Using the Autoregressive Model for the Economic Forecast during the Period 2014- 2018

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Abstract

The article is based on the analysis of the autoregressive model. The model will include in its structure a dependent variable represented by the macroeconomic indicator GDP, to be forecasted and as independent variable, granting an autoregressive character to our model, by including in the frame of the built up model of the autoregressive variable GDP (-1), namely the lag 1 of the variable GDP. Also considered as independent variables are the final consumption *(FC) and the flow of direct foreign* investments *(DFI) both influencing the tendency of the evolution of the economic growth in our country.*

Key words: *autoregressive model, indicators, GDP, correlation, forecast, representation*

Introduction

Using the data published by *UNCTAD,* for the variables included in the frame of the model, the evolutions for the period 2014 -2018 are going to be forecasted.

The achieved autoregressive model will include in its structure the macroeconomic indicator GDP, both as dependent variable, to be forecasted and as independent variable, granting an autoregressive character to our model, by including in the frame of the built up model of the autoregressive variable GDP (-1), namely the lag 1 of the variable GDP. Apart the independent variable, GDP(-1), included in the frae of the prediction model, *the final consumption* (FC) and *the flow of direct foreign investments* (DFI) are also considered as independent variables which are influencing the tendency of the evolution of the economic growth in our country.

We shall develop further on a un model of prediction for the evolution of the GDP, for the period 2014 - 2018, applied on the case of Romania .

In order to achieve the prediction, we shall utilize the final data published by *UNCTAD* during the period 1991 - 2013, for the main macroeconomic indicators which influence the evolution of the GDP in Romania, respectively: final consumption *(FC)* and flow of direct foreign investments (DFI), as previously proceeded, in the predictions achieved for identifying the most performing model of prediction.

Thus, assuming that the indicators of reference *FC* and *DFI,* are going to increase with 10% from one statistical period to another and utilizing in the frame of the first model, which grasps the prediction for the GDP, from the period 2014-2018, the autoregressive variable GDP (-5), we developed, according to the previously followed up stages, an econometric model of prediction, defined as *Model 1,* (Table 1).

The autoregressive model which defines the prima equation noted *EQ01*

Table 1

Dependent Variable: GDP				
Method: Least Squares				
Date: 07/26/15 Time: 18 OS				
Sample (adjusted): 1996 2013				
Included observations: *V.*] after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DFI	**-0.563367**	**0.203530**	**-2.767977**	**0.0151**
FC	**1.274288**	**0.021404**	**59.53490**	**0.0000**
C	**-4495.684**	**7S5.7157**	**-5.721769**	**0.0001**
GDP(-5)	**0.027089**	**0.016453**	**1.646514**	**0.1219**
R-squared	**0.999459**	**Mean dependentvar**		**104101.1**
Adjusted R-squared	**0.999343**	**S.D. dependent var**		**64969. S9**
S.E. of regression	**1664.960**	**Akaike info criterion**		**17.36612**
Sum squared resid	**3S309273**	**Schwarz criterion**		**18.06393**
Log likelihood	**-156.7951**	**Hannan-Quinn criter.**		**17.89340**
F-statistic	**8624.014**	**Durbin-Watson stat**		**2.326815**
Prob(F-statistic)	**0.000000**			

As explained in the previous sub-chapter, where we aimed to test and validate the model of prediction, this time as well we get a valid and correct model, both from the statistical and practical point of view, a fact which is grasped by the outcomes of the tests R-*squared* and *Adjusted R-squared,* which underline a percentage of validity of 99.94%, respectively 99.93%. Meantime, the result of these tests is pointing out that the variables utilized in the frame of the model, are exercising a very high influence on the forecasted variable, respectively, the gross domestic product at the level of Romania .

We notice that the result evidenced by de *F-statistic* is also confirming the correctness of the model, the value of 8 624.01, being by far superior to the tableted level, considered as guide mark in the analyses methodology aiming the econometric models. Meanwhile, the result evidenced by *Prob (F-statistic),* is grasping the degree of null risk of the practical utilization of the developed model, *Model 1.*

Thus, the developed, *Model 1* can be represented through the equation :

GDP = 1.27428*FC - 0.56336*DFI + 0.02708*GDP (-5) - 4495.68 ***(EQ01)***

As previously done, we shall have to test whether the proposed model *(Model 1*), for achieving the prognosis for the evolution of the GDP in Romania is submitting the serial correlation.

Further to the application of the test *"Breusch-Godfrey Serial Correlation LM Test",* (Table 2), we identified the existence of a serial correlation on the lag 6. We notice this fact through the result obtained after testing the serial correlation, for the series of data utilized in the frame of the built up model, *Model 1*.

