ANALYSIS OF THE DYNAMICS OF INVESTMENT VOLUME IN ROMANIA ACCORDING TO GDP, INTEREST RATE AND INFLATION RATE

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ABSTRACT: *In this article, the analysis of the dynamics of the volume of investments in the Romanian economy is carried out according to four input variables: the real GDP, the monetary policy interest rate, the annual inflation rate and the linear trend of investments. The analysed period is 1990-2021. A nonlinear dynamic model was applied, composed of a linear model and an ARMA type model. Following the analysis, it was observed that the inflation rate and the monetary policy interest rate determined decreases in the volume of investments for the analysed period, and the real GDP and its linear trend positively influenced their dynamics. Finally, forecasts were made for a period of three years 2022-2024.*

KEY WORDS: *real investment, real GDP, inflation rate, interest rate, econometric model, forecast.*

JEL CLASSIFICATIONS: *C5, E27, L8.*

1. INTRODUCTION

Even if the crisis generated by the COVID 19 pandemic led to a lack of investments throughout the territory of our country, in the last two years an improvement in the situation has been observed from this point of view. On the other hand, against the backdrop of the war between Russia and Ukraine, in 2022, many foreign investors turned to Romania and other neighbouring states, making foreign investments total 9.4 billion dollars. Romania has thus become the second national economy in Eastern Europe, after Poland. As is known, in Romania, the resources for investments are extremely limited. However, in order to have economic growth and to create jobs, it is strictly necessary to attract investments from European funds and not only that. Thus, it is necessary at the governmental level to implement viable and

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lasting strategies to attract money for investments. According to the data provided by the BNR (https://www.bnr.ro/Raport-statistic-606.aspx), the correlation between the level of public investments and the evolution of GDP is a positive one, the benefits of investments in the national economy being obvious.

On the other hand, investments are also influenced by inflation, which can be seen from this point of view as a tax, which even if we do not actually pay, erodes the real earnings of investments. Therefore, in periods affected by high inflation, profitable investment measures and strategies should be adopted. Thus, the entrepreneur must have the ability to transfer the negative effects of the increase in inflation in the final cost of the investment. At the same time, monetary policy also has an impact on investments, in the sense that the increase in interest rates causes the cost of investments to increase.

In the diagrams below, the evolutions over time of the four quantities analysed are represented. As can be seen in the two diagrams above, in 2013 Romania experienced the highest growth, both in the volume of investments and in the real level of GDP, followed by a period of decline until 2016. In recent years analysed, there was a slight recovery in the level of the two quantities, even if in 2020-2022 it was a difficult period due to the global pandemic.

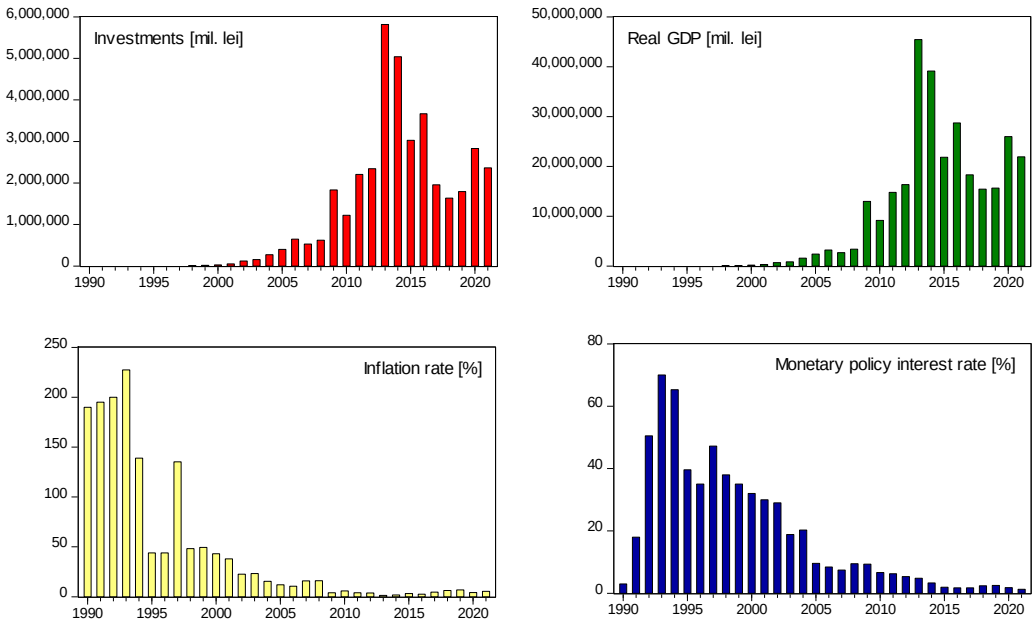


Figure 1. Representation in time of the analyzed economic variables

Regarding the monetary policy interest rate recently, the board of directors of the National Bank of Romania tried to keep it at an optimal level, even if in 2022 it reached 4.41% per year. Romanian specialized literature has studied this topic in recent years. Thus, Anglelache in his work (Anghelache, et.al, 2015) creates an analysis model of the dynamics of the balance of Foreign Direct Investments correlated with the

