THE USE OF THE SIMPLE LINEAR REGRESSION IN THE ANALYSIS OF CORRELATION BETWEEN GDP AND FINAL CONSUMPTION

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Abstract

The realization of the gross domestic product has become so common that the meaning of a necessary interpretation is not lost in order to reveal in concrete terms the effect of the increase of the gross domestic product on consumption, investment in our country. In this article, we intend to analyze the correlation between gross domestic product and final consumption, starting from the fact that without an in-depth analysis, an increase in gross domestic product will in fact lead to an increase in final consumption, but we're interested in seeing what correlation exists between the two macroeconomic sizes. In this regard, we have proposed and analyzed using some statistical and econometric methods of analysis in this field. We have discussed a concrete case, namely, the use of simple linear regression which, through the modular system of the function considered, we could use some variables to analyze and test the correlation between them. In this respect, we considered in the study that there is a close link between the GDP macroeconomic indicator and the final consumption as well as the elements in its structure. We used data in a 20-year period and, applying this statistical-econometric, we determined the regression coefficients, those that express the direction and intensity of the correlation that exists between the two variables. Indeed, Gross Domestic Product is considered to be the resultant variable and consumption (structural elements of consumption) dependent variable, ie the calculated coefficients show that the higher the Gross Domestic Product, the higher the consumption. In the study we presented the data we analyzed and based on which we extracted the elements of interest for their interpretation.

Keywords: *GDP, final consumption, correlation, linear regression model, regression parameters*

JEL Classification: C20, E21

Introduction

Aspects relating to the use of linear linear regression in the analysis of the correlation between gross domestic product and some of its structural elements are some that have proven their usefulness and the possibility of analyzing and interpreting over time as the data series are larger, and the results obtained are more conclusive and highlight the intensity of the correlation, as well as the meaning of the evolution of this correlation. Based on the data we have provided, we have made this correlation, we have been econometric models, we have introduced the data on which we made the calculations, which underwent interpretation and analysis, have led to some conclusions. The article is accompanied by some graphs and some necessary tables, resulting from the use of the regression model, so that it becomes relevant for those studying this article to conclude that this is only a model of analysis, and it can be extended to other possible correlations that are established between the macroeconomic outcome indicators and other structural or macroeconomic variables.

Literature review

Andrei and Bourbonais (2008) highlighted fundamental aspects of the use of econometric tools in economic analyzes. Anghel, Lilea and Mirea (2017) studied the correlation between gross domestic product and inflation in Romania. Anghel, Stoica, Samson and Badiu (2017) and Anghelache, Marinescu, Avram, Burea and Bodo (2017) analyzed the link between GDP and final consumption. Anghelache and Sacal (2016) used multiple regression to analyze the correlation between GDP and some variables. Anghelache and Lilea (2012) and Corbare, Durlauf and Hansen (2006) presented the importance of using econometric models in economic studies. A similar theme is studied by Davidson and Mackinnon (2004), Guijarati (2005), Wooldrige (2006). Censolo and Colombo (2008) addressed aspects of public spending structure, and Foerster and Choi (2016) raised consumption.

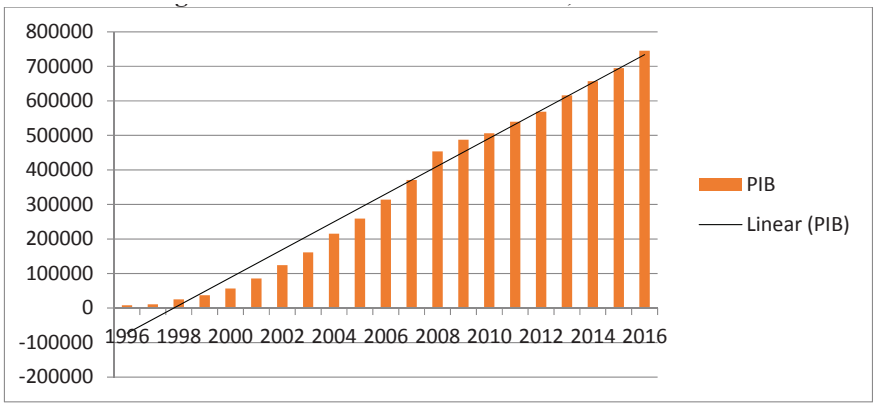
Methodology, data, results and discussions

In macroeconomic analyzes, it is important to analyze the link between the macroeconomic indicator (GDP) and final consumption and its structural elements. Data sets must be deflated beforehand. The data series used must be as broad as possible over time, with several terms.

