# ECONOMETRIC MODEL FOR COMPLEX ANALYSES AND FORECAST OF THE GROSS DOMESTIC PRODUCT

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***Abstract***

*This paper develops a complex analysis of GDP influence factors for the Romanian economy. The study takes into account the calculation methods for the main indicator and outlines several correlations between its evolution and the dynamics of different factors. The authors use the simple and multiple linear regression methods, data are drawn from the national accounts published by the National Institute of Statistics, and are processed with Eviews. The correlations are substantiated on graphical representations, analysis of the results of estimations for the regression models, and also on the specific valuation of models' validity based on statistical tests. The results outline the influences that different factors have on the evolution of Romania's Gross Domestic Product and also. Based on the configuration of the drawn models, the authors present a forecast of GDP's evolution in the next years. In this study, we wanted to identify the main factors that influence GDP growth in Romania and to estimate their influence with the help of multiple linear regression-based analysis. As the most complex multifactorial correlation, we will take into consideration the GDP as the explained variable and the six factorial variables, ie, Private consumption, Public consumption, Gross investments, Changes in inventories, Net Export, Gross available income.*

***Keywords:*** *Gross Domestic Product, investments, consumption, influence, incomes, inventories, foreign trade,*

***JEL Classification:*** *C51, E01, E21*

## 1.Introduction and context of the study

GDP is the most complex indicator which can outline the result at the national level. This indicator might express the level of development of a nation and at the same time give a solid idea about the standard of living in a country. Starting from the theoretical aspects regarding the possibility of the formation and calculation of GDP, we can consider on one hand the resources of formation of the indicator, and the final utilizations of GDP. As methods of calculation we mention the tree opportunities normally well known in statistics and practical activities. Those methods are: calculation based on production; calculation based on incomes and calculation based on expenses. In the process of analysis and forecast of GDP, calculated by using any method, we can start from the level of GDP obtained during a period of one year and consider:

- the resources used in that period;
- the final utilization of GDP obtained in that year.

We can analyze the use of resources and based on a complex system of indicators we can do, considering the principles and methods of forecasting, a deep forecast for future period.

On the other hand, we can do an analysis regarding the utilizations of GDP. Generally, the GDP is used for consumption in general terms and investment. Any time despite of policy strategies, the amount used for investment and total consumption depends on the value of GDP. As regard to the consumption, we might take in consideration the destination of money allocated to different type of consumption. In this respect we can consider the following types of consumption:

- final consumption, which is divided in private and public consumption;

- the influence of the net export, which is calculated as a difference between total export and total import. In different country and during the different periods the net export might be positive which means that the country export is more than import and on this way has a positive influence on the level of the GDP. In this case we say that the country obtains an excess balance from international trade. By the contrary when the export is lower compared with import that country has to pay abroad an amount of money for import. In such case we will say that the country registers a deficit of the balance of international trade. In our analyses we can deep the interpretation of the use of excess of import. If this is used as a complimentary import in order to develop future production this is anyway a positive step. But if the excess of import is done for consumer goods that is a negative policy of that country.

As regarding the consumption we can consider that in private field compering with gross available income, and available incomes of the population.

Sometimes by the end of the year part of the production remains in the stock. The value of current stock compared with the stock of previous year can be analyzed and considered in appreciation of the result of the year.

Starting from the ideas presented above we can see that between the level of GDP and the final utilizations there are some correlations. Those connections might be analyzed and interpreted through some econometrical models.

Among those in this paper we will consider the regression model based on regression function. We will consider the variables, starting from the view that GDP is a resultant one and other are factorial (dependent). In our study we can use a multiple regression model where GDP is result variable and final consumption, private consumption, public consumption, net export, stock level, general available incomes, and gross investments are factorial variables. After analyzing the situation based on graphical presentation we will came to the conclusion that between those variables there is linear direct connection. As far, can be built the direct multiple linear regression and by using the Eviews software we will test the correlation. At the same time we will calculate the regression parameters on which we can extend the analyses. Also, multiple direct regression might be used to analyze other correlations as between final total consumption on one hand and private consumption and public consumption on the other hand or the correlation between GDP on one hand and investment and final total consumption, and so on.