evolution of GDP in the territorial structure, in Romania. In the article published by Anghelache, the analysis of the correlation between the Gross Domestic Product and foreign direct investments in Romania is carried out. Based on the collected data series, the correlation was analyzed both graphically and by means of a simple linear regression equation (Anghelache, et.al, 2016).

Taking into account the considerations above, this article carries out the econometric analysis of a dynamic multivariable model in which the independent variable are the government investments in Romania in the period 1990-2021, and the dependent variables are the real GDP, the interest rate, the annual rate of inflation and the linear trend of investments.

2. DATA ANALYSIS AND SPECIFICATION OF THE MODEL

In order to carry out the econometric analysis of the dependence between the volume of investments and the real GDP, the interest rate, the inflation rate in Romania and the liniar trend of the investments, in the period 1990-2021, the real level of these variables was taken into account. Data on nominal GDP and investments in Romania were taken from the website of the National Institute of Statistics (http://statistici.insse.ro). Both GDP and investment were converted to real values using the GDP deflator (previous year=100). The data on the monetary policy interest rate were taken from the statistical reports of the BNR (https://www.bnr.ro/Raport-statistic-606.aspx).

As specified above, government investments in Romania represent the output of the analyzed model, and GDP, interest rate, inflation rate and linear trend of the investments are inputs to the model.

We will use the following notations for the analyzed variables:

$Y=(y_t)_{t=\overline{1,T}}$ represents the real investments in Romania, measured in millions lei;

$X_1=(x_{1t})_{t=\overline{1,T}}$ represents real GDP from Romania, measured in millions lei;

$X_2=(x_{2t})_{t=\overline{1,T}}$ represents inflation rate from Romania, measured in percentages;

$X_3=(x_{3t})_{t=\overline{1,T}}$ represents the monetary interest rate from Romania, measured in percentage;

$t=\overline{1,T}$ the time period analyzed, between the years 1990-2021;

T the number of terms in the series;

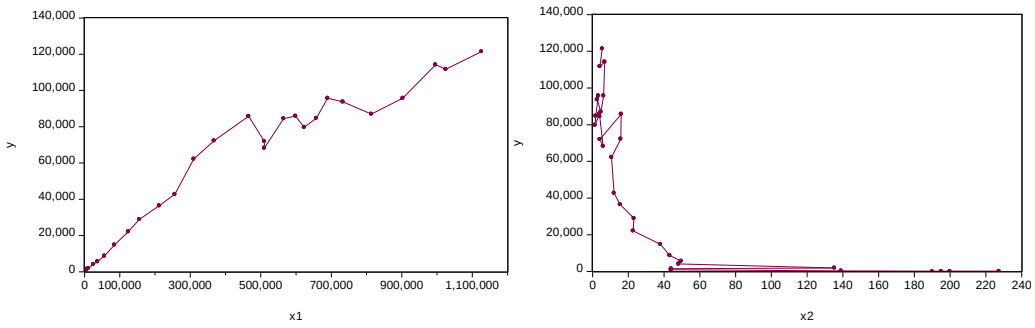
The data series of the five variables analyzed are entered in the table below. As specified, the data series for Romania's GDP and for Romania's investments were processed and transformed by the author, from nominal values to real values.

Table 1. The data series of the analyzed variables

T	Y [mil. lei]	X1 [mil. lei]	X2 [%]	X3 [%]
1990	5.79	29.55	190	3
1991	10.64	74.71	195.00	18
1992	29.65	201.06	199.86	50.5