GDP dynamics in the period 1996-2016 is described in the following graph.

GDP Dynamics of Romania, 1996 - 2016

Figure 1



Source: Data processed by authors based on communiqués and publications I.N.S.

Using the Eviews 7.2 program product, the following statistical sizes of the analyzed indicator were calculated.

The result of the tests carried out on Romania's GDP, 1996-2016

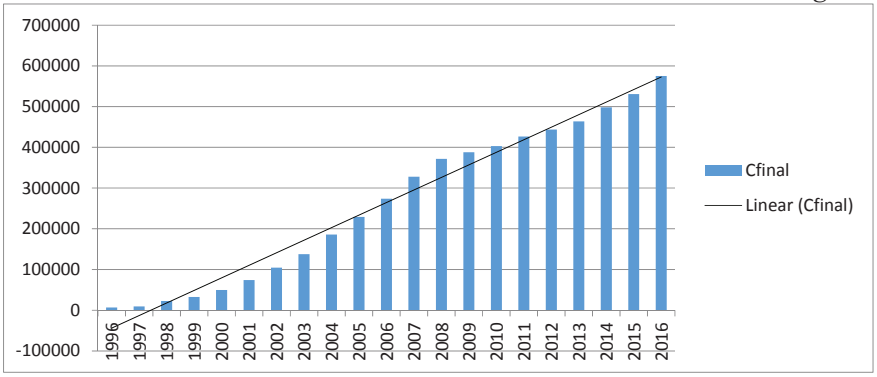
Figure 2

```
Summary statistics, using the observations 1996 - 2016
for the variable 'PIB' (21 valid observations)

  Mean                      330364.890476190
  Median                    313889.300000000
  Minimum                   7953.00000000000
  Maximum                   745365.100000000
  Standard deviation        252582.694320626
  C.V.                     0.764556711690978
  Skewness                 0.132680384686363
  Ex. kurtosis             -1.43154114476707
  5% percentile             8248.84000000000
  95% percentile            740298.030000000
  Interquartile range       482805.700000000
  Missing obs.                    0
```

Similarly, the final consumption indicator in Romania, the evolution of which in the period 1996-2016 is presented in Figure 3:

Final consumption dynamics in Romania, 1996 - 2016

Figure 3



The graph shows a sharp rise in this indicator, which closely follows the evolution of the Gross Domestic Product indicator, which could indicate a significant link between these two indicators. The results of the statistical tests applied to this data series are described below.

Tests on the Final Consumption of Romania, 1996 - 2016

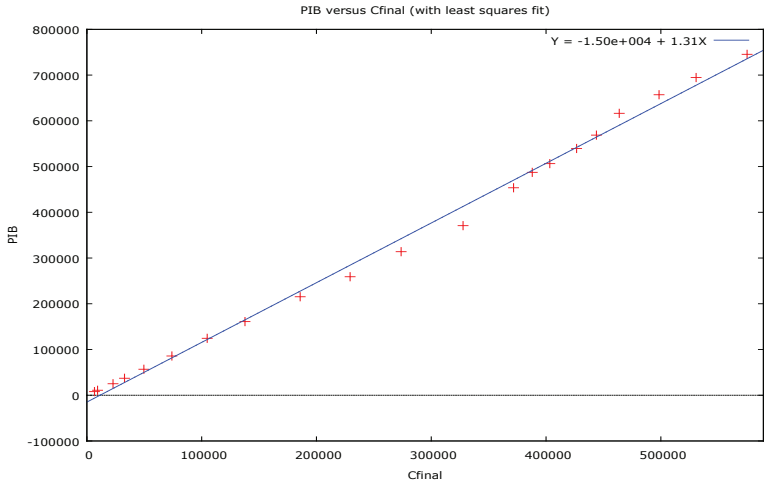
Figure 4

```
Summary statistics, using the observations 1996 - 2016
for the variable 'Cfinal' (21 valid observations)

  Mean                      264565.928571429
  Median                    273763.800000000
  Minimum                   6631.70000000000
  Maximum                   575123.100000000
  Standard deviation        193065.436595961
  C.V.                     0.729744142182075
  Skewness                 0.0120317663941011
  Ex. kurtosis             -1.46078658304561
  5% percentile             6900.66000000000
  95% percentile            570683.320000000
  Interquartile range       373405.700000000
  Missing obs.                    0
```

