

# Methods of Measuring and Analyzing Inflation and Its Effect on Economic Growth

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## Abstract

*This paper delves into the relationship between inflation and economic growth, two pivotal elements in contemporary economic discussions. It aims to demystify and elucidate these concepts, particularly examining how they are interlinked through the development of a comprehensive econometric model. The study pays special attention to key economic indicators such as the Consumer Price Index (CPI), Producer Price Index (PPI) and the growth rate of Gross Domestic Product (GDP). In addition, the paper considers the role of monetary and fiscal policies in managing inflation and fostering economic growth. This exploration not only contributes to a deeper understanding of economic dynamics but also offers valuable insights for policymakers and economists in formulating effective economic strategies.*

**Key words:** Consumer Price index, economic growth, econometric model, inflation, monetary and fiscal policies

**J.E.L. classification:** E30, E31, E37

## 1. Introduction

The topicality and importance of this paper derives from the fact that the inflationary problem is still a relevant issue that is being addressed through monetary and fiscal policies. Alongside this, from the point of view of human progress, economic growth is also an important issue. This importance derives from the fact that the prosperity of nations is linked to the recorded performance of economic growth. The economic growth of any country reflects its ability to increase the production of goods and services.

The aim of this paper is to clarify the concepts of inflation and economic growth and to determine their dependence by constructing an econometric model that analyses the effect of inflation on economic growth.

Inflation is often determined by the Consumer Price Index (CPI), to which is added the Producer Price Index (PPI) or GDP deflator. Economic growth is most often stated as the growth of the Gross Domestic Product (GDP) of the country concerned. Hence the main objective of this paper is to identify a set of indicators that determine inflation and influence economic growth, with which to build a valid econometric model.

The secondary objectives of the research are to clearly define and understand the concepts of inflation and economic growth, to identify theories and explanatory models of inflation, to identify the positive and negative effects of inflation on economic growth, and to identify monetary and fiscal policies in the context of inflation and economic growth.

The objectives, both primary and secondary, are achieved in the three sections of the paper. Thus, the paper is structured into three chapters, the first two consisting of a theoretical part and the last one representing a practical part.

## 2. Literature review

The complex relationship between inflation and economic growth has long captivated economists, sparking diverse theories and extensive empirical research (Khan et al., 2022). Historically, the discourse around inflation and economic growth has been rich and varied. Early economic theories, particularly those of Keynes and Friedman, laid the foundational perspectives on how inflation could influence economies (Aganbegyan, 2022). Keynes highlighted the short-term trade-offs between inflation and unemployment, suggesting a complex interplay with economic growth. Friedman's monetarist perspective, on the other hand, emphasized the long-term neutrality of money, redirecting the focus towards inflation's monetary roots.

Progressing into theoretical frameworks, various models have been developed to explain the dynamics between inflation and growth. The Phillips Curve, for instance, proposed an inverse relationship between inflation and unemployment, indirectly implicating economic growth. However, this model's applicability has been questioned over time, especially considering the stagflation episodes of the 1970s (Bowles et al., 2020). Monetarist theories provided a more monetarily focused view, asserting that inflation is primarily a result of changes in the money supply. New Keynesian models introduced elements like price stickiness and short-term non-neutrality of money, offering nuanced views on the inflation-growth nexus. Empirical research provides a more grounded understanding of this relationship. Various studies have demonstrated that the impact of inflation on economic growth can differ significantly across countries and economic contexts. For instance, research focusing on developed economies often reveals a different inflation-growth dynamic compared to studies centered on developing economies (Stoica et al., 2020). Additionally, comparative analyses across different economic systems and periods have highlighted the diversity of experiences and policy outcomes.

Central to this discussion are key economic indicators like the Consumer Price Index (CPI) and Producer Price Index (PPI). The methodologies behind these indices are crucial for accurately measuring inflation. Similarly, the Gross Domestic Product (GDP) growth rate is an essential indicator of economic growth. The interplay between these indicators provides vital insights into how inflation and growth are interconnected in the practical economic scenario (Saymeh et al., 2013). Monetary and fiscal policies also play a significant role in shaping this relationship. Central banks utilize various tools, such as interest rate adjustments and controlling the money supply, to manage inflation and stimulate growth. Government fiscal policies, through mechanisms like spending and taxation, further influence this dynamic. The literature offers a range of perspectives on the effectiveness of these policies in different economic conditions (Combes et al., 2018). In the realm of contemporary challenges, phenomena like hyperinflation, stagflation, and the impacts of globalization are increasingly relevant. The interconnectedness of global economies has added complexity to the traditional narratives of inflation and economic growth, prompting a need for a more globalized perspective in economic analysis.