Simple linear direct regression might be used between GDP and each individual variables mentioned above.

The data for such analyses are provided by the macroeconomic accounts calculated by National Institute of Statistics. The data of consumption are calculated an provided by the same national institution.

In order to approach some theoretical aspects regarding the direct linear multiple regression, we will consider a case study.

## 2. Literature review

Since 1999, Anghelache has conducted an analysis of Romania's economic and financial situation, insisting on macroeconomic developments and their effects. The use of econometric models in macroeconomic analysis has been approached by Anghelache and Anghel (2016), who focused, mainly, with the utility of econometric models in calculating and forecasting macroeconomic indicators. Also, Anghelache, Partachi and others (2016), Anghel and others (2016) are preoccupied with the application of this class of models. Bastagli and Hills (2013) develop on the households consumptions and the correlation between private and public consumption. Various aspects of public and private consumption were also approached in the works of Bachman (2011). Censolo and Colombo (2008) study the composition of the public

consumption in a growing economy, we consider that the Romanian economy is generally perceived as growing. Chamberlin (2011) performs an estimate of actual income, ie a corrected or adjusted version of GDP, which is related to current and future consumption opportunities. Cohen and others (2003) made an overview of the key concepts of multiple regression, as well as a review of bivariate correlation and regression. The researches and works of Benjamin and others (2010), Jula and Jula (2010) provided the basis of statistical and econometric instruments and concepts included in our research. Braun (2014) criticizes Rothbard's work and argues that the gross investment value is an arbitrary figure that depends on the length of the different stages of production. Draper and Smith (1998) have focused on the use and verification of linear and non-linear regression models, using small and large data sets in this regard. Dougherty (2007) conducted a review of all the notions and fundamental statistical concepts needed to study econometrics. Garin (2016) performs nominal GDP comparisons taking into account the inflation target, comparisons based on welfare losses in relation to a hypothetical balance, with flexible prices and salaries. Freedman (2005) presented the fundamental aspects of association and regression, described the main patterns that link these causal ideas, paying particular attention to the applications of linear models. Nalewaik (2012) said that a stronger focus on gross domestic income proved useful in assessing the current state of the economy.

## 3. Research methodology

The study of the evolution of GDP in Romania can follow a multiple linear regression model, based on, as explanatory variables, final consumption, gross investments and inventories. The result obtained in this study can be valid, but the main drawback would be the high value of the constant term, which implies a significant influence of the factors that were not included in the model. To eliminate these drawbacks, research can be continued and improved by using a more developed multiple regression model, the variable GDP is the result, while final consumption, private consumption, public consumption, gross investments, changes in inventories net exports and brut incomes of the population are used as independent variables.

For an analysis based on direct linear multiple regression we can consider final consumption as the aggregate of private and public consumption, as far as, theoretically, first indicator (final consumption) is equal with the sum of public and private consumption.

The first step consisted in selecting the variables describing the evolution of GDP, namely final consumption, gross investments, changes in inventories, net export and gross available income of population. The statistical data used in the regression model were collected from the National Statistics Institute official database and publications, and refers to the period 1990-2014. Particular attention was paid to the values expressed in current prices. A deflation of data was necessary in order to ensure comparability, as the base of comparison is the first year of the analysis, 1990.

Table no. 1. **GDP, private consumption, public consumption, gross investments, changes in inventories, net exports and gross available income of the population in Romania during 1990-2014**

| Year | GDP | Private consumption | Public consumption | Gross investments | Changes in inventories | Net Export | Gross available income* |
|---|---|---|---|---|---|---|---|
| 1990 | 85,8 | 55,8 | 12,2 | 17,0 | 9,0 | -8.2 | 58.8 |
| 1991 | 81,6 | 49,0 | 12,9 | 11,7 | 11,1 | -3.2 | 49.8 |
| 1992 | 71,9 | 44,7 | 10,6 | 13,8 | 8,8 | -6.1 | 46.3 |
| 1993 | 67,1 | 42,4 | 8,6 | 12,0 | 7,4 | -3.3 | 44.2 |
| 1994 | 70,4 | 44,5 | 9,9 | 14,3 | 3,2 | -1.5 | 47.9 |

