

STATISTICAL STUDY ON THE CORRELATION BETWEEN “GROSS DOMESTIC PRODUCT” AND “EXTERNAL DEBT” IN ROMANIA, IN THE PERIOD 2007-2024

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Abstract: “Gross domestic product” is the main indicator for assessing a country's economic growth, reflecting the final result of the production activity of resident manufacturing units. “External debt” reflects the totality of the financial obligations that resident entities of a country (which may be: the government, institutions, corporations or individuals) have to external creditors (which can be: international financial institutions, foreign banks or foreign governments). The relationship between Gross Domestic Product and External Debt is assessed mainly from two perspectives: GDP growth leads to a reduction in external debt, respectively, the increase in external debt is an obstacle to economic growth. This article analyzes the correlation between these two indicators in Romania, between 2007 and 2024.

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1. INTRODUCTION

Economic growth is usually measured by the variation of the *Gross Domestic Product* (GDP) over a given period. In our study, GDP will be used as an independent variable that could influence external debt, along with other factors.

The most appropriate description of the *Gross Domestic Product* is the one provided by the National Institute of Statistics. According to it, GDP is “the main macroeconomic aggregate of the national accounts, it represents the final result of the production activity of resident manufacturing units. It is equal to the sum of the gross value added of the different institutional sectors or branches of activity, plus taxes and subtracting subsidies by product (which are not distributed by sectors and branches of activity). It also represents the balance of the production account of the total economy.” [www.insse.ro]

In other works, GDP is described as “the value of goods produced in society during a year and reached the last stage of the economic circuit. This value is determined by branches of the national economy and is summed up at its level. In principle, at the level of the national economy, GDP is calculated as the difference between the gross global product and intermediate consumption; At the branch level, the difference is made between its gross global production and the related intermediate consumption. Gross global output expresses the value of goods created, whether or not they are commodity. This way of determining GDP at the level of the branch or economy is known as the method of production.” [Ciurlău C. et. al., 2008]

In the guide developed by the IMF (International Monetary Fund, *External Debt Statistics - Guide For Compilers And Users*, in collaboration with the Bank for International Settlements, Commonwealth Secretariat, Eurostat, International Monetary Fund, Organisation for Economic Co-operation and Development, Paris Club Secretariat, United Nations Conference on Trade and Development, World Bank) gross external debt is presented as “the amount, at a given time, of the gross external debt of the paid and outstanding contractual obligations of the residents of a country towards non-residents for the repayment of principal, with or without interest, or for the payment of interest, with or without principal.” [International Monetary Fund, 2003]

According to the definition of the United Nations, “foreign debt is the totality of current and non-contingent contractual financial obligations that residents of an economy (government, corporations, institutions, individuals) owe to non-resident creditors, which must be repaid principally and/or interest at a future date. These obligations include loans, debt securities and other financial instruments, and the creditors may be foreign banks, foreign governments or international financial institutions.” [UNCTAD, 2021]

In the description of World Bank “gross external debt, at any given time, is the outstanding amount of those actual current, and not contingent, liabilities that require payment(s) of interest and/or principal by the debtor at some point(s) in the future and that are owed to nonresidents by residents of an economy.” [World Bank]

The study of the link between gross domestic product and external debt led to two main perspectives, namely:

- the first emphasises that GDP, as a factor of growth, leads to a reduction in external debt;
- the second emphasizes the role of brake on the development of external debt.

In the first category we find Blanchard [Blanchard, 1990] and Bohn [Bohn, 1998], according to which higher levels of GDP increase a country’s repayment capacity, allowing governments to maintain higher levels of external debt without compromising macroeconomic stability. From this perspective, GDP growth improves fiscal space and credibility in international financial markets.

Growth-based development models — promoted by Krugman [Krugman, 1988] and Easterly [Easterly, 2001] — argue that sustained GDP growth reduces dependence on external borrowing by strengthening domestic economies, export capacity, and tax revenues. In such cases, GDP growth is expected to have a negative effect on external debt, especially when debt is measured as a ratio to GDP.

For EU countries, empirical evidence suggests heterogeneous effects of GDP on external debt, reflecting differences between fiscal institutions and stages of economic development. Studies focusing on the EU’s advanced economies generally find that GDP growth contributes to lower external debt ratios by improving fiscal balances and external competitiveness: Checherita-Westphal and Rother [Checherita-Westphal, Rother, 2012]; Afonso and Jalles [Afonso, Jalles, 2013]. Panel analyses covering both the EU’s core and peripheral countries indicate that GDP growth reduces long-term external debt, but may increase short-term borrowing due to expansionary fiscal policies – [Égert, 2015], [Gómez-Puig, Sosvilla-Rivero, 2017]. These findings support the view that the impact of GDP on external debt is time-dependent and sensitive to macroeconomic conditions. Also, for EU Member States in Central and Eastern Europe (CEE), the empirical results are heterogeneous.

