP than in Romania. In other words, an increase in inflation in the EU will have a more significant impact on economic growth, with an estimated impact of more than USD 1.5 billion.

In conclusion, the econometric models developed in this paper suggest that inflation has a negative effect on economic growth (GDP), with a stronger impact in the European Union than in Romania. It is essential to approach these models with caution, recognizing that they represent a simplification of the complex reality and that the relationship between inflation and economic growth is influenced by many other variables, which cannot be fully integrated into a single model. Finally, we believe that the objective of this paper, to develop two econometric models illustrating the relationship between inflation and economic growth, both in the Romanian and EU contexts, has been successfully achieved.

V. CONCLUSIONS

In this paper, we have analyzed the economic dynamics of Romania and the European Union, focusing on the evolution of inflation (CPI and GDP deflator), but also on the growth of the economy (GDP). On the basis of the econometric models we have identified a negative correlation between inflation and economic growth, valid for both Romania and the European Union. We observe that during periods of economic growth in Romania, inflation showed high levels, but the economy continued to grow steadily, except in 2020, when the Covid-19 pandemic had a significant impact. In contrast, the European Union has shown more effective inflation management, maintaining a favorable

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balance between growth and inflation. The exchange rate analysis also revealed a depreciating trend of the Romanian leu throughout the period analyzed, suggesting higher inflation in Romania compared to the EU average, also influenced by the widening current account deficit.

At the same time, the econometric models in this paper highlight an inverse relationship between inflation (CPI) and economic growth (GDP) in both the EU and Romania. The coefficients of the models indicate that an increase in inflation would generate a decrease in GDP. Note that the impact of inflation on GDP is more pronounced in the EU than in Romania, with a difference in impact of more than $1.5 billion for a unit change in inflation. These findings align with economic theory, which posits that excessive inflation can erode consumer purchasing power and increase costs for businesses, generating economic uncertainty and instability. Moreover, it is essential to recognize that econometric models cannot incorporate all the variables that influence the relationship between inflation and economic growth, so caution is required in interpreting the results. Future research could benefit from expanding the variables analyzed and exploring in more detail the interaction between inflation and economic growth in different economic contexts. It would be useful to look at inflation in emerging economies or in different regions to provide a global perspective on this phenomenon and to further investigate the impact of monetary policy on inflation.

Although this paper has been largely based on public data and expert studies, it must be acknowledged that there are certain limitations, such as the narrowness of the perspectives addressed and the influence of macroeconomic dynamics on the results. Nevertheless, the results obtained can be valuable for a wide range of stakeholders, including economic policy makers, who can use the information to shape and adjust policies, especially those targeting inflation and growth. The paper contributes to the creation of effective strategies and informed, evidence-based decision-making.

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