## 3. Research methodology

The present study has been carried out on a database containing the values of certain indicators at the Romanian level relating to inflation and economic growth over a 10-year period. The aim of the study is to check whether the value of GDP is influenced by the value of the consumer price index, the industrial production price index and foreign direct investment. If a dependence is confirmed between these variables, the objective of the research is to determine and analyse how GDP is influenced by the other variables and to draw conclusions based on econometric analysis.

In the first stage of the research, data from the NBR reports were processed. With the help of these, a database was created in which the values refer to economic indicators recorded at the Romanian level and covering a 10-year period, i.e. 2012-2021. The database was developed in the Excel program offered by the Microsoft suite. The indicators that were mainly targeted were GDP, CPI (consumer price index) and FDI (foreign direct investment). The main objective was to observe how GDP is influenced by the other indicators already mentioned. To do this, I ran a multiple regression model using IBM SPSS Statistics 26. GDP was defined as the dependent variable, the other indicators being independent variables. A particularly important part of this

study consisted in observing the influence that the independent variables have on the dependent variable, and then developing an explanation to justify this behaviour from an economic perspective. In the final stage, a histogram and a P-P Plot were constructed, based on which we formulated some conclusions regarding the validity of the chosen model.

#### 4. Findings

The development and processing of economic information within the database played a key role in developing an econometric model to establish a relationship between the variables GDP (in billions of dollars), CPI and FDI (in billions of dollars). For data analysis and regression model validation, we used IBM SPSS Statistics 26 software. The purpose of the proposed model is to assess the dependence link between the dependent variable GDP and the independent variables CPI and FDI, as shown in Table 1.

Table no. 1 Variables analysed

Variables Entered/Removed <sup>a</sup>			
Model	Variables Entered	Variables Removed	Method
1	FDI (bn \$), CPI <sup>b</sup>	.	Enter
a. Dependent Variable: GDP (bn \$)			
b. All requested variables entered.			

Source: Own processing in SPSS 26

The dependent variable GDP represents Romania's gross domestic product over the period 2012-2021. Gross Domestic Product (GDP) is a macroeconomic measure reflecting the total market value of all goods and services for final consumption produced within a country during a year in all sectors of the economy. GDP is also the most widely used indicator for measuring economic growth. CPI, the consumer price index, is the most widely used indicator for measuring inflation. It is calculated using permanent weights for the goods and services included in the consumption basket. The consumer price index measures the overall change in the prices of goods purchased and charges for services used by the population in a specific period compared with a previous period. The independent variable FDI refers to foreign direct investment. These are financial capital flows made by foreign investors into a country to own or control local businesses. They bring economic benefits through the transfer of capital, technology and job creation, stimulating economic growth and development in the host country. Both CPI and FDI figures cover the period 2012-2021.

The aim of our analysis is to determine the relationship of GDP dependence on several influencing factors. For this, we use a multiple linear regression model of the type: The dependent variable GDP represents Romania's gross domestic product over the period 2012-2021. Gross Domestic Product (GDP) is a macroeconomic measure reflecting the total market value of all goods and services for final consumption produced within a country during a year in all sectors of the economy. GDP is also the most widely used indicator for measuring economic growth. CPI, the consumer price index, is the most widely used indicator for measuring inflation. It is calculated using permanent weights for the goods and services included in the consumption basket. The consumer price index measures the overall change in the prices of goods purchased and charges for services used by the population in a specific period compared with a previous period. The independent variable FDI refers to foreign direct investment. These are financial capital flows made by foreign investors into a country to own or control local businesses. They bring economic benefits through the transfer of capital, technology and job creation, stimulating economic growth and development in the host country. Both CPI and FDI figures cover the period 2012-2021.