2. STUDY OF THE CORRELATION BETWEEN “GROSS DOMESTIC PRODUCT” AND “EXTERNAL DEBT” IN ROMANIA, IN THE PERIOD 2007-2024

The evolution of the “Gross Domestic Product” in Romania, between 2007 and 2024, is shown in Figure 1. (data are taken from Annex 1). For most of the period we are seeing its growth, which is a favorable situation. The exceptions are in 2009 (when it decreases, compared to 2008, by -21369.9 million euros) and in 2020 (when it decreases, compared to 2019, by -3501.6 million euros).

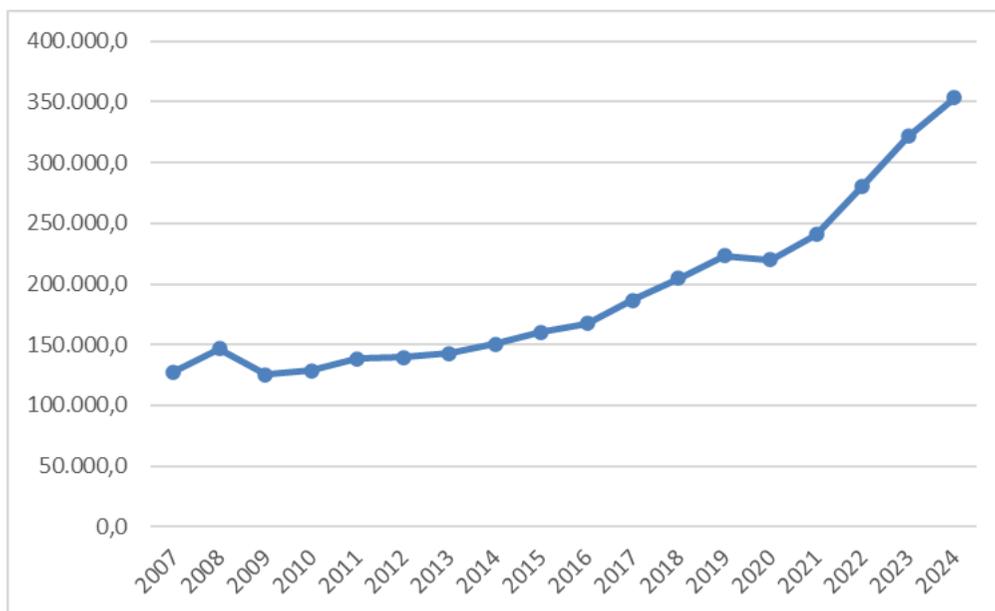


Figure 1. Evolution of the “Gross Domestic Product” in Romania, between 2007 and 2024

In Figure 2. the evolution of the “External Debt” in Romania in the period 2007-2024 is graphically represented (the data are taken from Annex 2). Despite the fact that there is also a 5-year period of reductions (2012-2016), the indicator shows, overall, an upward trend, in the last 6 years even noting a sharp increase.

For the study of the link between “Gross domestic product” and “External debt” we used a linear unifactorial regression model, whose form is:

$$y_i = \alpha + \beta \cdot x_i + \varepsilon_i, i = 1, 2, \dots$$

and the adjustment equation

$$y_i = a + b \cdot x_i + e_i, i = 1, 2, \dots$$

where:

y is the dependent variable, “Gross domestic product”;

x is the independent variable, “External debt”;

α it is the free term;

β is the regression coefficient;

ε is the residual variable.

The graphical approximation of the link model between the two variables is made using the scatter plot in Figure 3.

