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Analysis of Final Consumption, Gross Investment, the Changes in Inventories and Net Exports Influence of GDP Evolution, by Multiple Regression

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Abstract *This paper presents a model that can be used for the analysis and forecast of Gross Domestic Product. The starting point of the research is the final output method used in GDP calculation. Based on this assumption, the conceptualization of the model will consider the GDP as main variable and the other measures as influence factors. The dataset was constructed using data drawn from official sources. The parameters of the model were estimated with the help of Eviews.*

Key words Final consumption, gross investment, charges in inventories, net exports, correlation

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1. Introduction

Anghelache (2014) offers a detailed analysis on the macroeconomic indicators approached in the scope of this research, at the level of the Romanian economy. The volume coordinated by Anghelache (2013) includes several papers on the use of statistical and econometrical instruments in the analysis of macroeconomic indicators. Carp (2014) studies the correlation between exports and economic growth. Anghelache and Manole (2012) present an analysis of Romania's foreign trade. Rădulescu (2013) analyzes the export potential of the Romanian economy. Iordache *et al*. (2011) present a model for the calculation of GDP, constructed as an econometric relation. Chamberlin (2011) approaches the relation between GDP, real income and economic welfare. Constantin (2013) analyzes the case of GDP and investments in Romania and EU.

In the examination of the factors that determine the variation in GDP, we started from the specific methodological elements using final output method (method of expenses), considering that it constitutes a significant source of information on key correlations influencing the evolution of the main macroeconomic aggregate. Thus, according to this method of calculation, GDP can be determined by adding components that express the use of goods and services that form the final output, respectively: final consumption (CF), gross investments (INVB) changes in inventories (VS) and export net (EXN).

2. Research methodology and data

The study of the evolution of GDP in Romania can follow a multiple linear regression model (Anghelache *et al.* 2013, Iordache *et al.* 2011, Chamberlin 2011), based on, as explanatory variables, final consumption, gross investments (Constantin 2013) 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, gross investments, changes in inventories and net exports (Carp 2014, Anghelache and Manole, 2012) are used as independent variables.

In this study we wanted to identify the main factors that influence GDP growth in Romania (Anghelache 2014, Rădulescu 2013) between 1990-2014 and to estimate their influence with the help of multiple linear regression-based analysis.

The first step consisted in selecting the variables describing the evolution of GDP, namely final consumption, gross investments, changes in inventories and net exports. 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 deflationary data was necessary in order to ensure comparability, as the base of comparison is the year of the analysis, 1990. The five indicators can be presented in summary form as follows:

Table 1. GDP by final consumption, gross investments, changes in inventories and net exports in Romania during 1990-2014

Year	Gross Domestic Product (comparable prices) million RON*	Final consumption (comparable prices) million RON*	Gross investments (comparable prices) million RON*	Changes in inventories (comparable prices) million RON*	Net exports (comparable prices) million RON*
1990	85.8	68.0	17.0	9.0	-8.2
1991	81.6	61.9	11.7	11.1	-3.2
1992	71.9	55.3	13.8	8.8	-6.1
1993	67.1	51.0	12.0	7.4	-3.3
1994	70,4	54.4	14.3	3.2	-1.5
1995	77,1	62.7	16.5	2.2	-4.3
1996	83,9	69.3	19.3	2.4	-7.1
1997	76.5	66.1	16.2	-0.4	-5.4
1998	71.0	64.1	12.9	-0.3	-5.7
1999	71.1	63.1	12.6	-1.2	-3.4
2000	71.9	62.0	13.6	0.4	-4.0
2001	77.7	66.2	16.0	1.5	-6.0
2002	82.5	69.0	17.6	0.6	-4.6
2003	93.0	79.5	20.0	0.4	-7.0
2004	104.2	88.9	22.7	2.0	-9.4
2005	111.6	97.0	26.5	-0.5	-11.3
2006	124.9	106.9	32.0	1.1	-15.0
2007	143.8	118.3	43.4	1.1	-19.0
2008	168.1	134.2	52.7	-1.1	-17.6
2009	155.0	122.9	37.2	1.4	-6.5
2010	152.8	121.2	39.6	1.4	-9.4
2011	152.9	118.8	41.4	1.2	-8.5
2012	156.2	121.8	43.0	-0.8	-7.8
2013	160.5	122.2	38.2	1.2	-1.1
2014	166.1	128.3	36.5	1.7	-0.4

* 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 final consumption;
• x_2 shows the level of gross investments;
• x_3 shows changes in inventories;
• x_4 shows the variation of net exports.