The aim of our analysis is to determine the relationship of GDP dependence on several influencing factors. For this, we use a multiple linear regression model of the type:

$$GDP = \alpha + \beta_1 * FDI + \beta_2 * CPI + \varepsilon$$

Where:

- GDP is the dependent variable of the model;
- FDI, CPI are the independent variables;

- $\alpha$ ,  $\beta_1$ ,  $\beta_2$  are the regression model parameters;
- $\varepsilon$  is the random error variable.

This stage of the research aims to demonstrate that the model developed adequately describes the economic problem under analysis and provides a high level of confidence. The aim is to determine the degree of sensitivity of the dependent variable to variations in the independent variables. Furthermore, table number 2 shows the value of the correlation ratio.

Table no. 2 Summary of the model

Model Summary <sup>b</sup>					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,979 <sup>a</sup>	,958	,946	8,70460	2,175
a. Predictors: (Constant), FDI (mld \$), CPI					
b. Dependent Variable: GDP (mld \$)					

Source: Own processing in SPSS 26

Table Summary provides information on the strong influence of the variables used in the econometric model design. The coefficient of multiple correlation (R) measures the strength of the relationship between the selected variables, and the coefficient of multiple determination (R square) indicates the proportion of the variation in goodwill explained by the variation in the independent variables. We observe that both R and R square exceed the threshold of 0.75, suggesting a very strong correlation between the variables of about 97.9%, and that 95.8% of the variation in GDP is explained by the variation in the independent variables.

FDI can contribute to GDP growth through investment in new businesses or expansion of existing businesses. These investments can generate jobs, boost output and economic growth. Through FDI, new production capacities can be created, technology and knowledge can be transferred, and innovations can be promoted, all of which contribute to GDP growth through increased economic output. Foreign direct investment often brings with it the transfer of technology and know-how. Foreign companies can introduce new technologies, efficient production practices and innovative methods in the host country. This technology transfer can improve productivity and efficiency in different sectors of the economy, leading to increased output and GDP (Hansen et al., 2006, p. 21). Foreign direct investment can create jobs in the host country. By opening new businesses or expanding existing ones, it can provide employment opportunities for the local population. This can increase incomes and living standards, which in turn can boost domestic demand and consumption. Foreign direct investment can play an important role in stimulating local investment and developing a country's private sector. Through partnerships and collaboration with foreign investors, local businesses can benefit from access to capital, technology and resources, which can increase their competitiveness and capacity to grow. Foreign direct investment can also help integrate a country into global supply chains. Through foreign investment, a country can become an attractive destination for the production or assembly of components or products that are exported to other countries. This can increase exports and bring additional revenue into the economy, which has a positive impact on GDP (Agrawal et al., 2011, p. 72).

The CPI measures the increase in prices of goods and services consumed by the population. If the CPI rises, it means that prices are rising in the economy, which can lead to a reduction in consumer purchasing power. In this case, consumers may spend less, which can have a negative impact on aggregate demand and thus on GDP. If inflation is persistent and prices continue to rise at an accelerating pace, consumers and businesses may become more cautious about spending and investment, which may negatively affect economic growth and GDP. The CPI can also influence consumer purchasing power. If prices rise rapidly over a period of time and consumer incomes do not adjust accordingly, then consumer purchasing power falls. A fall in purchasing power may lead consumers to spend less and look for cheaper alternatives or reduce discretionary spending. Aggregate demand can thus be negatively affected, which can lead to a fall in economic output and thus GDP. The CPI can also affect the cost of production for businesses. If the prices of goods and

services needed in the production process rise rapidly, then production costs for businesses may increase. This can reduce profits and discourage investment in new production capacity or business expansion. If investment is negatively affected, there may be a reduction in economic output and GDP. Monetary authorities and governments can use monetary and fiscal policies to influence inflation and the CPI. For example, by adjusting interest rates or fiscal policy, they can try to control inflation. If inflation is high and prices are rising rapidly, the authorities may take measures to reduce inflation, but these measures may also have an impact on GDP. For example, monetary tightening or tight fiscal policies can reduce spending and investment, which can negatively affect GDP (Savmeh et al., 2013, p. 353).