1993	86.22	612.14	227.31	70
1994	334.90	2082.35	139.02	65.3
1995	902.92	5011.76	43.93	39.6
1996	1454.56	7563.70	44.00	35
1997	1875.39	10835.50	135.34	47.2
1998	4085.14	24982.50	48.13	38
1999	5614.41	36868.31	49.52	35
2000	8729.31	56483.21	43.18	32
2001	14801.42	85093.17	37.96	30
2002	22143.72	124086.20	22.71	28.98
2003	28948.65	155836.40	23.15	18.84
2004	36473.69	211931.00	15.46	20.27
2005	42721.89	256110.70	12.01	9.59
2006	62227.31	309893.50	10.61	8.44
2007	72235.65	367557.40	15.82	7.46
2008	85786.41	465312.20	16.02	9.46
2009	71996.94	510049.80	4.09	9.33
2010	68260.31	510183.00	5.91	6.67
2011	84456.99	564743.80	3.98	6.25
2012	85828.17	598506.90	3.80	5.31
2013	79740.85	622945.90	1.39	4.81
2014	84711.21	657629.20	1.71	3.31
2015	95761.62	690016.30	3.26	1.92
2016	93706.58	732904.90	2.62	1.75
2017	86998.36	813763.70	4.65	1.75
2018	95754.00	902964.00	6.21	2.39
2019	114219.90	996012.70	6.81	2.71
2020	111714.80	1024673.00	4.11	1.83
2021	121459.90	1126390.00	5.42	1.35

The figures below, show the graphs of investments in Romania in the period 1990-2021, depending on the real GDP, the inflation rate, the monetary policy interest rate and the linear trend of real investments.



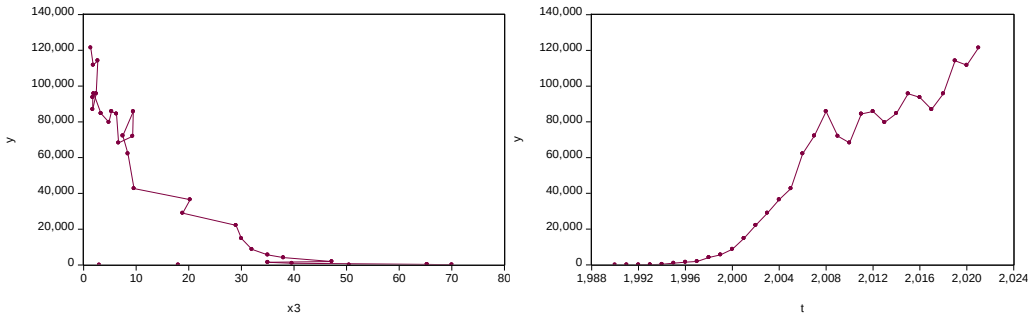


Figure 2. The graphic representations of the volume of investments in Romania in function to the four analyzed variables

In the table below, the data specific to the main descriptive indicators of the analyzed model variables are entered.

Table 2. Mean, max and min values, and standard deviation for model variables

	T	Y	X1	X2	X3
Mean	2021.000	121459.9	1126390.	227.3087	70.00000
Maximum	1990.000	5.793103	29.55172	1.389687	1.350000
Minimum	8.842105	1990.000	45.10526	1.389687	1.350000
Std. Dev.	9.380832	42430.78	360381.8	68.42731	19.65632

By using the Eviews software package, the best model to estimate the data series of the analyzed variables was sought. Finally, by comparison, it was decided based on the analysis of specific statistical indicators and not only that, that the best model is a non-linear dynamic model. This model is a combination of a multivariate linear model and an ARMA (autoregressive moving average) model.

This model has the following representation:

$$y_t = a_1 + a_2 T + a_3 x_{1t} + a_4 x_{2t} + a_5 x_{3t} + a_6 y_{t-1} + a_7 \varepsilon_{t-1} + \varepsilon_t \quad (1)$$

where the model parameters $a_1, a_2, ..., a_7$ were determined using the least squares method, their values being found in Table 2, in the second column.

Following the data in Table 2, it can be seen that both the inflation rate and the monetary policy interest rate determined decreases in the volume of investments for the analyzed period, and the real GDP, the linear trend of investments, as well as the two coefficients specific to the model of type ARMA positively influenced their dynamics.

On the other hand, it is observed that the value of the coefficient of determination R^2 and that of the adjusted coefficient of determination *Adjusted* R^2 (very close to the value of 1) show that the variation in the volume of investments in Romania is explained to a large extent by the real GDP, the interest rate and inflation rate. Also, the three indicators that are used to choose between several valid models from the point of view of the formulated hypotheses, the Akaike indicator, the Schwarz

indicator and the Hannan-Quinn indicator have quite small values, so that we can say that the chosen model is one valid and which gives very good results.