The graphical representation of the link between these two indicators confirms the existence of a strong link between GDP and Final Consumption for the period considered (1996-2016) in Romania.

GDP correlation - final consumption

Figure 5



From the graph we can see that the pairs of points describe almost perfectly the trajectory of a straight line, which indicates a linear, direct connection of the two indicators. This link can be described with the help of a one-factor linear econometric model, having as independent variable the level of the final consumption and the variable depending on the Gross Domestic Product. Further using the C.M.M.P. and with the same software program Eviews 7.2, the following parameters of the econometric model were described which describe the relationship between the two indicators.

Estimated regression model parameters

Figure 6

```
Model 2: OLS, using observations 1996-2016 (T = 21)
Dependent variable: PIB

             coefficient     std. error    t-ratio    p-value
  ------------------------------------------------------------
  const      -14961.3       6619.27       -2.260     0.0357    **
  Cfinal          1.30526      0.0203796   64.05      1.16e-023 ***

Mean dependent var   330364.9   S.D. dependent var   252582.7
Sum squared resid    5.88e+09   S.E. of regression   17596.03
R-squared            0.995390   Adjusted R-squared   0.995147
F(1, 19)             4102.050   P-value(F)           1.16e-23
Log-likelihood      -234.0308   Akaike criterion     472.0617
Schwarz criterion    474.1507   Hannan-Quinn         472.5150
rho                  0.824764   Durbin-Watson        0.326183
```

The value of the two tests (determination ratio and adjusted determination ratio) is very high, showing the change of gross domestic product, y on account of final consumption, x (98,24%). The values of the F-statistic tests (1283,507 - a value that far exceeds the value of the table level) and prob F-statistic (0 <0,05) indicate the correct use of the regression that can be successfully used, highlighting the dependency structure elements existing.

The linear linear regression model resulting from the data analyzed is:

$$PIB = - 6{,}161308 + 1{,}303038 \cdot CF$$

Thus, for an increase in final consumption (1 million lei), the GDP will increase by 1.303038 million lei, which reinforces the presence of the link once again. The negative term (C), having a negative value, allows us to assert that the non-computed indicators within the model negatively influence the evolution of the dependent variable - Gross Domestic Product. We find that GDP is determined in the highest proportion of final consumption. Next, we will carry out an analysis between GDP and final consumption, in order to demonstrate that, at the base of the growth of the Romanian economy in recent years, consumption and not investments were almost exclusively.

- **Model of GDP correlation analysis and final consumption elements**

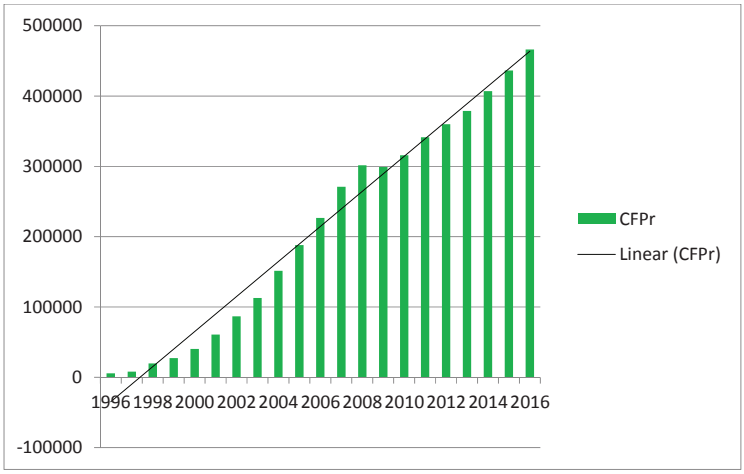
- Studies on the correlation between GDP and private consumption

The regression model is used to highlight the effect of private consumption on GDP formation.

