# ANALYSIS OF THE CORRELATION BETWEEN THE GROSS DOMESTIC PRODUCT AND SOME FACTORIAL VARIABLES

**Assoc.prof. Mădălina-Gabriela ANGHEL PhD.**
*„ARTIFEX" University of Bucharest*
**Prof. Constantin ANGHELACHE PhD.**
*Bucharest University of Economic Studies, „ARTIFEX" University of Bucharest*
**Assistant Diana Valentina DUMITRESCU PhD.**
*„ARTIFEX" University of Bucharest*
**Daniel DUMITRESCU PhD.**

**Abstract**

*In this article we left that GDP increases due to the influence of factors. The structural analysis of GDP, the most important indicator of national results, we perform studies on factors based on source or final use of GDP. In literature there are many such analyzes. In the present study we left that international economic activity, namely foreign direct investment and international trade of a country have certain effects on GDP change. The simple interpretation of data from the data sets comprising GDP and foreign direct investment or international trade value realized (import, export or net exports) highlights a trend in the same direction. In this context we can conclude that trends of FDI reflects the change of the GDP. So we appreciate that it is a correlation between the two indicators evolve after the straight line function. In this article, we aim to highlight the effect of net exports, calculated as the difference between export and import the tendency of change in GDP. Net exports is basically balance international trade balance. In Romania, since 1992 until today, this indicator has negative values. In other words, it shows us how occurs in the country and are used to cover imports carried. The two established correlations we analyzed using statistical and econometric methods. Thus, we used the analysis of the correlation analysis, data sets and graphical format or developments in the dynamic study analyzed data series. To quantify these trends, we used linear regression models using simple and multiple.*

**Keywords:** *Regression, correlation, some data, international trade, import, export, net exports, foreign direct investment*

## Introduction

Studying the evolution of GDP is a critical issue because its value expresses the efficiency with which inputs are consumed. In such an analysis can take into account a number of factors such as the balance of foreign direct investment and international trade volume. In this article we identified theoretical correlation exists between changes in GDP and Foreign Direct Investment and International Trade activity.

The study was focused on the analysis of data series, the primary graphic representation or interpretation thereof. In analyzing the data series we have identified a correlation between GDP and the two indicators, which reflects a direct link connection.

## Literature review

Andrei and Spataru (2010) develop on econometric applications. Anghelache, Manole and Anghel (2015) use multiple regression to estimate some influences on GDP. Anghelache, Anghel, Prodan, Sacală, Popovici (2015) focus on the use of multiple regression. Anghelache, Anghelache, Dumbravă (2009) analyse the foreign trade activity. Büthe and Milner (2008) evaluate the FDI politics in developing countries. Dobrodolac (2011) considers econometric models as support instrument for management. Jones and Wren (2006) characterize the FDI and the regional economy. Koulakiotis, Lyroudi and Papasyriopoulos (2012) develop on inflation and GDP for European countries. Moosa (2002) studies the Foreign Direct Investments. Nistor (2014) analyzes the influence of FDI on Romania's economic growth. Zaman and Geamănu (2014) evaluate the Romanian economic environment from the perspective of FDI.

## Research data and methodology

To accurately measure the effect of these two sizes (FDI and trade balance International, symbolized as Export Net) on the growth of macroeconomic indicators (GDP), considering that it is a linear function directly have resorted to using models simple and multiple linear regression. As interdependent relationship we used the following relationship:

$Y= \alpha + \beta X+ \varepsilon$ (for simple linear regression)

And

$Y=a0+a1x1+a2x2+ \varepsilon$ (if multiple linear regression)

In the two calculation relations have noted:

Y = GDP (resultant feature);

X0 = Net exports (characteristic factor);

X1 = Foreign Direct Investment (characteristic factor);

X2 = Net exports (characteristic factor);

$\varepsilon$ = residual variable.

