IMPACT OF THE CONSUMER PRICE INDEX ON GROSS DOMESTIC PRODUCT IN ROMANIA

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Abstract
This paper presents the influence of the consumer price index on the economic growth of Romania over a period of 28 years, based on the annual data, 1991-2018. The increase of the values of the gross domestic product ensures a sustainable economic growth in Romania. It is proposed to use the cubic analysis model. The results obtained from the analysis show the influence of the consumer price index (CPI) on the gross domestic product (GDP).

Key words: *consumer price index, gross domestic product, cubic model*

JEL Classification: *C21, C51, C87*

I. INTRODUCTION

Economic growth is an important factor in the economic development of a country and plays an essential role in the economic policy of each country. The evolution of the measure of the change of the prices of all new products, products in Romania, finished products and services represents the deflator of the gross domestic product (GDP) and associated with the consumer price index (CPI), characterizes the fluctuation of the economic growth or decrease of a country.

The consumer price index (CPI) is an important macroeconomic phenomenon, is calculated annually and measures the price evolution of a fixed basket of goods and services used by an average household every year. The National Institute of Statistics determines the composition of this basket and also its weight in the total expenses. The value of the CPI is very important for both investors and the national economy, being used to establish the monetary policies respectively to adjust the mechanisms of the monetary flow. The increase or decrease of the CPI influences the economic activity of the investors, for this reason the value of the CPI must be known by them and, depending on it, they should resize their investments. Rising prices of goods and services in an economy, leads to an increase the value of CPI. During the last two decades, within the European Union (EU), the CPI has grown at a relatively modest rate. In the period 2000-2007 it has a value in the range 101.2 - 102.3. Since 2008, according to Eurostat Statistics Explaind, higher volatility in food and, in particular, energy prices, has led to general changes in the value of the CPI. In the EU, in 2008 the CPI has a value of 103.7 much lower than in the case of Romania, a developing country. Due to the political movements and the financial crisis in the EU in the period 2008-2014, the rate of increase of prices slowed down to 0.6% in 2014 and negative inflation rates were recorded. During this period, Romania also registered decreases in the value of CPI, but without registering a negative inflation. The overall change in the ICC in the EU was 20.9%, similar to the rate registered in the United States (22.1%). Between 2005 and 2014, prices for energy and non-energy industrial products in the EU have the highest growth rate, and food prices for services have increased at a slow pace, but have an influence on the CPI. In EU member countries, the value of CPI differs from country to country.

Gross domestic product (GDP) represents the market value of all goods and services of a final country and is calculated annually. The economic crisis in Romania in the period 2008-2010 has led to a significant decrease in GDP and CPI.

According to [Ţigănescu, 2002] there are three fundamental differences between the CPI and the GDP deflator, namely:

- the deflator includes a much larger group of goods and services than the one used in the calculation of the CPI,
- CPI measures the evolution of the prices of a given basket of goods, the same every year (which is not the case for the deflator)
- The CPI also includes the prices of imported products, while the deflator includes only the prices of goods produced inside the country.

In the paper [Sarel, 1995], it is analyzed the possibility of non-linear effects of the CPI on the economic growth, when this indicator has a critical value of 108. Below this value the CPI has no effect on the growth, or may even have a slightly positive effect.

In our study we propose as a model, the cubic model:

$$Y = \alpha + \beta X + \gamma X^2 + \lambda X^3 + \varepsilon \quad (1)$$

where:
- Y is the dependent variable, random,
- X is the independent, non-random variable,
- ε is the random variable error or residue,
- $\alpha, \beta, \gamma, \lambda$ are the parameters.

II. MODEL ANALYSIS. EMPIRICAL DATA AND RESULTS

The present research aims to analyze the evolution of the deflators of the gross domestic product and the index of the consumer price of Romania during the period 1991-2018, as well as their interdependence. The data used in the analysis are taken from the statistical directories published by the National Institute of Statistics of Romania.