We used the data series available for the period 1996-2016. Data was deflated compared to 1990. The data series includes deflated data on GDP and private consumption. The software Eviews 7.2 was used.

Dynamics of private consumption in Romania (1996 - 2016)

Figure 7



Private consumption of households increased throughout the analyzed period, with only one exception, in 2009 when it decreased by 9.78% compared to the previous year, a decrease that coincided with the beginning of the global economic and financial crisis. As in the case of final consumption, between 1996 and 1616, private consumption follows the Gross Domestic Product trend, indicating a possible link between the two indicators. Analyzing the data series we have obtained the following results

Consumption tests (1996 - 2016)

Figure 8

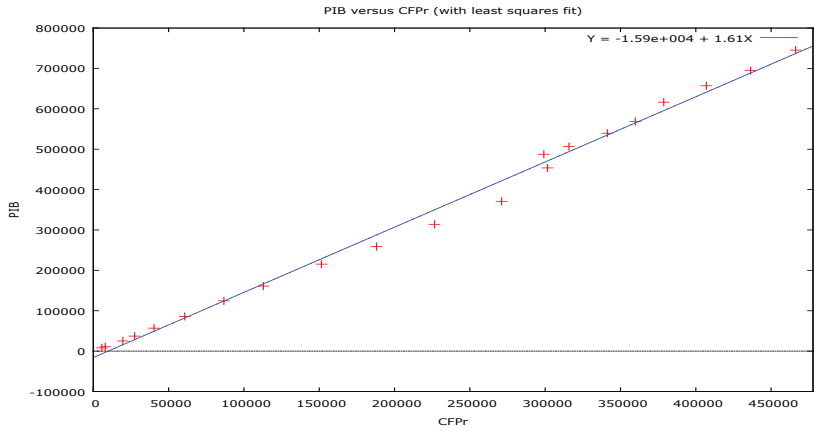
```
Summary statistics, using the observations 1996 - 2016
for the variable 'CFPr' (21 valid observations)

  Mean                      214501.861866416
  Median                    226554.500000000
  Minimum                     5688.00000000000
  Maximum                   466291.999194744
  Standard deviation        156001.247478044
  C.V.                     0.727272230276470
  Skewness                0.0250559293630042
  Ex. kurtosis             -1.42846187504441
  5% percentile              5915.50000000000
  95% percentile           463302.039275270
  Interquartile range       300034.400000000
  Missing obs.                    0
```

Private consumption was 214.501 million lei. The range of variation is between 5688 million lei and 466292 million lei.

The value of the Skewness test and the inferior level of the Kurtosis test indicate in this case an unbalanced distribution of the annual values of the indicator considered. The results obtained as well as the graphic representation confirm the existence of a strong link between private consumption and GDP (1996-2016).

GDP correlation - private consumption

Figure 9



From the graph we can see that the pairs of points are ordered by a straight line, so there is a linear one-factor mathematical function, being GDP, the independent variable being the level of private consumption.

The econometric model can be described by the equation: $y = a + bx + \varepsilon$.

Using the econometric method used, we obtained the results from Figure 10.