$\alpha$ , $\beta$, a0, a1, a2 = parameters of the regression function

From the moment in which the regression model built, it is important to confirm the significance of the relationship between the model and the estimated parameters. Common tests include checks, assumptions and residual values. Statistical significance can be checked by F-test and test that generally followed by a T-test for individual parameters.

The interpretation of these diagnostic tests are based on the assumption of a particular model. Even if the residual value analysis can be used to invalidate a model, F or T test results are often difficult to interpret even if alleged violations models.

For example, if the error term is not a normal distribution. If an analysis based on a small number of parameters is made, the parameters will not follow a normal distribution and this may complicate interference. However, when using large data sets can use the central limit theorem, so testing can continue using approximations asymptomatic hypothetical.

The answer can be continuously variable (limited data covers a subset of linear regression). For binary variables, if applicable last analysis squares linear regression model is called the linear probability model.

Regression models predict a value of variable Y based on the values of variables known to predict X. The range of values in the data set used is known as interpolation model. Data outside this range are known as extrapolation, which is based on the assumption than the regression model.

The extrapolation of existing data values appears outside, and there are chances that model to fail because of differences between assumptions and actual values of the data.

It is recommended that occurs when extrapolating the estimated value of the dependent variable to be accompanied by a prediction interval represents uncertainty. Such periods of time to expand rapidly, because the values of the independent variables are moved outside the scope of data analysis.

However, this model does not fully cover the errors that may appear: in particular the presumption of a particular form of relationship between Y and X. A regression analysis performed correctly will include an analysis of how the model is offset to the data analyzed, but this is only possible for a range of variables independent variables available. This means that any extrapolation is particularly relevant if based on assumptions made on the structural form of the relationship regression.

Best practice recommends that a linear model with variables selected parameters are not conventional but be considered and explored all existing knowledge to implement a regression model. The implications of this step which chooses a suitable form and functional regression can be important when the decision is to extrapolation. At a minimum, we can ensure any extrapolation of a suitable model is realistic.

**Analysis of the influence of the net export on the growth of Gross Domestic Product**

For the study of the simple regression between GDP and net export, the dataset can be taken from the table below:

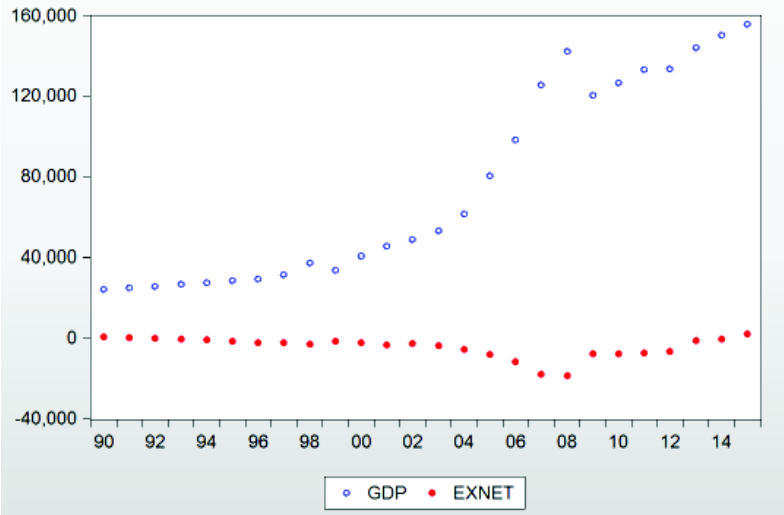
| Year | GDP | EXNET |
|---|---|---|
| 1990 | 24231,1 | 457,5 |
| 1991 | 25071,2 | 180,9 |
| 1992 | 25925,6 | -151,5 |
| 1993 | 26824,6 | -529,9 |
| 1994 | 27676,9 | -1004,8 |
| 1995 | 28763,0 | -1438,4 |
| 1996 | 29228,7 | -2284,1 |
| 1997 | 31683,6 | -2142,0 |
| 1998 | 37313,9 | -2893,8 |
| 1999 | 33942,7 | -1533,0 |
| 2000 | 40796,8 | -2154,7 |
| 2001 | 45503,5 | -3450,3 |
| 2002 | 48810,4 | -2733,5 |