In order to validate the multiple linear model econometrically, we perform the anova test in Table 3.

Table no. 3 Anova test

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12057,373	2	6028,686	79,565	,000 <sup>b</sup>
	Residual	530,391	7	75,770		
	Total	12587,764	9			
a. Dependent Variable: GDP (bn \$)						
b. Predictors: (Constant), FDI (bn \$), CPI						

Source: Own processing in SPSS 26

According to the results presented in the anova table, the values of the variance components are as follows: the estimated explained variance is 12057.373, the estimated residual variance is 530.391, and the estimated total variance is 12587.764. The Fisher test has a value of 79.565. The Sig value is significant in accepting the model econometrically. When its value is less than 0.05, the multiple linear model is 95% validated. In our case, the Sig value is 0, less than 0.05, which indicates that the selected independent variables have a significant influence on the variation of the dependent variable, GDP. Therefore, the chosen multiple regression model is representative. Table 4 shows the coefficients of the model.

Table no. 4 Model coefficients

Coefficients <sup>a</sup>								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-407,566	142,671		-2,857	,024	-744,929	-70,203
	CPI	4,563	1,460	,272	3,125	,017	1,111	8,016
	FDI (bn\$)	2,101	,222	,824	9,449	,000	1,575	2,626
a. Dependent Variable: GDP (bn \$)								

Source: Own processing in SPSS 26

The table shows the regression parameters of the model, which allow us to determine the estimated equation. This equation allows us to rewrite the GDP according to the factors analysed, having the following form:

$$GDP = -407,566 + 2,101 * FDI + 4,563 * CPI$$

The intervals from which  $\alpha$ ,  $\beta_1$ ,  $\beta_2$  can take values are (-744.929; -70.203), (1.575; 2.626), (1.111; 8.016) respectively.

Also, in the table we can observe the t-values corresponding to the independent variables, respectively 9.449 for FDI and 3.125 for CPI.

The most important parameter in the table is Sig, as it provides information about the significance and influence of the independent variables on the dependent variable, in this case

GDP. Lower values of Sig indicate a more significant influence of the independent variables on GDP and how they influence it. If several variables have equal values for Sig, their order can be determined according to the values of the parameter t. The variable with a higher value of t will have a stronger influence on the dependent variable.

In the case of our model the order is as follows, foreign direct investment (FDI - bn \$), followed by the consumer price index (CPI).

From an econometric perspective, the interpretation of the Coefficients table is as follows:

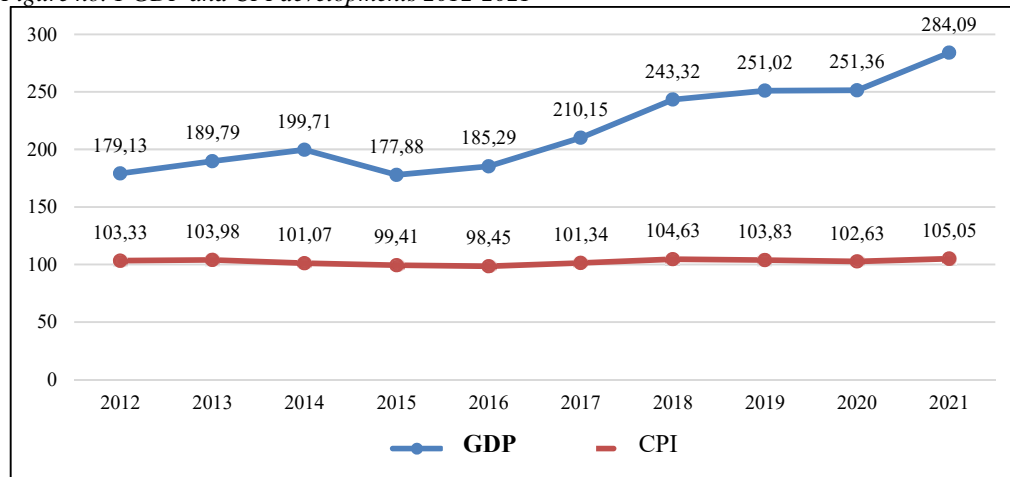
- If the value of the CPI variable increases by one unit and the value of the FDI variable remains constant, then GDP is estimated to increase on average by 4.563 units;
- If the value of the FDI variable increases by one unit and the CPI value remains constant, then GDP is estimated to increase on average by 2.101 units.