Table 3. The results obtained from the Eviews Program

Dependent Variable: Y
Sample: 1990 2021
Included observations: 32
Convergence achieved after 53 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1408545.	5001065.	-0.281649	0.7806
T	709.7040	2499.573	0.283930	0.7789
X1	0.094501	0.051374	1.839492	0.0782
X2	-9.847074	97.04152	-0.101473	0.9200
X3	-20.36875	530.1014	-0.038424	0.9697
AR(1)	0.554986	0.187437	2.960928	0.0068
MA(1)	0.511798	0.160561	3.187553	0.0040
SIGMASQ	31362724	11575532	2.709398	0.0122

R-squared	0.982018	Mean dependent var	49471.17
Adjusted R-squared	0.976773	S.D. dependent var	42430.78
S.E. of regression	6466.604	Akaike info criterion	20.63563
Sum squared resid	1.00E+09	Schwarz criterion	21.00206
Log likelihood	-322.1701	Hannan-Quinn criter.	20.75709
F-statistic	187.2374	Durbin-Watson stat	1.983733
Prob(F-statistic)	0.000000		

Inverted AR Roots	.55
Inverted MA Roots	-.51

The error series are not affected by the autocorrelation phenomenon. This remark emerges from comparing the Durbin-Watson statistic with the two critical values of the same statistic $d_1 = 1{,}11; d_2 = 1{,}82$ for a significance threshold of 5% and $k = 4$ input variables. Thus, since the double inequality $d_2 = 1{,}11 < DW = 1{,}98 < 4 - d_2 = 2{,}18$ is satisfied, we say that the error series does not show correlations of the first order.

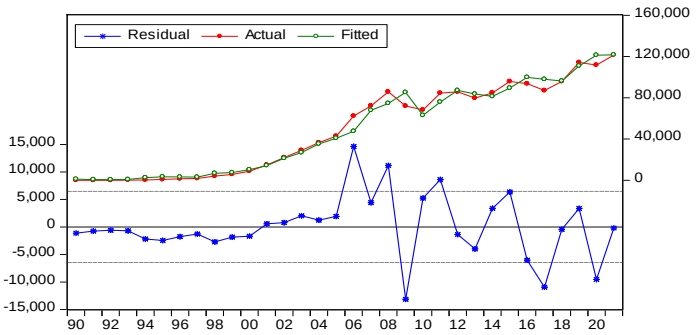


Figure 3. The graphs of real values, values approximated by dynamical model and residuals

The Breusch-Pegan-Godfrey test is applied to verify the hypothesis of homoscedasticity. As can be seen in Table 4, the calculated value of the statistic $F = 1{,}11$ is lower than the critical value of the statistic $\chi_r^2 = 2{,}167$ for a threshold of 5%, where r is the number of parameters in the analyzed model.

Table 4. Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.106159	Prob. F(4,27)	0.3739
Obs*R-squared	4.505647	Prob. Chi-Square(4)	0.3419
Scaled explained SS	3.738998	Prob. Chi-Square(4)	0.4425

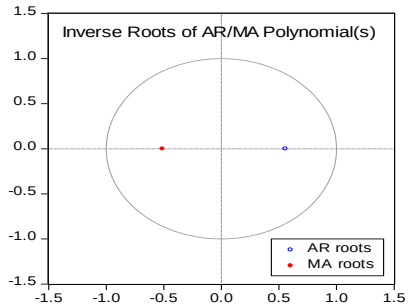


Figure 4. Graphical representation of the roots of the characteristic polynomial of the AR model

On the other hand, to check the stationarity of the ARMA model (stability), we check if the modulus of the root of the polynomial equation of the model is found inside the unit circle of the complex plane. Thus, from Figure 4, it is observed that the polynomial of the poles of the AR model has the subunit modulus, which indicates that the model is input-output stable. On the other hand, note that the root of the MA model is found inside the circle of unit radius (it has modulus less than unity).

In Figure 5 are represented the results of the analysis of the impulse-type input model, through a Dirac signal of the form:

$$\delta(t)=\begin{cases}1, & t=0\\ 0, & t\neq 0\end{cases} \tag{2}$$

The obtained results indicate that the model analyzed here is asymptotically stable, because the impulse response tends to zero.

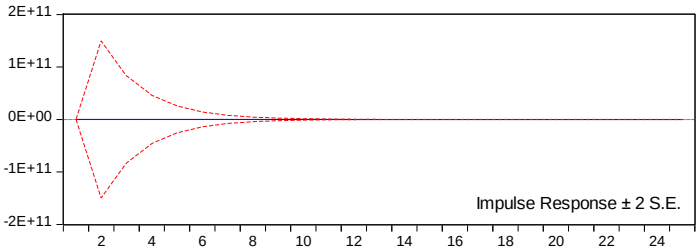


Figure 5. The impulse response

To validate the nonlinear dynamic model represented in relation (1), the so-called analysis of variance is applied. Thus, the value of the Fisher-Snedecor statistic is compared with the critical value of the same statistic, for a significance threshold of 5% and pairs of degrees of freedom $(4,27)$. If $F_{calculat}=186,23>F_{0,05;4;27}=2,728$, then the nonlinear dynamic model is correctly specified, more precisely between the series of real and estimated values of the volume of investments in Romania there is a significant dependence.