| Year | GDP | EXNET |
|---|---|---|
| 2003 | 52931,0 | -3931,0 |
| 2004 | 61404,0 | -5489,5 |
| 2005 | 80225,6 | -8111,2 |
| 2006 | 98418,6 | -11743,5 |
| 2007 | 125403,4 | -17935,1 |
| 2008 | 142396,3 | -18868,6 |
| 2009 | 120409,2 | -7717,9 |
| 2010 | 126746,4 | -7783,4 |
| 2011 | 133305,9 | -7420,4 |
| 2012 | 133511,4 | -6640,2 |
| 2013 | 144253,5 | -1119,0 |
| 2014 | 150230,1 | -461,9 |
| 2015 | 155938,8 | 2177,1 |

All values are expressed as millions of euro
Source of data: Statistic Annuary of INS and EUROSTAT.

Data were taken and statistical methods (interpolation) were applied to complete the statistical series

The analysis of the correlation was made, at first, from the graphical viewpoint. Representing the two indicators on the same chart led to the following result:




The relative similar designs of the two dot lines supports the idea of building a regression model. The estimation through least squares led to the following model:

Dependent Variable: GDP
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 10/10/16 Time: 16:57
Sample: 1990 2015
Included observations: 26
GDP=C(1)+C(2)*EXNET

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | 55296.82 | 11409.19 | 4.846692 | 0.0001 |
| C(2) | -4.473670 | 1.678925 | -2.664604 | 0.0136 |

| | | | |
|---|---|---|---|
| R-squared | 0.228299 | Mean dependent var | 75036.39 |
| Adjusted R-squared | 0.196144 | S.D. dependent var | 49347.68 |
| S.E. of regression | 44244.14 | Akaike info criterion | 24.30664 |
| Sum squared resid | 4.70E+10 | Schwarz criterion | 24.40341 |
| Log likelihood | -313.9863 | Hannan-Quinn criter. | 24.33451 |
| F-statistic | 7.100116 | Durbin-Watson stat | 0.060818 |
| Prob(F-statistic) | 0.013561 | | |

The low values of the tests (R2 and adjusted R2) explain a slim direct correlation between the net export and the Gross Domestic Product. The model can be written as:

GDP = 55296.82 + (-4.4) * EXNET

The explained tests and the high value of the free parameter call for a multiple regression, with an additional factor, the Foreign Direct Investments.

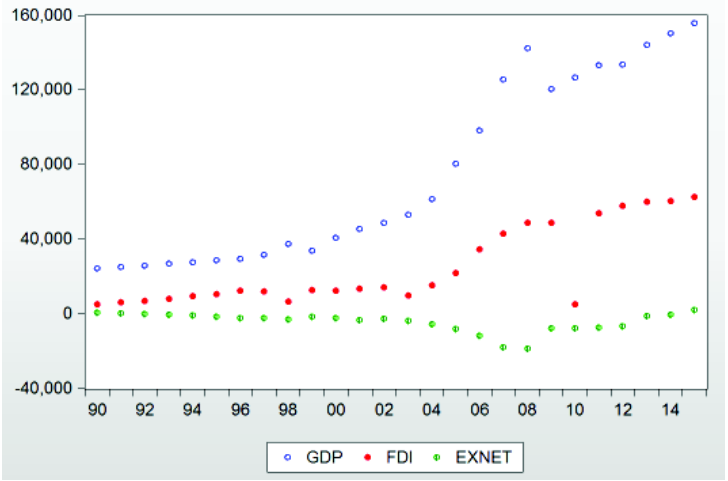
**Influence of Foreign Direct Investments and Net Export on the growth of Gross Domestic Product**