| Year | GDP | Private consumption | Public consumption | Gross investments | Changes in inventories | Net Export | Gross available income* |
|---|---|---|---|---|---|---|---|
| 1995 | 77,1 | 51,9 | 10,8 | 16,5 | 2,2 | -4.3 | 56.2 |
| 1996 | 83,9 | 58,0 | 11,3 | 19,3 | 2,4 | -7.1 | 61.3 |
| 1997 | 76,5 | 56,3 | 9,8 | 16,2 | -0,4 | -5.4 | 57.0 |
| 1998 | 71,0 | 59,1 | 5,0 | 12,9 | -0,3 | -5.7 | 49.6 |
| 1999 | 71,1 | 59,1 | 4,0 | 12,6 | -1,2 | -3.4 | 52.1 |
| 2000 | 71,9 | 56,8 | 5,2 | 13,6 | 0,4 | -4.0 | 51.1 |
| 2001 | 77,7 | 61,0 | 5,2 | 16,0 | 1,5 | -6.0 | 53.5 |
| 2002 | 82,5 | 63,5 | 5,6 | 17,6 | 0,6 | -4.6 | 55.8 |
| 2003 | 93,0 | 70,4 | 9,1 | 20,0 | 0,4 | -7.0 | 56.2 |
| 2004 | 104,2 | 80,6 | 8,2 | 22,7 | 2,0 | -9.4 | 67.5 |
| 2005 | 111,6 | 87,6 | 9,3 | 26,5 | -0,5 | -11.3 | 69.2 |
| 2006 | 124,9 | 97,3 | 9,6 | 32,0 | 1,1 | -15.0 | 75.5 |
| 2007 | 143,8 | 107,4 | 10,9 | 43,4 | 1,1 | -19.0 | 86.3 |
| 2008 | 168,1 | 121,7 | 12,5 | 52,7 | -1,1 | -17.6 | 101.8 |
| 2009 | 155,0 | 109,8 | 13,1 | 37,2 | 1,4 | -6.5 | 94.1 |
| 2010 | 152,8 | 110,5 | 10,7 | 39,6 | 1,4 | -9.4 | 92.1 |
| 2011 | 152,9 | 109,3 | 9,5 | 41,4 | 1,2 | -8.5 | 87.9 |
| 2012 | 156,2 | 112,0 | 9,8 | 43,0 | -0,8 | -7.8 | 86.0 |
| 2013 | 160,5 | 110,9 | 11,4 | 38,2 | 1,2 | -1.1 | 90.6 |
| 2014 | 166,1 | 115,0 | 13,2 | 36,5 | 1,7 | -0.4 | 89.4 |

* Gross available income of households and non-profit institutions serving households

** Romanian currency, at the level of 1 $ = 4,00 RON on August 5th, 2015

Source: Statistical Yearbook of Romania- gross domestic product by category of uses, NIS, Bucharest, 2008, 2009, 2010, 2011, 2014

Based on this information, we analyze the existence of any link of dependency between:

- Variable explained, dependent or result - Y, the Gross Domestic Product on the one hand and

- Explanatory variables, independent or causal.

- $x_1$ shows private consumption;
- $x_2$ shows public consumption;
- $x_3$ shows the level of gross investments;
- $x_4$ shows changes in inventories;
- $x_5$ shows the variation of net exports;
- $x_6$ shows gross available income of the population.

The mathematical expression of the relationship between the variables mentioned above is:

$y = a_0 + a_1 \cdot x_1 + a_2 \cdot x_2 + a_3 \cdot x_3 + a_4 \cdot x_4 + a_5 \cdot x_5 + a_6 \cdot x_6 + \varepsilon$

ie a multifactor linear regression model with k = 6 explanatory variables, where:

- $a_0$, $a_1$, $a_2$, $a_3$, $a_4$, $a_5$ and $a_6$ are regression coefficients of the model;
- $\varepsilon$ is the residual variable.