Foreign direct investment (FDI) as a growth-enhancing component has received a lot of attention in developed countries, even in developing and less developed countries in recent years. It has been a matter of greater concern to economists how FDI affects the economic growth of the host country's economy. In the closed economy there is no access to foreign instruments and savings, as this type of economy relies exclusively on domestic sources of savings and investment. But in the open economy, investment comes from both sources, either domestic savings or foreign capital flows such as FDI. FDI enables the host country to achieve a level of investment beyond its capacity to improve GDP and economic growth (Iqbal et al., 2014, p. 79).

There is a link between the CPI and GDP. If the CPI is growing faster than GDP, this may indicate high inflation. If consumer prices are rising faster than the value of economic output, then there is pressure on consumer purchasing power, which can lead to a reduction in demand for goods and services. As a result, GDP may be negatively affected. On the other hand, GDP growth at a faster pace than the CPI may indicate healthy economic growth and moderate inflation. If the economy is growing at a faster pace than prices, this may indicate that economic output is growing and that demand for goods and services is sustained. In this case, GDP can be positively influenced (Savmeh et al., 2013, p. 353).

This is also true in reality and the figure below illustrates the evolution of GDP and CPI indicators over the period under review.

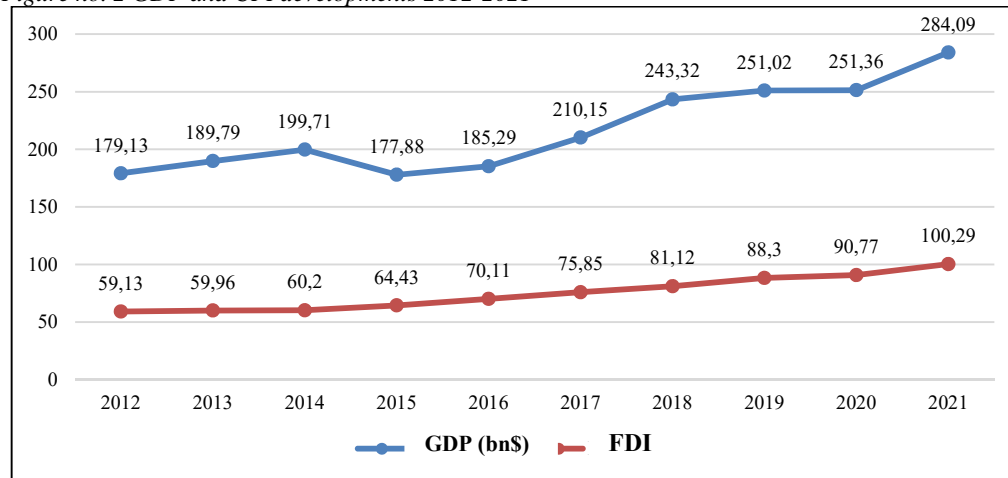
Figure no. 1 GDP and CPI developments 2012-2021



Source: Own processing in Microsoft Excel

The graph shows an upward trend in GDP, unlike the CPI which has remained relatively constant. The year 2015 is the only year in the period analysed in which the value of GDP decreased, with the largest increases in 2018 (from \$210.15bn to \$243.32bn) and 2021 (from \$251.36bn to \$284.09bn). We can also see that an increase in CPI does not always imply a decrease in GDP, like for example the period 2020-2021, as moderate inflation can be beneficial for economic growth. To observe the evolution of FDI over the period analyzed, we have made chart 2.

Figure no. 2 GDP and CPI developments 2012-2021



Source: Own processing in Microsoft Excel

From the graph it can be seen that foreign direct investment has been on an upward trend, increasing every year during the period analysed, reaching 59.13 billion euro in 2007. in 2012 to 100.29 bn. An upward trend in FDI may indicate an economic and stable environment, favorable government policies for foreign investment, and a favorable long-term growth outlook. Table 5 provides information on residual values, illustrating how well our model can forecast.