3. FORECASTS

Taking into account the above, and taking into account the fact that the dynamic model analyzed above is a correctly specified one, in this paragraph we will make forecasts for a period of three years (2022-2024). We must take into account the fact that at the level of the evolution of the analyzed phenomenon no special phenomena intervened. In the table below, the proposed values of the input variables for forecasting are introduced. Thus, for the three input variables, their increases expected by the European Commission for Romania were proposed (https://romania.representation.ec.europa.eu/). Thus, the forecasts for GDP made by the European Commission claim that it will have an increase of 5.8% in 2022, 1.8% in 2023 and 2.2% in 2024 compared to 2021. Also, according to BNR (https://www.bnr.ro), the inflation rate will reach an annual level of 10.67% in 2023, and 5.03% in 2024.

Table 5. The proposed values for the variable analyzed

Years	Real GDP [mil. lei]	Inflation rate [%]	Interest rate [%]
2022	1191720.62	15.9	4.41
2023	1146665.02	10.67	6.25
2024	1151170.58	5.03	7

Figure 6 shows the predicted values of the investment volume in Romania. In the cream band are represented the values for the three forecasted years 2022-2024.

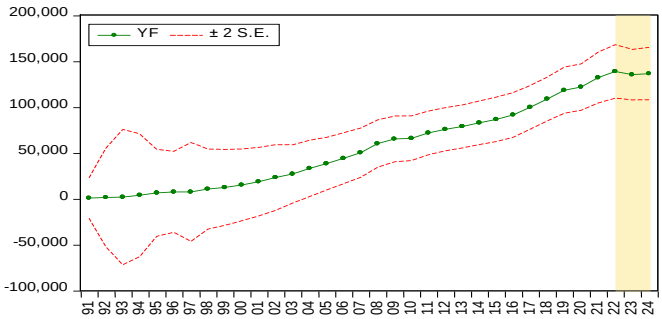


Figure 6. Predictions obtained based on the nonlinear dynamic model represented in (1)

The forecasted values for the investment volume in Romania in the period 2022-2024 are entered in the following table.

Table 6. The forecast values

Years	Investments [mil. lei]
2022	138849.59
2023	135315.50
2024	136491.25

As can be seen in the figure above and in Table 6, in 2022 investments in Romania had an increase of 14.82% compared to the previous year, reaching a level of 138849.59. According to the data provided by the National Institute of Statistics, in 2022 the investments in Romania were provisionally worth 135,152.8 million lei (https://insse.ro/cms/ro).

Table 7. Values of statistical masurement applied for forecast quality

Indicators	Value
Root Mean Squared Error	93.87
Mean Absolute Error	71.30
Mean Abs. Percent Error	56.40
Theil Inequality Coefficient	0.072
Bias Proportion	0.005
Variance Proportion	0.011
Covariance Proportion	0.984
Theil U2 Coefficient	32.83430
Symmetric MAPE	52.38870

The difference between the value predicted within this article, through the dynamic model (1) and the one provided by the National Institute of Statistics is a

rather small one of 3696.8 million lei. On the other hand, according to the forecasts made by the European Commission (https://romania.representation.ec. europa.eu), investments in 2024 will register a decrease compared to the previous year. From the data obtained in the article, the volume of investments will decrease in 2023 by 2.54% compared to 2022, after which in 2024 it will have a slight increase of approximately 1% compared to the previous year.

In order to be able to understand the quality of the forecast based on the dynamic model defined in relation (1), we will introduce the values of the main specific statistical indicators in the following table. The lower the values of these statistical measures, the more appreciated the quality of the predictions made by the nonlinear dynamic model.

4. CONCLUSIONS

This article analyzed the correlation between the real volume of investments in Romania and the real level of GDP, the inflation rate, the interest rate and the investments linear trend. Based on the dynamic nonlinear model analyzed, it was shown that the inflation rate, as well as the monetary policy interest rate, determined decreases in the volume of investments for the analyzed period, and the real GDP, the linear trend of investments, as well as the two coefficients specific to the model of ARMA type positively influenced their dynamics.

Also, following the realization of forecasts for a period of three years, 2022-2024, it was found that the volume of investments achieved an increase in 2022 by 14.82% compared to the previous year, after which it would register a decrease small in 2023 and a slight increase in 2024.

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