The dataset necessary for the analysis of the correlation between the three indicators is presented in the table below:

| Year | GDP | FDI | EXNET |
|---|---|---|---|
| 1990 | 24231,1 | 5116,2 | 457,5 |
| 1991 | 25071,2 | 5961,1 | 180,9 |
| 1992 | 25925,6 | 6916,7 | -151,5 |
| 1993 | 26824,6 | 7958,8 | -529,9 |
| 1994 | 27676,9 | 9201,0 | -1004,8 |
| 1995 | 28763,0 | 10314,0 | -1438,4 |
| 1996 | 29228,7 | 12396,0 | -2284,1 |
| 1997 | 31683,6 | 11975,0 | -2142,0 |
| 1998 | 37313,9 | 6435,0 | -2893,8 |
| 1999 | 33942,7 | 12810,0 | -1533,0 |
| 2000 | 40796,8 | 12375,0 | -2154,7 |
| 2001 | 45503,5 | 13210,0 | -3450,3 |
| 2002 | 48810,4 | 14020,0 | -2733,5 |
| 2003 | 52931,0 | 9662,0 | -3931,0 |
| 2004 | 61404,0 | 15040,0 | -5489,5 |
| 2005 | 80225,6 | 21885,0 | -8111,2 |
| 2006 | 98418,6 | 34512,0 | -11743,5 |
| 2007 | 125403,4 | 42770,0 | -17935,1 |
| 2008 | 142396,3 | 48798,0 | -18868,6 |
| 2009 | 120409,2 | 48827,0 | -7717,9 |
| 2010 | 126746,4 | 5141,0 | -7783,4 |
| 2011 | 133305,9 | 53723,0 | -7420,4 |
| 2012 | 133511,4 | 57851,0 | -6640,2 |
| 2013 | 144253,5 | 59958,0 | -1119,0 |
| 2014 | 150230,1 | 60198,0 | -461,9 |
| 2015 | 155938,8 | 62666,1 | 2177,1 |

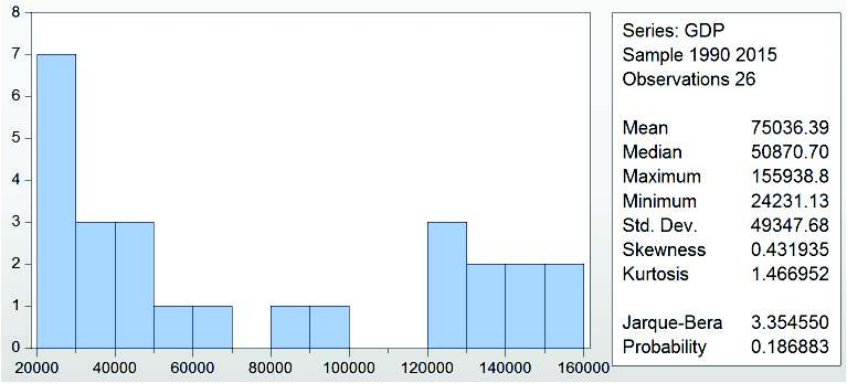
All values are expressed as millions of euro
Source of data: Statistic Annuary of INS and EUROSTAT.
Data were taken and statistical methods (interpolation) were applied to complete the statistical series

The correlation can be analyzed, also, in a more simple manner, by using a dot plot in which we represent the comparative evolution of the indicators, across the period 1990-2015.

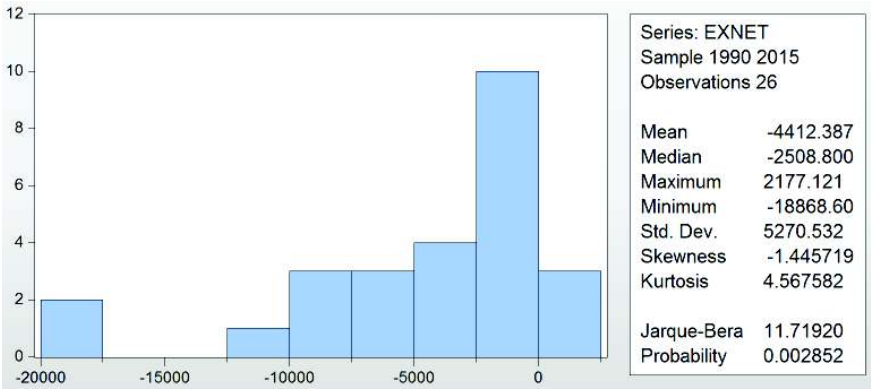


We can see that the indicators follow approximately similar patterns, a fact that encourages the study on the correlation based on a dedicated econometric software.

