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Analysis of final consumption and gross investment influence on GDP – multiple linear regression model

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Abstract. *This paper emphasizes the application of regression models in macroeconomic analyses. The particular situation approached is the influence of final consumption and gross investments on the evolution of Romania's Gross Domestic Product. The results of such research are supposed to contribute to deeper and more complex analyses of the GDP, the main indicator that shows the performance of a national economy. The dataset is made of official figures drawn from the Romanian Statistics authority, and the analysis is performed with the help of the Eviews software. The proposed model was tested by using proper instruments, the results of the tests are also presented in the paper.*

Keywords: final consumption, gross investment, prices, relationship, value.

JEL Classification: C51, C87, E22.

Introduction

Anghelache et al. (2014) focus on the role and potential of multiple regression instruments to be used in economic analyses. Chamberlin (2011) analyzes reflection on the economic welfare into the Gross Domestic Product. Ioneci and Mîndreci (2010) research the impact of the foreign direct investments on the same macroeconomic indicator, a similar analysis is realized by Mitruţ et al. (2014), while Constantin (2013) is more focused on the situation of GDP and investments at the level of Romania and EU. Also, Anghelache (coord., 2012), Iordache et al. (2011) are preoccupied with the utility of econometric models in calculating and forecasting the GDP. A sound reference on statistics and econometrics, including the topics that substantiate the research presented in this paper are the books of Anghelache (2008), Voineagu et al. (2007). Various issues on consumption were approached by Colloredo-Mansfeld (2005). Anghelache (2014) analyzes the situation of GDP, investments and consumption at the level of the Romanian economy.

It is widely known that information for the characterization of GDP evolution by using simple linear regression model, in the analysis of the correlation between this measure and final consumption are not always clear enough to identify its possible subsequent developments. A significant argument in this respect can be considered the high value of the free term (as the reflection of the factors that were not included in the model) in such simple regression.

To remedy these shortcomings, the simple linear regression method can be extended from sets of two variables to more variables by multiple linear regression method, in which case we have a dependent variable and many factor variables (Anghelache et al., 2014; Anghelache et al., 2012; Voineagu et al., 2007; Iordache et al. 2011).

Research methodology and data

Using a multiple linear regression model for the Romanian economy case will offer further insight on the analysis performed using simple linear models. In this regard, we consider the Gross Domestic Product as resultant variable and variable factor to be the final consumption value (Anghelache et al., 2012; Chamberlin, 2011; Anghelache, 2008; Colloredo-Mansfeld, 2005) and the value of gross investment (Constantin, 2013; Mitruţ et al., 2014; Ioneci and Mândreci, 2010) in Romania during 1990-2014. The values of these macroeconomic indicators were deflated using the consumer price index - CPI (Anghelache, 2008), as set by regulations of the National Institute of Statistics, the CPI being used to calculate the inflation rate in Romania, which reflects the evolution of prices and tariffs of goods and services purchased by the population in the current year compared to 1990, the main reference year.

The three indicators can be presented in summary form as follows:

Table 1. *GDP by final consumption and investment 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*
1990	85,8	68,0	17,0
1991	81,6	61,9	11,7
1992	71,9	55,3	13,8
1993	67,1	51,0	12,0
1994	70,4	54,4	14,3
1995	77,1	62,7	16,5
1996	83,9	69,3	19,3
1997	76,5	66,1	16,2
1998	71,0	64,1	12.9
1999	71.1	63,1	12.6
2000	71,9	62,0	13.6
2001	77,7	66,2	16.0
2002	82,5	69,0	17.6
2003	93,0	79,5	20.0
2004	104,2	88,9	22.7
2005	111,6	97,0	26.5
2006	124,9	106,9	32.0
2007	143.8	118,3	43.4
2008	168,1	134,2	52,7
2009	155,0	122,9	37,2
2010	152,8	121,2	39,6
2011	152,9	118,8	41,4
2012	156,2	121,8	43,0
2013	160,5	122,2	38,2
2014	166,1	128,3	36,5

* 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 will analyze the existence of a dependency between the Gross Domestic Product (resultant variable y), on the one hand and the final consumption (causal variable x_1) and the gross investment (causal variable x_2).

In this context it is particularly important to specify and analyze the relationship between the three macroeconomic indicators, using a multifactor regression model (Anghelache et al., 2014). From the mathematical point of view it can be transcribed as follows:

$$y_i = a + b_1x_{1i} + b_2x_{2i} + c_i$$

To facilitate the estimation of multiple regression model we used the software Eviews 7.2, where we defined as resultant variable the Gross Domestic Product (GDP) and as factorial variables the final consumption value (CF) and gross investment (INVB). We

also thought that this regression model will contain a free term c, to reflect the influence of the terms that were not considered when building the model.

Regression model

With the instruments of the Eviews 7.2, we estimated the model parameters using the least squares in method and we subsequently tested the validity of the model, its degree of reliability and statistical significance of the parameters included.

Results obtained by using Eviews 7.2 are as follows:

Figure 1. *The results of the regression model parameter estimates*

Dependent Variable: PIB
Method: Least Squares
Date: 07/24/15 Time: 02:17
Sample: 1990 2014
Included observations: 25

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.143838	5.405568	-0.396598	0.6955
CF	1.163113	0.152743	7.614816	0.0000
INVB	0.324933	0.344446	0.943350	0.3557

R-squared	0.983080	Mean dependent var	107.1040
Adjusted R-squared	0.981542	S.D. dependent var	37.53240
S.E. of regression	5.099152	Akaike info criterion	6.208192
Sum squared resid	572.0297	Schwarz criterion	6.354457
Log likelihood	-74.60240	Hannan-Quinn criter.	6.248760
F-statistic	639.1268	Durbin-Watson stat	0.273984
Prob(F-statistic)	0.000000		

From the above diagram, provided by the analysis software, the multiple regression model that describes the relationship between the three macroeconomic indicators can be written under the following form:

GDP = -2.143838 + 1.163113 • CF + 0.324933 • INVB.