Hence, the value of *« Prob. Chi-Square (6) »,* is indicating the acceptance of the null hypothesis according to which : « *There is serial correlation on the lag 6* ».

The testul Breusch-Godfrey for testing the serial correlation for the Model 1 *(EQ01)*

Table 2

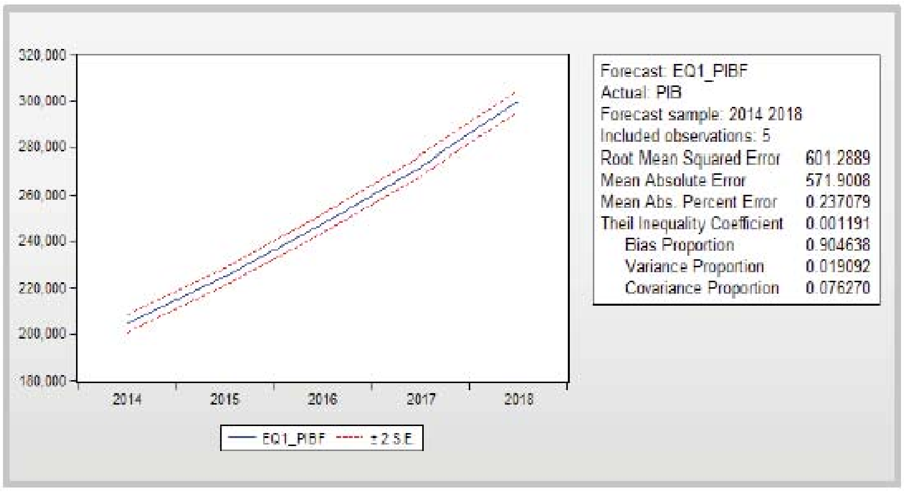
Breuscfi-Godfrey Serial Correlation LM Test				
F-statistic	**5.638039**	**Prob. F[6,8)**		**0.0144**
Obs'R-squared	**14.55735**	**Prob. Chi-Square(6)**		**0.0240**
Test Equation:				
Dependent Variable: RESID				
Method: Least Squares				
Date: 07/26r15 Time: 18 :05				
Sample: 1996 2013				
Included observations: 1i				
Presample missing value lagged residuals set to zero				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
DFI	**0.547795**	**0.272140**	**2.380368**	**0.0445**
FC	**-0.117421**	**0.032887**	**-3.570438**	**0.0073**
C	**2442747**	**628.5406**	**3.886379**	**0.0046**
PIBC-S;	**0.073954**	**0.024685**	**2.995896**	**0.0172**
RESIDC-1)	**-1.005891**	**0.244586**	**-4.112626**	**0.0034**
RESIDC-2)	**-1.426921**	**0.298148**	**-4.785940**	**0.0014**
RESIDf-3)	**-1.457765**	**0.293695**	**-4.963528**	**0.0011**
RES ID (-4}	**-1.614681**	**0.417577**	**-3.866789**	**0.0048**
RESID(-5)	**-1.447887**	**0.334907**	**-4.323255**	**0.0025**
RESID [-6)	**-1.239866**	**0.394708**	**-3.141220**	**0.0138**
R-squared	**0.808742**	**Mean dependent var**		**2.75E-11**
Adjusted R-squared	**0.593576**	**S.D. dependent var**		**1510.926**
S.E. of regression	**963.2366**	**Akaike info criterion**		**16.87366**
Sum squared resid	**7422598.**	**Schwarz criterion**		**17.37331**
Log likelihood	**-141.9079**	**Hannan-Quinn enter.**		**16.94686**
F-statistic	**3.758693**	**Durbin-Watson stat**		**2.OS7003**
Prob(F-statistic)	**0.037847**			

Thus, in order to improve the proposed model, *Model 1,* as shown in the previous sub-chapter, the component AR will be included. The improvement of the proposed model of prediction implies, meantime, the removal of the identified serial correlation.

In the achieved graphical representation, *Table 3,* we showed the future evolution of the GDP, for the proposed prognosis period, respectively 2014 -2018. Out of the statistical tests achieved for the forecasted values, evidenced through the equation *EQ01,* of the developed model, *Model 1,* we observe that the value *"RootMean SquaredError"* is indicating a very small prediction error, counting for 601.28.

The representation of the prediction for the GDP *(Model 1)*, during the period 2014 -2018, in Romania

Table 3



Following the stages proposed in the previous sub-chapter, for the process of validating the prediction model, taking into consideration the increase of the accuracy level of the estimation of the evolution of the GDP, achieved through the equation *EQ01,* resulting out of *Model 1,* we shall remove the serial correlation, by including the component AR(1), which would ameliorate the quality of the dynamic prediction model.