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

$$y_i = b_0 + b_1 \cdot x_{1i} + b_2 \cdot x_{2i} + b_3 \cdot x_{3i} + + b_4 \cdot x_{4i} + \varepsilon_i \ , \ (_{i=1,2,\ldots,25})$$

ie a multifactor linear regression model with k = 4 explanatory variables, where:
- b_0, b_1, b_2,b_3 and b_4 are regression coefficients of the model;
- ε is the residual variable.

3. Research results. Econometric model

By processing the data provided by NIS using the software Eviews 7.2, where we defined as variable resultant of the equation the Gross Domestic Product (GDP) and as factorial variables: final consumption value (CF), gross investments (INVB) variation stocks (VS) and net exports (EXN) 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: 07/27/15 Time: 05:58
Sample: 1990 2014
Included observations: 25

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.018862	0.065212	-0.289236	0.7754
CF	1.000153	0.001679	595.5924	0.0000
INVB	1.000045	0.004000	249.9881	0.0000
VS	1.008658	0.003494	288.7223	0.0000
EXN	1.003162	0.002906	345.2514	0.0000

R-squared	0.999998	Mean dependent var	107.1040
Adjusted R-squared	0.999998	S.D. dependent var	37.53240
S.E. of regression	0.051114	Akaike info criterion	-2.932655
Sum squared resid	0.052253	Schwarz criterion	-2.688880
Log likelihood	41.65819	Hannan-Quinn criter.	-2.865043
F-statistic	3235054.	Durbin-Watson stat	2.515456
Prob(F-statistic)	0.000000		

Figure 2. The results of the regression model parameter estimates

From the above data table, the multiple regression model describing the relationship of the five macroeconomic indicators may be given in the form of equation as follows:

$$GDP = -0.018862 + 1.000153 \cdot CF + 1.000045 \cdot INVB + 1.008658 \cdot VS + 1.003162 \cdot EXN$$

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 b_0 coefficient is -0.018862 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 -0.018862 million RON. Since statistical t-test probability attached is far superior to 5% significance mark, it means that this quotient is insignificant;

- b_1 coefficient is 1.000153, which means that the final consumption increase by one million RON, while maintaining unchanged the other explanatory variables in the model, will induce a GDP growth by an average of 1,000,153 RON. Working at the level of relevance 5% probability attached to the statistical t-test, this level is lower for the final consumption variable;

- The b_2 coefficient is 1.000045, which means that if gross investment increases by one million RON, while maintaining unchanged the other explanatory variables of the model, GDP will grow by an average of 1,000,045 RON. This is significant because the probability coefficient attached to the statistical t-test is lower than 5%;

- b_3 coefficient is 1.008658, which means that at an increase in the stock of one million RON, while maintaining unchanged the other explanatory variables in the model, GDP will grow by an average of 1,008,658 RON. Working at the level of relevance 5%, the probability of the statistical t-test is lower than this level for the exogenous variable stock variation;

- b_4 coefficient is 1.003162, meaning that if net exports increase by one million RON, while maintaining unchanged the other explanatory variables, GDP will grow by an average of 1,003,162 RON. Working at the level of relevance 5%, the probability of the statistical t-test is lower than this level for the exogenous variable net exports.

There is therefore a direct relationship between GDP and final consumption, gross investments, changes in inventories and net exports in Romania between 1990-2014.

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.

4. Conclusions

The determination report shows that the variables final consumption, gross investments, changes in inventories and net exports exert a decisive influence on all the variation in GDP. We can safely say that the model is statistically significant after applying the test F-statistic, whose value is more than the table reference value, considered to be benchmark in the analysis of the validity of econometric models, being valid for a significance level Prob (F-statistic) that is zero, lower than 5%.

Given the above observations we can say consider the chosen model to be representative to describe the influence that final consumption, gross investment, net exports and stock variation have on GDP growth. The much lower value of the free term shows that the influence of factors that were not included in the model of the evolution of GDP is relatively insignificant, which leads us to conclude that applying a multiple regression model offers superior results than potential single factor approaches.

Multiple regression analysis followed the evolution in terms of changes in final consumption, GDP, gross investments, changes in inventories and net exports in Romania in the period 1990-2014. It identified a linear relationship between the variables subject to the test. The multiple regression estimates proved to be accurate, having a determination ratio close to 1.

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