The evolution of the GDP-specific indicator during the timescale under analysis were illustrated in figure 1:

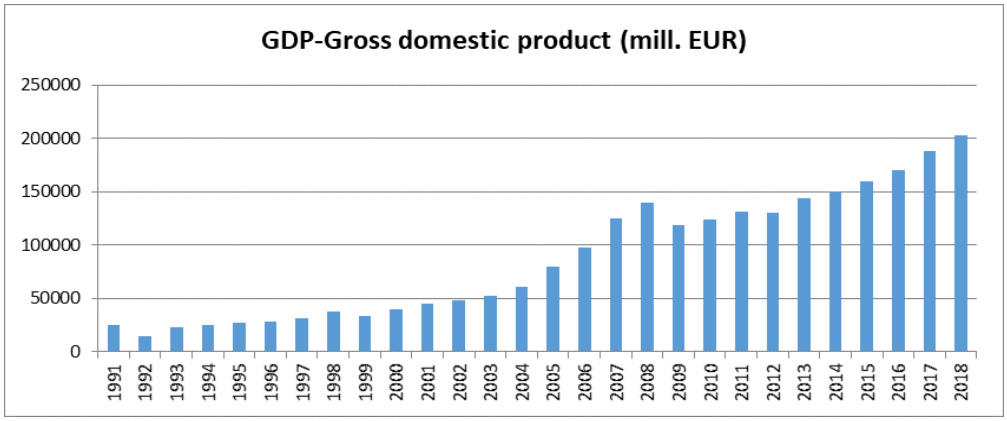


Figure 1. The evolution of indicator to *GDP* between 1991- 2018

Analyzing the evolution of the indicator we see an increase of 8 times from 1991 to 2018. During the analyzed period, GDP growth is thus, from 1992 to 1998 of 148.26%, from 1999 to 2008 of 317.29%, where registered the highest annual growth of 27.47% corresponding to 2006-2007, from 2009 to 2011 of 11.07% and from 2012 to 2014 of 15.19%. Decreases in the GDP index were recorded from 1991 to 1992 of -40.50%, from 1998 to 1999 of -10.50%, from 2008 to 2009 of -15.37%, where the largest annual decrease of 21480.5 (mill. EUR), and from 2011 to 2012 of -0.74%. Romania's government policies generated an increase in GDP, which is reflected in the period 2012-2018, where there is an increase of 55.62%. From an economic point of view in Romania there is a sustainable economic development.

During the analyzed period it is observed the existence of critical points that are due to the financial imbalances on the Romanian market. The years 1999, 2009 were a critical year, as the GDP in the periods 1998 - 1999, 2008-2009 drastically decreases and then increases. In the two periods all political decisions were praised for avoiding an economic crisis.

The evolution of the CPI-specific indicator during the timescale under analysis were illustrated in figure 2:

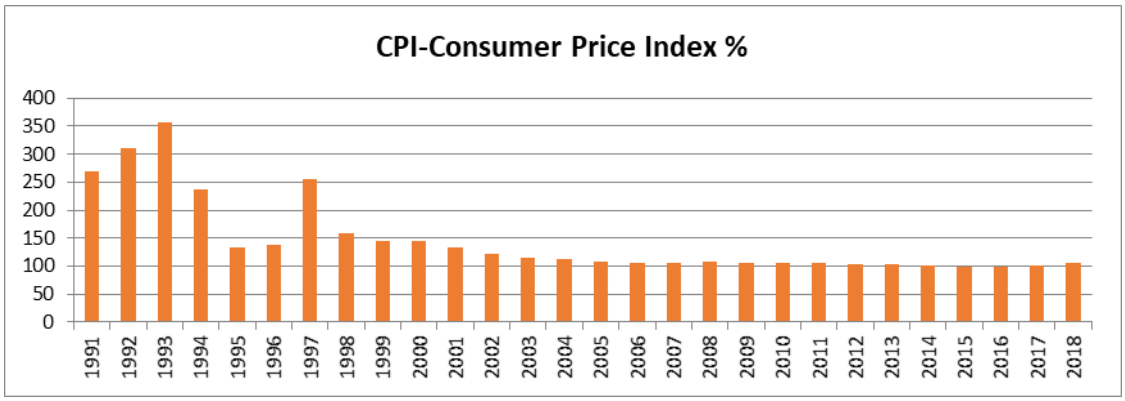


Figure 2. The evolution of indicator to *CPI* between 1991- 2018

Analyzing the evolution of the CPI indicator, a CPI decrease of 2.58 times from 1991 to 2018 is observed in Romania, as opposed to the EU where the CPI has increased in the last two decades. During the analyzed period, the CPI increases thus, from 31.79% from 1991 to 1993, from 92.59% from 1995 to 1997, where the highest annual CPI growth of 83.57% corresponding to the years 1996-1997, from 2007 to 2008 of 2.95%, an increase due to the change in energy prices, from 2009 to 2010 by 0.47% and from 2012 to 2013 by 0.67%, as a decrease of the CPI, from 1993 to 1995 of -62.84%, where the one is registered the largest annual decrease of the CPI of -33.52% corresponding to the years 1993-1994, from 1997 to 2007 of -58.87%, from 2008 to 2009 of -2.13%, from 2010 to 2012 of -2.64% and from 2013 to 2016 of -5.33%. The economic development of Romania in the last years leads to an increase of the CPI.

The estimated equation of the simple nonlinear regression model has the form:

$$GDP = \alpha + \beta\, CPI + \gamma\, CPI^2 + \lambda\, CPI^3 + \varepsilon\,, \tag{2}$$

where GDP represents the gross domestic product, the CPI represents the consumer price index.

Table 1. Regression model variables

Variable Processing Summary

		Variables	
		Dependent	Independent
		GDP-Gross domestic product (mil. euro)	CPI-Consumer Price Index %
Number of Positive Values		28	28
Number of Zeros		0	0
Number of Negative Values		0	0
Number of Missing Values	User-Missing	0	0
	System-Missing	0	0

The intensity of the links between the GDP dependent variable and the CPI variable is given by the correlation matrix:

Table 2. Correlation matrix

Correlations

		GDP-Gross domestic product (mil. euro)	CPI-Consumer Price Index %	CPI-Consumer Price Index %**2	CPI-Consumer Price Index %**3
Pearson Correlation	GDP-Gross domestic product (mil. euro)	1.000	-.649	-.574	-.509
	CPI-Consumer Price Index %	-.649	1.000	.989	.962
	CPI-Consumer Price Index %**2	-.574	.989	1.000	.991
	CPI-Consumer Price Index %**3	-.509	.962	.991	1.000
Sig. (1-tailed)	GDP-Gross domestic product (mil. euro)	.	.000	.001	.003
	CPI-Consumer Price Index %	.000	.	.000	.000
	CPI-Consumer Price Index %**2	.001	.000	.	.000
	CPI-Consumer Price Index %**3	.003	.000	.000	.
N	GDP-Gross domestic product (mil. euro)	28	28	28	28
	CPI-Consumer Price Index %	28	28	28	28
	CPI-Consumer Price Index %**2	28	28	28	28
	CPI-Consumer Price Index %**3	28	28	28	28

In the correlation matrix (table 2), the simple correlation coefficients between the independent CPI variables are calculated, and the GDP dependent variable and these coefficients are significant for a linear link, since the significance level (Sig.) it is lower than the 0.05 significance threshold. The Pearson correlation

coefficients are calculated in Table 2. The intensity of the link between GDP and the CPI is given by the Pearson correlation coefficient of -0.649 and expresses the strong, negative and linear relationship between the two variables.

The dependence between the dependent variable GDP-Gross domestic product (million euros) and the independent variable CPI-Consumer Price Index% is explained by the cubic model according to the graphical representation in figure 3.