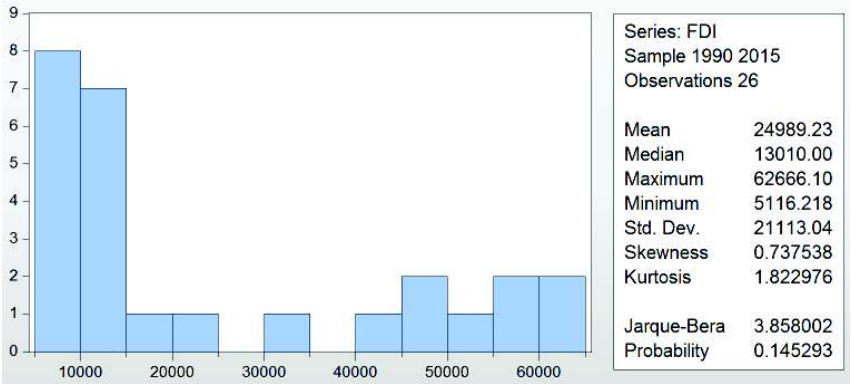
First, we have represented the statistical tests for the variables included in our study




The Gross Domestic Product has evolved within an interval bordered by the 24231.13, minimum value reached in 1990 and the maximum level, 155938,8 in 2015. The mean value recordered was 75036,39.




The net export had a minimum value which is negative, the maximum is, however, positive. The negative value of the mean is an element that should generate awarness about taking appropriate measures to increase the exports of the Romanian economy.




The maximum value of the Foreign Direct Investments was recorded in 2015, more than twice the medium value, which is a good correlation.
The regression model was estimated through the use of the least squares method, and the results are presented in the following figure:

Dependent Variable: GDP
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 10/10/16 Time: 16:59
Sample: 1990 2015
Included observations: 26
GDP=C(1)+C(2)*FDI+C(3)*EXNET

| | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | 17902.75 | 6451.245 | 2.775085 | 0.0108 |
| C(2) | 1.947628 | 0.200997 | 9.689840 | 0.0000 |
| C(3) | -1.918216 | 0.805167 | -2.382383 | 0.0259 |

| | | | |
|---|---|---|---|
| R-squared | 0.848159 | Mean dependent var | 75036.39 |
| Adjusted R-squared | 0.834956 | S.D. dependent var | 49347.68 |
| S.E. of regression | 20047.82 | Akaike info criterion | 22.75780 |
| Sum squared resid | 9.24E+09 | Schwarz criterion | 22.90296 |
| Log likelihood | -292.8513 | Hannan-Quinn criter. | 22.79960 |
| F-statistic | 64.23720 | Durbin-Watson stat | 1.862502 |
| Prob(F-statistic) | 0.000000 | | |

Based on the data provided by the software system used, we can write the regression model under the following form:

$$GDP = 17902{,}75 + 1{,}94 * FDI + (-1{,}91) * EXNET$$

The model is reliable enough to be used in further analyses, we see that the R squared and adjusted R squared values are well above 0.83. Also, the Prob (F-statistic) test is 0. All these values certify the soundness of the model.

## Conclusion

The parameters of the model lead to useful conclusions. For the FDI factor, an increase by 1 unit of this indicator leads to the increase of the Gross Domestic Product, almost twofold. In contrast, the net export exerts a negative influence on the main indicator analyzed, and the value of its parameter has almost the same value (but negative) as the coefficient of the previous factor. These values call for measures on two directions, that is towards the increase of both foreign direct investments and export (which, in turn, shall influence the net export, considered as distinct factor in this model).

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