Parameter estimation

Figure 10

```
Model 1: OLS, using observations 1996-2016 (T = 21)
Dependent variable: PIB

             coefficient     std. error    t-ratio    p-value
  ------------------------------------------------------------
  const      -15948.0       7366.47       -2.165     0.0433    **
  CFPr            1.61450      0.0280054   57.65      8.46e-023 ***

Mean dependent var   330364.9   S.D. dependent var   252582.7
Sum squared resid    7.25e+09   S.E. of regression   19538.25
R-squared            0.994316   Adjusted R-squared   0.994016
F(1, 19)             3323.458   P-value(F)           8.46e-23
Log-likelihood      -236.2295   Akaike criterion     476.4591
Schwarz criterion    478.5481   Hannan-Quinn         476.9125
rho                  0.728548   Durbin-Watson        0.517576
```

The analysis of the results shows that although the probability associated with the model and mainly reflected by the test ratio and the determined determination ratio is slightly lower compared to the one observed in the first regression analysis, it is sufficiently large (approximately 99%) to highlight the correctness of what points out that the estimation of the evolution of the economic phenomenon under investigation is correct. Given that F-statistic = 3323,458 is a large value and Prob F-statistic = 0 <0,05 we can accept that the chosen model fine-tunes the data in the sample and can be used for analyzing the dependence of the variables.

The simple linear regression model is in the following equation:

$$PIB = -15948 + 1{,}61450 \cdot CP$$

So an increase of one million RON of private consumption, GDP increases by 1,61450 million RON. In other words, there is a direct link between the variables.

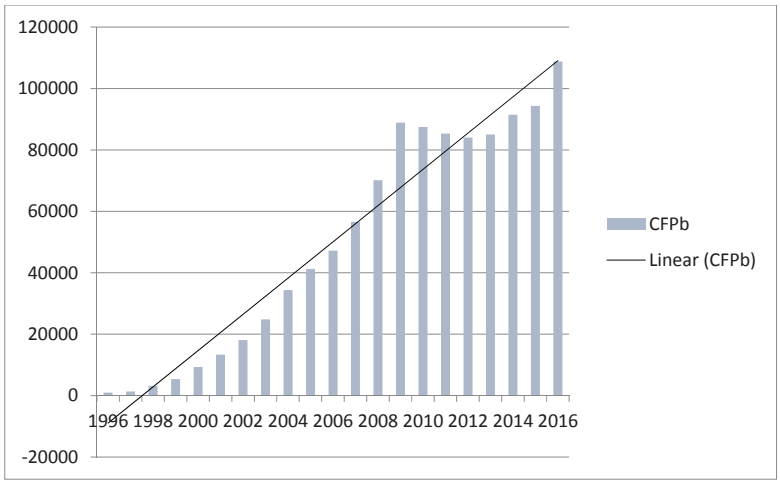
The analysis shows that GDP is determined by the evolution of private consumption.

- *Analysis of GDP correlation and public consumption. The unifactorial regression model will be used.*

The initial analysis can be done based on the data series study and then by graphical representation of the data. Finally, I will resort to the simple regression model.

Dynamics of public consumption (1996-2016)

Figure 11



The overall trend of this indicator for the period under review is rising, with an exception, in the period 2009-2013, when year-on-year declines occurred as a result of the strong global economic and social crisis of that period. In the following we will analyze with the help of statistical tests the possibility of a link between the public consumption in our country and the gross domestic product.

Tests on public consumption (1996 - 2016)