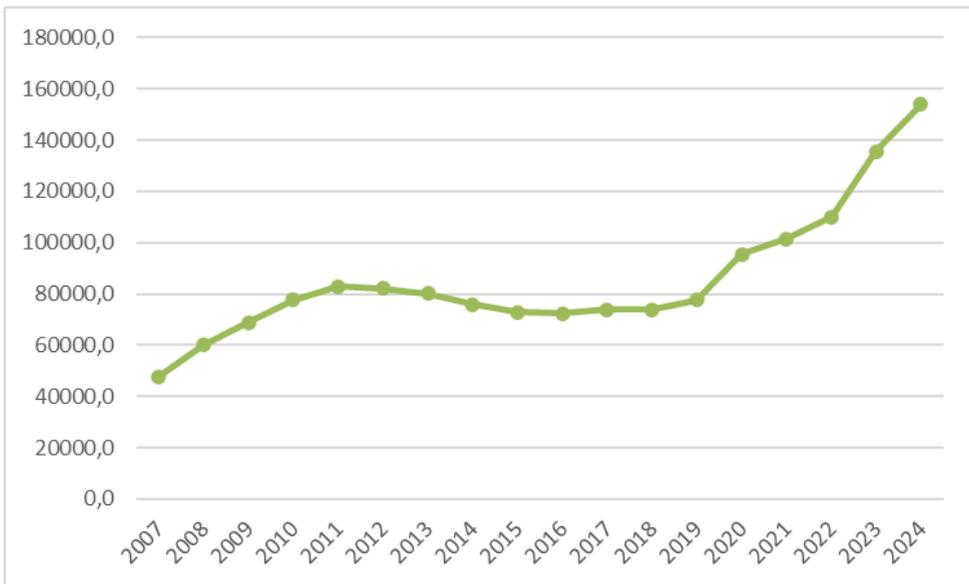


Figure 2. Evolution of the "External Debt" in Romania, between 2007 and 2024

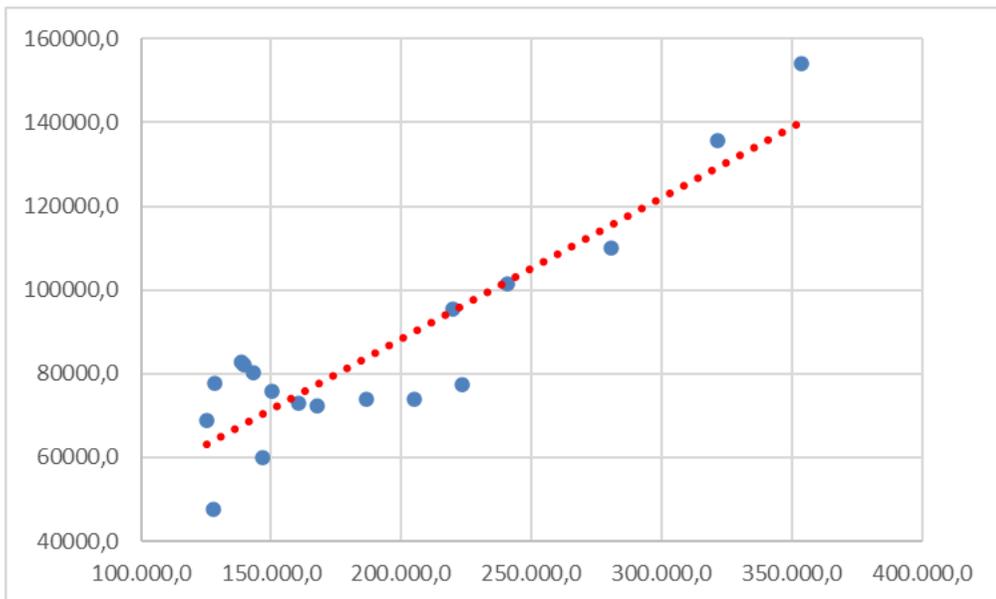


Figure 3. Scatter plot of the variables "Gross domestic product" and "External debt" in Romania, in the period 2007-2024

For the point estimation of the model parameters we will apply the method of least squares, by means of the system of equations:

$$\begin{cases} na + b \sum x_i = \sum y_i \\ a \sum x_i + b \sum x_i^2 = \sum x_i y_i \end{cases}$$

Following the solution of the system (the necessary calculations are in Annex 3), the adjustment equation will be:

$$y_i = 20934.71 + 0.34 \cdot x_i$$

For estimating the parameters by confidence intervals, we will use the calculations in Annex 4. *The confidence interval for the parameter α* is obtained as follows:

$$a - t_{\alpha/2, n-k} \cdot s_a \leq \alpha \leq a + t_{\alpha/2, n-k} \cdot s_a$$

where:

n represents the number of terms ($n=18$);

k - the number of parameters of the model ($k=2$).

$$t_{\alpha/2, n-k} = t_{0.025, 16} = 2.1199$$

$$s_a = s \cdot \sqrt{\frac{1}{n} + \frac{\bar{x}^2}{\sum(x_i - \bar{x})^2}}$$

$$s = \sqrt{\frac{\sum(y_i - Y_i)^2}{n - 2}} = \sqrt{\frac{2157411331.3}{18 - 2}} = 11611.99$$

$$s_a = 11611.99 \cdot \sqrt{\frac{1}{18} + \frac{192120.5^2}{81239369171.8}} = 8291.77$$

$$20934.71 - 2.1199 \cdot 8291.77 \leq \alpha \leq 20934.71 + 2.1199 \cdot 8291.77$$

$$3356.94 \leq \alpha \leq 38512.47$$

The confidence interval for the parameter β is obtained as follows:

$$b - t_{\alpha/2, n-k} \cdot s_b \leq \beta \leq b + t_{\alpha/2, n-k} \cdot s_b$$

$$s_b = s \cdot \sqrt{\frac{1}{\sum(x_i - \bar{x})^2}}$$

$$s_b = 11611.99 \cdot \sqrt{\frac{1}{81239369171.8}} = 0.0407$$

$$0.34 - 2.1199 \cdot 0.0407 \leq \beta \leq 0.34 + 2.1199 \cdot 0.0407$$

$$0.25 \leq \beta \leq 0.42$$

So, with a 95% α probability, it falls between 3356.94 and 38512.47, and β falls between 0.25 and 0.42. Because no range contains 0, we can guarantee that the parameters are statistically significant.

The linear correlation coefficient is determined as follows (the necessary calculations are in Annex 4):

$$r_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

$$r_{xy} = \frac{27370729742.7}{\sqrt{81239369171.8 \cdot 11379009852.9}} = 0,9002$$

The result reflects a direct link between the two variables. The value close to 1 shows us that the bond is very strong.

In order to test the significance of the linear correlation coefficient, the following hypotheses are issued:

H0: $\rho = 0$ (not statistically significant)

H1: $\rho \neq 0$ (is statistically significant)

The t-test will be:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} = \frac{0,9002\sqrt{18-2}}{\sqrt{1-0,9002^2}} = 18.99$$

Because $t(18.99) > t_{0.025; 13}(2.1199)$ the alternative hypothesis is accepted, i.e. r_{xy} is statistically significant.

In order to test the validity of the model, the following statistical assumptions are issued:

H0: the independent variable does not have a significant influence on the dependent variable, and the Coefficient of Determination (R^2) is not statistically significant.

H1: the independent variable has a significant influence on the dependent variable, and the Coefficient of Determination (R^2) is statistically significant.

Test F will be (the necessary calculations can be found in Annex 4):

$$F = \frac{\frac{\sum(Y_i - \bar{y})^2}{k-1}}{\frac{\sum(y_i - Y_i)^2}{n-k}} = \frac{\frac{9221598521.6}{2-1}}{\frac{2157411331.3}{18-2}} = 68.39$$

The coefficient of determination (R^2) will be:

$$R^2 = \frac{\sum(Y_i - \bar{y})^2}{\sum(y_i - \bar{y})^2} = \frac{9221598521.6}{11379009852.9} = 0.8104$$

As $F > F_{\alpha, k-1, n-k}$, i.e. $F(68.39) > F_{0.05; 1; 16}(4,49)$, the alternative hypothesis that the model is valid and R^2 is statistically significant is accepted.

Next, we will perform the testing of the parameters of the regression model.

For testing the parameter, the following α statistical assumptions are issued:

H0: $\alpha = 0$ (not statistically significant)

H1: $\alpha \neq 0$ (is statistically significant)

The t-test will be:

$$t = \frac{a-0}{s_a} = \frac{20934.71}{8291.77} = 2.52$$

Because $|t| > t_{0.025; 16}$ ($2.52 > 2.1199$) the alternative hypothesis that α it is statistically significant is accepted.

For testing the parameter, the following β statistical assumptions are issued:

H0: $\beta = 0$ (not statistically significant)

H1: $\beta \neq 0$ (is statistically significant)

The t-test will be:

$$t = \frac{b-0}{s_b} = \frac{0.34}{0.0407} = 8.27$$

Because $t(8.27) > t_{0.025; 16}$ (2.1199) rejects the null hypothesis, which assumes that the parameter β is significantly different from 0.

3. CONCLUSIONS

The evolution of the “Gross Domestic Product” reveals that, in most of the period, we are registering growth, which represents a positive situation. Unfortunately, the evolution of the “External Debt” is increasing, for most of the period, which represents a negative situation.

For the study of the link between “Gross domestic product” and “External debt” we used a linear unifactorial regression model, in which the adjustment equation is: $y_i = 20934.71 + 0.34 \cdot x_i$.

Following the estimation of the confidence intervals of the parameters, we obtain that α they fall between 3356.94 and 38512.47, and β between 0.25 and 0.42. It follows that the parameters are statistically significant (since no range contains 0).

The linear correlation coefficient by the high value obtained (0.9002) highlights a very strong link between GDP and external debt. Testing the coefficient leads to the conclusion that it is statistically significant.

Testing the validity of the model leads us to the conclusion that the model is valid and the coefficient of determination (R^2) is statistically significant. *Testing the parameters of the regression model* shows us that the parameters of the model (α and β) are statistically significant.

Consequently, through the econometric analysis, we showed that, in the period 2007-2024, the increase in the External Debt in Romania was correlated with the growth of the Gross Domestic Product.

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