## 4. Research results. Econometric model

By processing the data provided by NIS (table no. 1) using the software Eviews 7.2, where we defined as variable resultant of the equation the Gross Domestic Product (GDP) and as factorial variables: private consumption value (CP), public consumption value (CPL), gross investments (INVB) variation stocks (VS), net exports (EXN) and brut incomes of the population (VDBGP) estimators, we have determined the regression equation using the least squares method. Also, the free term was not omitted from the model, and it is supposed to reflect the influence of other factors, not taken into consideration at this moment.

Results obtained by using Eviews 7.2 are as follows:

Dependent Variable: PIB
Method: Least Squares
Date: 08/20/15 Time: 19:33
Sample: 1990 2014
Included observations: 25

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.079690 | 0.083061 | -0.959413 | 0.3501 |
| CP | 1.004411 | 0.001979 | 507.5073 | 0.0000 |
| CPL | 1.012361 | 0.006625 | 152.8054 | 0.0000 |
| INVB | 0.993191 | 0.003890 | 255.2972 | 0.0000 |
| VS | 0.996778 | 0.004432 | 224.8958 | 0.0000 |
| EXN | 0.995923 | 0.002554 | 389.9449 | 0.0000 |
| VDBGP | -0.003372 | 0.003474 | -0.970632 | 0.3446 |

| | | | |
|---|---|---|---|
| R-squared | 0.999999 | Mean dependent var | 107.1040 |
| Adjusted R-squared | 0.999999 | S.D. dependent var | 37.53240 |
| S.E. of regression | 0.043746 | Akaike info criterion | -3.189338 |
| Sum squared resid | 0.034447 | Schwarz criterion | -2.848052 |
| Log likelihood | 46.86672 | Hannan-Quinn criter. | -3.094680 |
| F-statistic | 2944393. | Durbin-Watson stat | 2.138240 |
| Prob(F-statistic) | 0.000000 | | |

Figure no. 1. **The results of the regression model parameter estimates**

From the above data (fig. no. 1), the multiple regression model describing the relationship of the six macroeconomic indicators may be given in the form of equation as follows:

GDP = -0.079690 + 1.004411 · CP + 1.012361 · CPL + 0.996778 · INVB + 0.996778 · VS + 0.995923 · EXN - 0.003372 · VDBGP

The analysis continues with statistical significance parameters included in the model, as well as with the test for the validity of the model and its degree of reliability:

- C is the constant term, so $a_0$ coefficient is -0.079690 and show the average dependent variable when all the explanatory variables is zero. So the average GDP to be obtained if no such record as final consumption would occur, gross investment would be void, stocks null, net exports would not realize, it would be -0.079690 million RON. Since statistical t-test probability attached is far superior to 5% significance mark, it means that this quotient is insignificant;

- $a_1$ coefficient is 1.004411, which means that the private consumption increases by one million RON, while maintaining unchanged the other explanatory variables in the model, will induce a GDP growth by an average of 1,004,411 RON. Working at the level of relevance 5% probability attached to the statistical t-test, this level is lower for the private consumption exogenous variable;

- the $a_2$ coefficient is 1.012361, which means that if public consumption increases by one million RON, while maintaining unchanged the other explanatory variables of the model, GDP will

grow by an average of 1,012,361 RON. This is significant because the probability coefficient attached to the statistical t-test is lower than 5%;

- $a_3$ coefficient is 0.993191, which means that at an increase in the gross investment of one million RON, while maintaining unchanged the other explanatory variables in the model, GDP will grow by an average of 993,191 RON. Working at the level of relevance 5%, the probability of the statistical t-test is lower than this level for the exogenous gross investment variation;

- $a_4$ coefficient is 0.996778, meaning that if variation stocks increases by one million RON, while maintaining unchanged the other explanatory variables, GDP will grow by an average of 996,778 RON. Working at the level of relevance 5%, the probability of the statistical t-test is lower than this level for the exogenous variable variation stocks;

- $a_5$ coefficient is 0.995923, which means that the net export increases by one million RON, while maintaining unchanged the other explanatory variables in the model, will induce a GDP growth by an average of 995,923 RON. Working at the level of relevance 5%, probability attached to the statistical t-test, this level is lower for the net export variable;

- $a_6$ coefficient is - 0.003372, which means that the gross available income of the population increases by one million RON, while maintaining unchanged the other explanatory variables in the model, will induce a GDP depreciation by an average of 3,372 RON. Working at the level of relevance 5%, probability attached to the statistical t-test, this level is lower for the gross available incomes of the population variable;

There is therefore a direct relationship between GDP as result variable and all six dependent (factorial) variables.