Figure 12

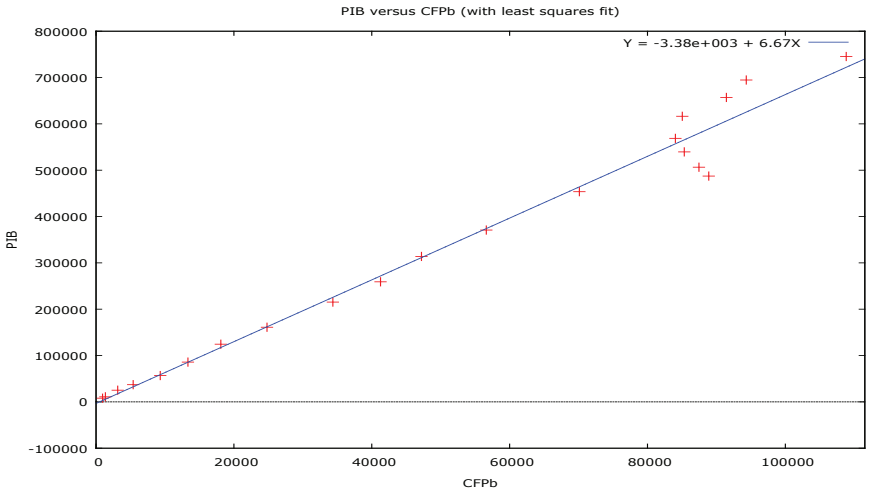
```
Summary statistics, using the observations 1996 - 2016
for the variable 'CFPb' (21 valid observations)

  Mean                      50064.0613932555
  Median                    47209.3000000000
  Minimum                   943.700000000000
  Maximum                   108831.089258365
  Standard deviation        37473.5224960515
  C.V.                     0.748511436211602
  Skewness                0.00834999710127799
  Ex. kurtosis              -1.56631724215166
  5% percentile             985.160000000000
  95% percentile            107381.270332528
  Interquartile range       75078.2000000000
  Missing obs.                     0
```

We find that the average level of public consumption is RON 9,536 million, the level being between RON 4 million and RON 13.2 million.
The Skewness test has a value other than zero and is inferior to the reference value of the Kurtosis test, as in the case of Gross Domestic Product and Final Consumption, it indicates a distribution of the unbalanced annual values.

The graphical representation of the two series will allow us to determine the shape and meaning of the dependence between the two variables, public consumption and gross domestic product.

GDP correlation - public consumption

Figure 13



As can be seen from the graphs of the data series of public consumption and GDP, in the period between 1996 and 2016, it is ordered by a straight line. The existence on the graph of values deviating from the straight line also indicate an influence from unidentified incident factors, which we will eliminate by adjusting. Therefore, the econometric model is given by the relation:

PIB = a + b · CPL + Ɛ, where CPL is the factorial variable, and „a" and „b" calculated parameters.

Using the econometric method we will further estimate the parameters of this model, shown in Figure 14:

Estimation of regression parameters

Figure 14

```
Model 2: OLS, using observations 1996-2016 (T = 21)
Dependent variable: PIB

             coefficient    std. error    t-ratio    p-value
  ---------------------------------------------------------
  const      -3381.72      14158.1        -0.2389   0.8138
  CFPb           6.66639       0.228363   29.19     3.01e-017 ***

Mean dependent var   330364.9   S.D. dependent var   252582.7
Sum squared resid    2.78e+10   S.E. of regression   38270.60
R-squared            0.978190   Adjusted R-squared   0.977043
F(1, 19)             852.1776   P-value(F)           3.01e-17
Log-likelihood      -250.3480   Akaike criterion     504.6960
Schwarz criterion    506.7851   Hannan-Quinn         505.1494
rho                  0.687783   Durbin-Watson        0.630806
```

The value of the determinant coefficient, R-squared = 0.978190, shows that 97.81% of the GDP change is determined by public consumption, which is a determinant of the GDP change. Following the results we can write the simple linear regression model:

PIB = - 3381,72 + 6,66639 CPL

Thus, when public consumption increases by one million lei, GDP increases by 6.66639 million lei.

Factors that were not taken into account at the time of constructing this regression model have a large and opposite effect on the Gross Domestic Product, as indicated by the value of the free term. In conclusion, we can state that the GDP of our country is determined by public consumption.

Conclusion

The practical study shows that there is a close correlation between gross domestic product and final consumption, be it public or private. The limits between the growth of gross domestic product are also those that can be used to increase consumption. We make some abstractions for this correlation because it is not yet entirely sustainable to conclude that we share as much as we want gross domestic product for consumption and capital growth or for investment because there are certain limits. In this respect, the study reveals without a doubt the fact that, based on the data analyzed, the correlation parameter coefficient reveals a close link between gross domestic product and consumption. There may be other administrative influences or limitations to

increase consumption or change, to change the relation between consumption and investment, but we generally draw the conclusion that there is a true link between gross domestic product and other indicators confirmed by the linear regression model used has been tested and led to the results we have mentioned.

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