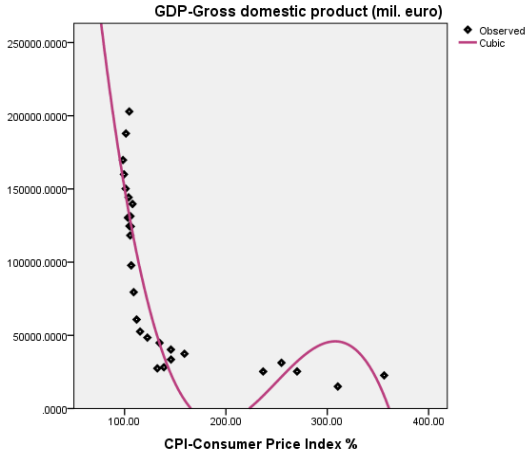


Figure 3. Link between GDP and CPI

The point estimates of the parameters of the nonlinear regression model are presented in table 2:

Table 2. Estimation of the regression model

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	953157.177	130830.688		7.285	.000	683135.908	1223178.446
	CPI-Consumer Price Index %	-12675.187	2129.683	-15.218	-5.952	.000	-17070.637	-8279.736
	CPI-Consumer Price Index %**2	53.635	10.386	26.998	5.164	.000	32.199	75.071
	CPI-Consumer Price Index %**3	-.072	.016	-12.628	-4.574	.000	-.104	-.039

a. Dependent Variable: GDP-Gross domestic product (mil. euro)

According to table 2, we have,, and, thus, we obtain the nonlinear equation estimated by the form:

$$GDP = 953157.177 - 12675.187\, CPI + 53.635\, CPI^2 - 0.072\, CPI^3 + \varepsilon \quad (3)$$

Because, $\Delta = 154.97$ it turns out that the cubic function (3) has two points, a local maximum and a local minimum.

If we derive equation (3) we obtain:

$$\frac{\partial GDP}{\partial CPI} = -12675.187\, CPI + 107.27\, CPI - 0.216\, CPI^2 . \quad (4)$$

The critical points for the cubic function (4) are and. The values of the cubic function at the two critical points are $GDP_1 = -9895.965$ and $GDP_2 = 45891.195$. So we have a minimum point and a maximum point $(307.755, 45891.195)$.

According to the Coefficients table (table 2) with a probability of 95% of the model parameters, α, β, γ and λ, are covered by the confidence intervals $(683135.908, 1223178.446)$, $(-17070.637, -8279.736)$, $(32.199, 75.071)$ and respectively $(-0.104, -0.039)$ for α the regression coefficient (Constant) and it corresponds to the minimum value of 683135.908, and the maximum value to 1223178.446, for β the corresponding CPI the minimum value is -17070,637, and the maximum is -8279,736, for γ the corresponding minimum value is 32,199, and the maximum is 75,071 and for λ the corresponding minimum value is -0.104 and maximum is -0.039.

In the table Coefficients (table 2) the values of the t-test (Student) appear, which verifies the validity of the hypotheses for each variable in the model (11) at the level of the analyzed sample. The value of the CPI Test t is -5.952. For CPI we have Sig = 0.000, which is less than 0.05. This can be interpreted: with a 95% probability of rejecting the null hypothesis, and the existence of a significant link between GDP and the CPI.

The correlation and determination indicators measure the intensity between the cubic model variables and are determined in the Model Summary Table (table 3).

Tabelul 3. Model summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.900[a]	.809	.785	27230.4858700	.626
a. Predictors: (Constant), CPI3, CPI-Consumer Price Index %, CPI2					
b. Dependent Variable: GDP-Gross domestic product (mil. euro)					

The high value of these indicators, according to table 3, where the correlation ratio is and the determination ratio is, shows that there is a strong correlation between the GDP dependent variable and the independent CPI variable. It follows that 80.9% of the GDP variation is explained by the CPI variation in the cubic model.