From the point of view of statistical tests that verify the accuracy of the econometric model considered, it can be seen that the values of tests $R^2$ and $R^2$ - adjusted are very high, tending to unit value, which allows us to say that the model is correctly and it grants a minimum risk for economic analyses. We can also notice that the introduction, into the model, of several factor variables led to an increase in the likelihood of it.

Taking into account all the relevant aspects expressed above, we can appreciate the used model is representative to describe the influence of private consumption, public consumption, gross investments, stock variation, net exports and brut incomes of the population on GDP evolution.

Using the direct linear multiple regression in our analysis, we got the target to see the GDP evolution as far as factorial variables are changeably.

The direct linear multiple regression is very precise as far as the determination report is very close to unit value.

## 5. Conclusion

In this paper, we search the possibilities to use the econometric models, based on mathematical functions, to analyze the evolution of a macroeconomic system. Among a lot of econometric models, we chose the regression model because it can express precisely the correlations and influences between variables. After, we study the datasets provided by the National Institute of Statistics, we considered that the GDP is influenced by, and at the same time it influences itself, a lot of other variables. As the most complex study of GDP, we have used eight variables. Among these, we have identified the investments, the final consumption, net export, annual final stock, as well some more variables regarding private and public consumption or the level of available incomes of the population. Within the graphic presentations, we realized that the evolution of the sector variables is connected with the GDP's evolution. On the other hand, we can say that the increase of GDP positive influence leads to a move in the same direction of all variables. In this respect, we clarify that there is a direct influence between the variables and we use the mathematical function of straight line. As far as we are concerned, the model that can be used is the linear regression, in both alternatives - simple and multiple. Having at hand our datasets for 25

years, we have built appropriate tables then we presented by graphics and considered the econometric models. We have used some symbols and then create the connections within regression models. From the multiple linear regression models, we considered the regression parameters, which are very expressive and show the dependencies, correlations and influences between variables.

The determination reports show that the variables as gross investments, changes in inventories, final consumption, net export, private and public consumption and as well as the gross available income exert a decisive influence on all the variations in the Gross Domestic Product. At the same conclusions we come if we will consider any of the multiple regression. In our paper, we consider only two other alternative regression models (GDP and: gross investments, final consumption, net export and changes in inventories, or final consumption and private consumption, public consumption, incomes). The conclusions are the same. Taking into account the simple linear regression, we have demonstrated that between GDP, final consumption and so on, and other variables, correlations and influences can be studied. We can use, without any restrictions, the simple and multiple linear regression.

We can safely say that the models are statistically significant, after applying the f-statistic test, whose value is higher than the table reference value, considered to be benchmark in the analysis of econometric models validity, being valid for a significance probability level below 5%.

From the above observations, we can consider the chosen model as representative to describe the influence of factorial variables, in each considered case, on the Gross Domestic Product of Romania.

On the other hand, the lower value of the free term shows that the influence of factors that have not been included in the model of Gross Domestic Product evolution is relatively significant, which leads us to conclude the applying of multiple linear regression model for more convenient results, than potential single approaches. But in different studies regarding the influence of only one factor on the evolution of the GDP, we can statistically use the simple linear regression.

We might not forget that the residual variable concentrates all the influences except that of the selected variables. It has identified a relationship between the variables subjected to the test. At the same time, in our paper, we focused on possibility to make a forecast study on the evolution of the GDP, using different statistical and econometric techniques. Finally, we can express some opinions on the evolutions of the Romanian economy and the possibility to have a better development in the future. As a remark, we underline that the Romanian economy of the last 25 years has been constructed almost exclusively on the basis of the consumption stimulation and less on promoting an active investment strategy.

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