Table no. 5 Residuals Statistics

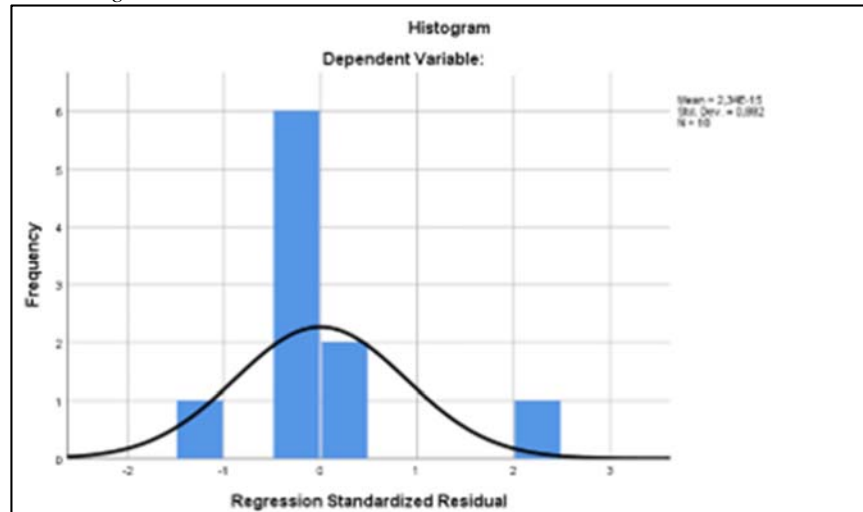
Residuals Statistics <sup>a</sup>					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	180,1080	282,4886	217,1740	36,60202	10
Std. Predicted Value	-1,013	1,784	,000	1,000	10
Standard Error of Predicted Value	3,184	5,989	4,683	,945	10
Adjusted Predicted Value	174,7242	281,1577	217,6908	35,96800	10
<b>Residual</b>	<b>-9,04322</b>	<b>19,60197</b>	<b>,00000</b>	<b>7,67674</b>	<b>10</b>
Std. Residual	-1,039	2,252	,000	,882	10
Stud. Residual	-1,289	2,542	-,024	1,021	10
Deleted Residual	-13,91138	24,98575	-,51683	10,34691	10
Stud. Deleted Residual	-1,366	8,505	,572	2,830	10
Mahal. Distance	,304	3,360	1,800	1,059	10
Cook's Distance	,000	,592	,112	,191	10
Centered Leverage Value	,034	,373	,200	,118	10

a. Dependent Variable: GDP (bn \$)

Source: Own processing in SPSS 26

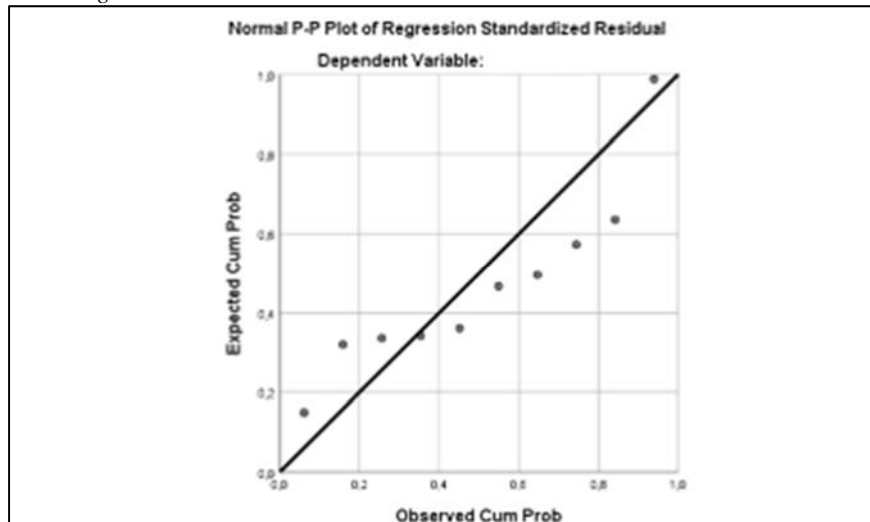
GDP is influenced by the selected independent variables, but sometimes the actual figures may vary from those identified by the multiple regression model. In this context, in the table, the minimum and maximum values of the residuals are particularly important. In our model, we identified that the minimum point of the residual is -9.04322, while the maximum point is 19.60197. The histogram and P-P Plot of the model are shown in Figure 3 and Figure 4 respectively.