It is noted that, for an increase in final consumption by one million RON, GDP will increase by 1,163,113 RON, while maintaining the other variable constant, and in the case of gross investment, the difference is much smaller, being able to find that, in Romania, every million RON invested only bring an increase of 0,324933 million RON of the GDP, provided that other factor included in the model remains constant.

There is therefore a direct relationship between GDP and final consumption, gross investments in Romania respectively in the period 1990-2014.

It should be noted that the free term value can be significantly lower compared with single factor analysis based on the same type of model, which allows us to conclude that the use of multifactor regression models is recommended to be included in such macroeconomic analysis, and generally, in all analyses approaching macroeconomic indicators and evolutions/forecasts.

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 high (R^2 = 98.31% and R^2 adjusted = 98.15%), allowing us to conclude that the model is correct and with a minimum risk for economic analysis. We can also notice that the introduction, in the model, of additional factor variable can lead to an increase in its likelihood when compared with a simple linear regression.

The determination report shows that 98.31% of the variation of the GDP is explained by the simultaneous variation of final consumption and gross investment in Romania during 1990-2014, suggesting a strong link between endogenous variable and the two exogenous variables, as confirmed by adjusted determination coefficient (adjusted R-squared = 0.9815), which takes into account the number of observations (25) and the number of exogenous variables (2). The correlation report (R = 0.98308), tending towards unit value 1, demonstrates that the estimated regression model approximates the observation data very well, with high reliability.

We can safely say that the model is statistically significant after applying the F - statistic test, as its value is more than the table-based reference, used to test the validity of econometric models. Also, the proposed model is valid, having a zero significance level Prob (F-statistic), much lower than 5%.

For each independent variable and constant, Eviews reported the standard error of the coefficient, the t-statistic test and the associated probability. Working at the level of relevance 5%, the probability attached to the statistical t-test is below that level only for "final consumption" exogenous variable. Free term coefficient is not significant because the probability attached to the statistical t-test is higher than 5% significance threshold.

Conclusions

From the methodological standpoint, it can be seen that the use of multifactor regression model allows the researcher to draw conclusive results in macroeconomic analysis, without stating that single factor regression models does not allow relevant observations on the evolution of the national economy.

In view of the aforementioned considerations, it can be appreciated that the model chosen can be representative to describe the impact that final consumption and gross investment have on GDP growth.

Multiple regression analysis has followed the evolution of GDP in terms of changes in consumption and investment in Romania during 1990-2014. It helped us to outline a linear relationship between the studied variables. The multiple regression model estimated proved to be one of precise character, as it has a high ratio of determination R^2 = 0.98308, so GDP is explained nearly 98.31% by the independent variables included in the model.

Based on all the comments made following the analysis of Romania's GDP by using multiple regression models, we conclude that this indicator is significantly influenced by changes in final consumption and gross investment.

References

Anghelache, C., Anghel, M.G., Prodan, L., Sacală, C. and Popovici, M., 2014. Multiple Linear Regression Model Used in Economic Analyses. *Romanian Statistical Review Supplement.* Vol. 62. Issue 10 (October), pp. 120-127.

Anghelache, C., 2014. *România 2014. Starea economică pe calea redresării.* Editura Economică. Bucureşti.

Anghelache, C. (coord.) et al., 2012. Modele statistico-econometrice de analiză economic – utilizarea modelelor în studiul economiei României, *Revista Română de Statistică* (Supplement).

Anghelache, C., 2008. *Tratat de statistică teoretică şi economic.* Editura Economică. Bucureşti.

Chamberlin, G., 2011. Gross domestic product, real income and economic welfare. *Economic & Labour Market Review*, Vol. 5. Issue 5 (May). pp. 5-25.

Colloredo-Mansfeld, R., 2005. Consumption. In James G. Carrier (Ed.). 2005, *A Handbook of Economic Anthropology.* Books, Edward Elgar, No. 2904. p. 6.

Constantin, S., 2013. Gross Domestic Product and the Investment percent in Romania and in the European Union. Ovidius University Annals. Economic Sciences Series. Vol. XIII. Issue 1 (May), pp. 175-178.

Ioneci, M. and Mîndreci, G., 2010. The Impact of The Foreign Direct Investment on Romania's Economy. Annals of the University of Petroşani – Economics, Vol. 10. Issue 2, pp. 199-206.

Iordache, A.M.M., Tudorache, I.C. and Iordache, M.T., 2011. An Econometrical Model for Calculating the Romanian Gross Domestic Product, Journal *of Information Systems and Operations Management*, Vol. 5. Issue 21 (December). pp. 492-499.

Mitruţ, C., Dinu, A.M., Prodan, L. and Dragomir, B., 2014. GDP and Foreign Investments Evolution. *Romanian Statistical Review Supplement*, Vol. 62. Issue 1 (January). pp. 126-129.

Voineagu, V., Ţiţan, E. şi colectiv, 2007. *Teorie şi practică econometrică.* Editura Meteor Press, Bucureşti.

*** The Statistical Year Book of Romania, Issues 2002, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014.

www.insse.ro – official site of the National Institute of Statistics of Romania.