The ANOVA table (Table 4) presents the estimated explained variation, in the amount of 75520131170.000, the estimated residual variation, in the amount of 17795984660.000, the estimated total variation, in the amount of 93316115830.000, the degrees of freedom $df_1 = 3$ and $df_2 = 24$ and the value of the Fisher statistics., value of 33,949 and sig. value = 0.000 <0.05 show us that the cubic model is valid, which can be seen from the graph corresponding to figure 3. It results with a probability of 95%, rejecting the hypothesis that the model is not valid, there is a significant link between the CPI variable and the GDP dependent variable.

Tabel 4. ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	75520131170.000	3	25173377060.000	33.949	.000[b]
	Residual	17795984660.000	24	741499360.700		
	Total	93316115830.000	27			
a. Dependent Variable: GDP-Gross domestic product (mil. euro)						
b. Predictors: (Constant), CPI3, CPI-Consumer Price Index %, CPI2						

The minimum and maximum values of the residue are presented in table 5. The highest value of the residue, 70775.9140600, is recorded in 2018 when is registered the highest GDP growth, so Romania's economic growth policies have been efficient and correctly implemented.

Tabel 5. Resiuals Statistics

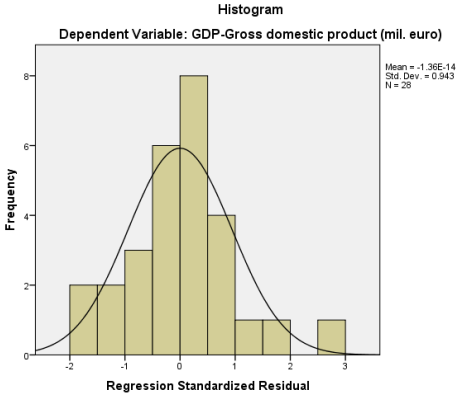
Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	5924.333008	156835.015600	87651.900050	52887.0673700	28
Std. Predicted Value	-1.545	1.308	.000	1.000	28
Standard Error of Predicted Value	5837.417	26045.225	9360.145	4358.273	28
Adjusted Predicted Value	-141066.640600	155304.000000	82216.829040	67105.2086700	28
Residual	-45298.2031300	70775.9140600	.0000000	25673.1482800	28

Std. Residual	-1.664	2.599	.000	.943	28
Stud. Residual	-1.703	2.684	.046	1.041	28
Deleted Residual	-47480.1406300	163716.4219000	5435.0710100	42021.9751000	28
Stud. Deleted Residual	-1.778	3.140	.061	1.105	28
Mahal. Distance	.276	23.736	2.893	4.627	28
Cook's Distance	.000	8.267	.322	1.558	28
Centered Leverage Value	.010	.879	.107	.171	28
a. Dependent Variable: GDP-Gross domestic product (mil. euro)					

The histogram is equivalent to the frequency table graph and must follow a normal distribution.

Figure 4. Histogram



The P-P Plot diagram highlights the differences between an empirical distribution, namely the residual evolution and specific theoretical distribution representing Henry's right. This diagram shows that the assumptions of the performed analysis are respected.

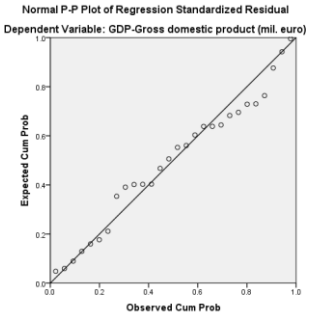


Figure 5. The P-P Plot diagram

III. CONCLUSION

In this paper, the evolution of the gross domestic product was investigated according to the consumer price index over a period of 28 years, using a nonlinear model, namely the cubic model. The period analyzed 1991-2018 is a critical period for the Romanian economy, experiencing a financial crisis at the beginning of 2008 when the value of GDP is declining. Analyzing the model we obtain two critical points $CPI_1 = 191.806$ and $CPI_2 = 307.755$, the values of the cubic function in the two critical points are $GDP_1 = -9895.965$ and $GDP_2 = 45891.195$. It can be concluded from the analysis of the period 1991 - 2018 that the CPI has a special impact on GDP.

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