Further on, we shall develop an autoregressive model, containing the AR(5), called *Model 2,* which, according to the Eviews outcomes may be represented mathematically as follows:

GDP = 1.27137*FC - 0.50020*DFI + 0.03072*GDP (-5) - 0.09860*AR(-5) - 4854.68

Similar to the situation of the models previously interpreted, a very high level of accuracy of the built up prediction model - (Table 4) – is to be observed. This aspect is underlined in a proportion of 99.91%, respectively 99.87%, by the outcomes of the tests *R-squared,* respectively *Adjusted R-squared.* Meantime, the value *Prob(F-statistic)* as well, is underlining a degree of null risk in the situation of the implementation of the built up model, *Model 2,* in practice, in the predictions for the evolution of the gross domestic product at the level of our country``.

Meantime, the achieved model gets a high applicability given by the individual values of the probabilities obtained by each variable alone, (Table 4), which evidences the fact that it is significant for explaining the evolution of the gross domestic product in Romania.

Model 2.The autoregressive model which defines the second equation *EQ02*

Table 4

Dependent Variable: PIB
Method: Least Squares
Date: 07/26/15 Time: 18:09
Sample (adjusted): 2001 2013
Included observations: 13 after adjustments
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ISD	-0.500204	0.289235	-1.729402	0.1220
CF	1.271370	0.030599	41.54999	0.0000
C	-4854.688	1387.285	-3.499416	0.0081
PIB(-5)	0.030722	0.022364	1.373724	0.2068
AR(5)	-0.098601	0.395386	-0.249380	0.8094

R-squared	0.999171	Mean dependent var	129710.8
Adjusted R-squared	0.998756	S.D. dependent var	58480.69
S.E. of regression	2062.259	Akaike info criterion	18.38471
Sum squared resid	34023297	Schwarz criterion	18.60200
Log likelihood	-114.5006	Hannan-Quinn criter.	18.34005
F-statistic	2410.458	Durbin-Watson stat	2.259395
Prob(F-statistic)	0.000000		

Inverted AR Roots	.51+.37i	.51-.37i	-.19-.60i	-.19+.60i
	-.63			

As previously specified, the component AR(5) is improving the proposed model of prediction, eliminating meantime the serial correlation. Thus, applying the test *"Breusch-Godfrey Serial Correlation LM Test",* in order to verify whether the serial correlation is still identified on the lag 6, through processing in Eviews 7.2, we get the outcomes pointed out in the Table 5.

According to the probability result, *"Prob Chi-Square (6)",* obtained for the assumed null hypothesis, according to which "« *There it would exist a serial correlation on the lag 6* », for the series utilized for the construction of the model, *Model 2,* we deduce that this one does not submit a serial correlation any more.

Thus, we observe that the *Model 2,* which comprise the component AR on the lag 5, is submitting an accuracy very little improved as against the *Model 3,* a fact underlined by the result obtained for the test *"RootMean SquaredError",* which indicates an estimated error between the possible real values of the evolution of the GDP and those estimated by the prediction model, counting for 599.10, Table 6.

The test Breusch-Godfrey for testing the serial correlation for the Model 2 *(EQ02)*

Table 5

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.280065	Prob. F(6,2)	0.5006
Obs*R-squared	10.31416	Prob. Chi-Square(6)	0.1120

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 07/26/15 Time: 18:11
Sample: 2001 2013
Included observations: 13
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ISD	1.001895	0.801704	1.249707	0.3378
CF	-0.141260	0.089018	-1.586878	0.2534
C	2125.434	2319.207	0.916449	0.4562
PIB(-5)	0.095631	0.081461	1.173946	0.3613
AR(5)	0.010418	1.063607	0.009795	0.9931
RESID(-1)	-0.798622	0.619524	-1.289090	0.3263
RESID(-2)	-1.225779	0.619636	-1.978224	0.1865
RESID(-3)	-0.825225	0.820037	-1.006326	0.4202
RESID(-4)	-1.828047	1.238728	-1.475745	0.2780
RESID(-5)	-1.480951	1.361232	-1.087949	0.3903
RESID(-6)	-0.637718	1.576895	-0.404414	0.7251