Figure no. 3 Histogram



Source: Own processing in SPSS 26

Figure no. 4 Diagram P-P Plot



Source: Own processing in SPSS 26

The histogram plots the data and should have a shape similar to a Gaussian bell. The P-P Plot is used to assess the fit of the distribution of variables to a specified distribution. If the standardized residuals follow a normal distribution, the points should roughly line up on the normal distribution line, indicating a fit between the data and the specified distribution. Looking at our plots, we observe that the histogram shows an almost uniform distribution, but we can see that the distribution is imperfect, as in the P-P Plot, because the GDP variable is influenced by factors other than those considered in our model. From our analysis we can conclude that there is a correlation between the chosen variables. This correlation can be better observed in Table 6.



Table no. 6 Correlations

Correlations				
		GDP (bn \$)	CPI	FDI (bn \$)
Pearson Correlation	GDP (bn \$)	1,000	,648	,948
	CPI	,648	1,000	,456
	FDI (bn \$)	,948	,456	1,000
Sig. (1-tailed)	GDP (bn \$)	.	,021	,000
	CPI	,021	.	,093
	FDI (bn \$)	,000	,093	.
N	GDP (bn \$)	10	10	10
	CPI	10	10	10
	FDI (bn \$)	10	10	10

Source: Own processing in SPSS 26

Foreign direct investment and the consumer price index, have a significant influence on the variation of the dependent variable GDP. Using the data provided by the SPSS program, we had access to tables that provide relevant information about the multiple correlation ratio R and the multiple determination ratio R square. Both ratios recorded significant values, exceeding the 75% threshold, thus confirming the compatibility of the model. Also, the Sig value recorded is 0, which is within the 0.05 limit, and the  $F > 0$  test demonstrates the existence of a strong relationship between the selected variables. It should be noted that the histogram does not have an identical shape to the Gaussian bell. This discrepancy shows that there are no perfect models in economics. The imperfection of the curve is the result of the influence of other factors on the GDP variable, which were not included in our study.

## 5. Conclusions

Methods of measuring both inflation and economic growth are important to highlight. They refer to certain indicators that are calculated when it is desired to determine the value of inflation or economic growth. Thus, the most commonly used indicators when referring to inflation are the consumer price index, the producer price index and the GDP deflator. As for economic growth, the most commonly used indicators for measuring it are gross domestic product and gross domestic product per capita.

Another important point to note is the theories and models explaining inflation. Demand-pull theory, cost-push theory, monetarist theory, structural theory and international transmission theory are the most popular theories explaining inflation. Of the inflation models, the most common are the monetary model, the cost model, the aggregate demand model and the expectations model.

In terms of the relationship between inflation and economic growth, the latter can be influenced both positively and negatively by the former. Stimulating consumption and investment, reducing real debt, supporting exports are some of the positive effects of inflation on growth. In antithesis, reduced consumer purchasing power, economic instability and uncertainty, unequal income distribution are some of the negative effects of inflation.

Price stability has become the overriding objective of modern central banks, which are primarily concerned with fighting inflation in order to increase economic growth, so monetary as well as fiscal policies play a particularly important role, as through them central banks and governments can help achieve a stable and sustainable economy.

Based on the correct econometric model, we can conclude that the value of GDP is influenced by changes in the independent variables that we have analysed in our model, i.e. FDI and CPI. The relationship between CPI and GDP can vary depending on economic conditions and the level of inflation. If inflation is moderate and GDP is growing at a healthy pace, this may indicate a favourable economic situation. However, high inflation and weak GDP growth may signal economic problems that need to be addressed. The impact of FDI on GDP may vary depending on government policies, the business environment, infrastructure and other country-specific

conditions. Despite this, in general, FDI can play a significant role in boosting economic growth and GDP. In addition, it should be noted that the econometric model presented is not perfect as there are other factors that influence GDP. The identification and analysis of these factors may be directions for future research.

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