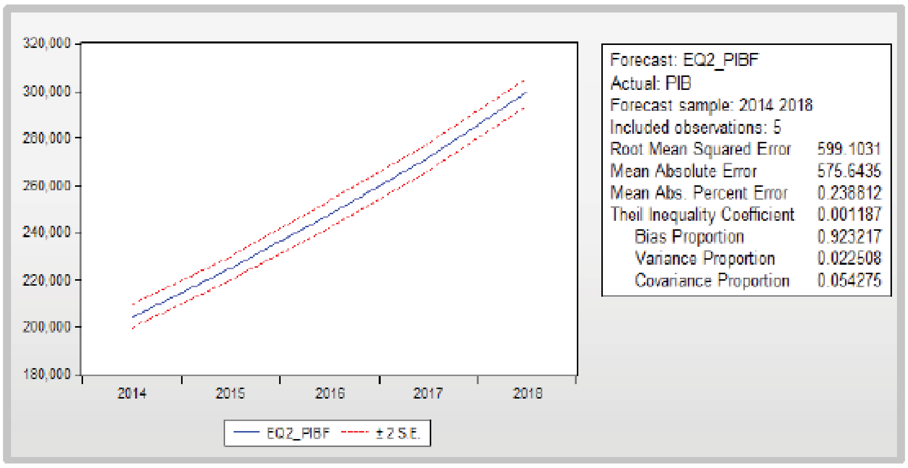
R-squared	0.793397	Mean dependent var	1.01E-06
Adjusted R-squared	-0.239620	S.D. dependent var	1683.827
S.E. of regression	1874.743	Akaike info criterion	17.73084
Sum squared resid	7029325.	Schwarz criterion	18.20887
Log likelihood	-104.2504	Hannan-Quinn criter.	17.63258
F-statistic	0.768039	Durbin-Watson stat	2.076639
Prob(F-statistic)	0.685622		

We remained that the achieved prediction was grounded on the presumption that the considered macroeconomic indicators in the construction of the prediction model (final consumption, respectively flow of direct foreign investments), would increase by 10%, from one year to another.

Thus, in conformity with the previous statements, the graphical representation of the forecast achieved with the help of the informatics softs Eviews 7.2., from the point of view of the *Model 4,* previously built up, is of the form (Table 6):

The representation of the GDP forecast *(Model 2)*, during the period 2014 -2018, in Romania

Table 6



In this context, according to the values submitted in the tables below (Table 7), the forecasted evolution of the gross domestic product in Romania, for the period 2014 -2018, is grasped in parallel by the equations: *EQ1PIBF* (representing the first equation of prediction for the GDP) and *EQ2PIBF* (representing the second equation, anticipating the evolution of the GDP for the considered prediction interval).

As shown by the tests *« Root Mean Squared Error »* as well, achieved for both *Model 1,* and *Model 2,* (Table 3 – Table 6) there are no major differences between the comparative evolutions of the values recorded by the GDP, for the 2014 -2018, in both cases considering the assumed supposition concerning the increase of the consumption and the drawn foreign capitals with 10% in each forecasted year, Table 7.

The parallel representation of the outcomes of the *expost* predictions grasped by EQ01 *(Model 3)* vs EQ02 *(Model 2)* for the period 2014 -2018

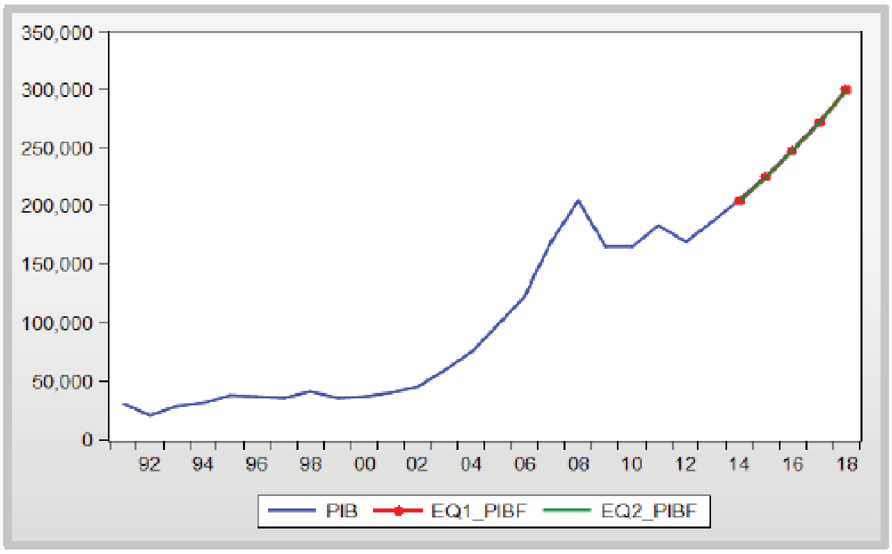
Table 7

Obs	GDP	EQ1_PIBF	EQ2_PIBF
1991	30593.07	NA	NA
1992	2075975	NA	NA
1993	27951.94	NA	NA
1994	31887.80	NA	NA
1995	37618.60	NA	NA
1996	36911.15	NA	NA
1997	35616.63	NA	NA
199S	41749.52	NA	NA
1999	35995.56	NA	NA
2000	37305.10	NA	NA
2001	405S5.S9	NA	NA
2002	45988.51	NA	NA
2003	59466.02	NA	NA
2004	75794.73	NA	NA
2005	99172.61	NA	NA
2006	122695.85	NA	NA
2007	170616.95	NA	NA
2003	204338.60	NA	NA
2009	164344.38	NA	NA
2010	164792.25	NA	NA
2011	182610.67	NA	NA
2012	169396.06	NA	NA
2013	186438.48	NA	NA
2014	205082.33	204402.6	204367.5
2015	225590.57	224859.3	224984.3
2016	248149.62	247331.1	247686.7
2017	272964.59	272211.1	272190.4
2018	300261.04	299384.6	299941.1

Hence, if the macroeconomic indicators: final consumption, respectively flow of direct foreign investments increase with 10% from one year to another, over the interval 2014 -2018, according to the built up dynamic prediction models, the GDP would record the value of 204 367.5 million USD, in the year 2014, reaching the level of 299 941 million USD in 2018, values estimated through the *Model 2 (EQ2)* of prediction, which contains the component AR(5). If we consider the equation *EQ01,* evidenced by the *Model 1,* the evolution would not differ too much, the GDP of our country going to reach level of 204 402.6 million USD, in the year 2014, so that in 2018 it records the value of 299 884 million USD. Out of the graphical representation submitting the dynamic prediction of the GDP evolution (Table 8), during the period 2014 -2018, we notice the very close values estimated by the two built up models *(Model 1* and *Model 2).* Thus, the red dotted line of the graphical representation, respectively in the Table 8, achieved with the help of the informatics soft Eviews 7.2., is showing the prediction estimated by utilizing the equation *EQ 1,* namely *EQ1PIBF,* established as a result of the development of the dynamic model, *Model 1,* while the green line emphasizes the estimated prediction through the equation *EQ02,* respectively *EQ2PIBF,* established through the econometric model defined as *Model 2.*

The representation of the GDP forecast, through the two models *(Model 1* and *Model 2)* represented by EQ01 vs EQ02 during the period 2014 -2018, in Romania

Table 8



Conclusions

The test *"Breusch-Godfrey Serial Correlation LM Test", n*identifies the existence of a serial correlation on the lag 6. We notice this fact through the result obtained after testing the serial correlation, for the series of data utilized in the frame of the built up model, *Model 1*. The value of *« Prob. Chi-Square (6) »,* is indicating the acceptance of the null hypothesis according to which : « *There is serial correlation on the lag 6* ».

The future evolution of the GDP, for the proposed prognosis period, respectively 2014 -2018. Out of the statistical tests achieved for the forecasted values, evidenced through the equation *EQ01,* of the developed model, *Model 1,* we observe that the value *"RootMean SquaredError"* is indicating a very small prediction error, counting for 601.28.

The component AR(5) is improving the proposed model of prediction, eliminating meantime the serial correlation. Thus, applying the test *"Breusch-Godfrey Serial Correlation LM Test",* in order to verify whether the serial correlation is still identified on the lag 6, through processing in Eviews 7.2, we get the outcomes pointed out in the Table 5.

The *Model 2,* which comprise the component AR on the lag 5, is submitting an accuracy very little improved as against the *Model 3,* a fact underlined by the result obtained for the test *"RootMean SquaredError",* which indicates an estimated error between the possible real values of the evolution of the GDP and those estimated by the prediction model, counting for 599.10, Table 6.

According to the values submitted in the tables below (Table 7), the forecasted evolution of the gross domestic product in Romania, for the period 2014 -2018, is grasped in parallel by the equations: $EQ1PIBF$ (representing the first equation of prediction for the GDP) and $EQ2PIBF$ (representing the second equation, anticipating the evolution of the GDP for the considered prediction interval).

As shown by the tests *« Root Mean Squared Error »* as well*,* achieved for both *Model 1,* and *Model 2,* (Table 3 – Table 6) there are no major differences between the comparative evolutions of the values recorded by the GDP, for the 2014 -2018, in both cases considering the assumed supposition concerning the increase of the consumption and the drawn foreign capitals with 10% in each forecasted year, Table 7.

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