THE USV ANNALS OF ECONOMICS AND PUBLIC ADMINISTRATION | VOLUME 17, ISSUE 1(25), 2017

USING ARIMA IN ROBOR EVOLUTION MODELLING

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Abstract:
Economic and social developments in the period January 2000 - December 2013 both internally and externally caused an evolution of ROBOR with significant increases or decreases. Their extent makes it difficult to build models that can be used in the study and forecast of ROBOR. This paper analyzes the possibilities of describing the evolution of ROBOR by autoregressive and moving average models. The analysis is based on three data sets: the first includes ROBOR values the entire period; the second set includes data from January 2006 - December 2013 and the third series, data from February 2009 - December 2013. Starting from these, six models are presented, three for the first period, two for the second and one for third period.

Key words: time series, modeling, ARIMA, ROBOR

JEL classification: C15, C22, E4

1. INTRODUCTION

In the last decades, and especially after 1990, the process of globalization was characterized by the modernization of economic, production development and global communications [15], but also an “assembly increasingly integrated into which the roles of the member-nation remain important, but where economic movements may not be reduced to international trade”[4]. On the other hand, once with the outbreak of the economic crisis, the development disparities, materialized by the overall average per capita income has increased [18], emphasizing inequalities, and requiring the need to implement measures against the negative effects of globalization [14].

One way to study the financial and banking processes used in most of the above studies to identify the effects of short-term and long-term decisions is a whole of techniques and methods known as Box-Jenkings methodology [2]. Box and Jenkings have shown that they can obtain proper operators to eliminate cyclical components. This methodology allows the elaboration and analysis of dynamic models of stationary random processes (AR, MA, and ARMA) and nonstationary (ARIMA and SARIMA). Also, important contributions to the study of economic dynamics meet at Akaike [1], Mendes [10] and not least at Gandolfo [6].

In Romania, a well-founded presentation of the dynamic stochastic processes is provided by Oprescu [12], which analyzes in detail the dynamics of the random component of time series, and prediction and filtering mechanisms (Volta, Wiener, Kalman - initially analyzed in [13]), using adaptive stochastic algorithms for estimation and prediction, together with economic applications including a stochastic financial market model (the Black-Merton-Scholes model). Also among Romanian contributions on the using of econometric models in the study of financial and banking processes we mention those of Mutu [11] and Trancea [16],[17].

The study of the evolution of time series, especially of the banking and financial processes, raises some difficulties, due to the multitude of factors that influence them, specialy during the crisis [Buch], as well as high volatility that characterizes the phenomena and processes of the banking and financial system. In these conditions, analysis of the evolution of specific indicators of banking financial sector, as time series, is a useful and effective method. In this respect we emphasize the works of Hytinen [9] and Dunis [5].

Based on these considerations, the paper presents a way of using ARIMA models to study ROBOR (Romanian Interbank Offer Rate) evolution, in Romania, during 2000-2013

2. METHODOLOGICAL ISSUES

As specified by National Bank of Romania [8], ROBOR is calculated by mandated (i.e. Reuters) as „the arithmetic average of the latest rates quoted by the each participants in fixing for the RON deposits offered with 15 minutes before fixing, after rejecting extreme rates". In other words, ROBOR express the price at which a bank wants to provide liquidity.

For the analysis of the ROBOR and EURIBOR evolutions, were used time series published by the European Commission and available on the EUROSTAT "Money market interest rates - monthly data (irt_st_m)"[7]. The discrete values dependences, from statistical point of view, is reflected in the links between successive observations of the series, leading to an analysis of the series, based on empirical autocorrelation.

The dynamic model generally applicable to time series as realizations of random processes $\{y_t / t \in \Im\}$, with $\Im$ set of time moments (continuous $\Im = R$ or discrete $\Im = N \, ori \, \Im = Z$), is of the form:

$$y_t = f(y_{t-1}, y_{t-2}, ..., t) + \varepsilon_t \tag{1}$$

where: ε_t - is a random process, generally, as "white noise" ($M(\varepsilon_t) = 0$ and $D(\varepsilon_t) = \sigma^2$), represented by the residuals $y_t - f(...)$,

Modeling of such processes is based on standalone applications of autoregressive models (AR) and / or moving average (MA) or combinations thereof ARMA, ARIMA, etc.

Autoregressive models AR (p) are models which allow describing the evolution of a stationary random process based on its previous values. A stationary series, $\{y_t\}_{t\in Z}$, follows a process $AR(p)$ if it is satisfied the condition:

$$y_t - \sum_{k=1}^{p} \phi_k y_{t-k} = \varepsilon_t, \quad \forall t \in Z \tag{2}$$

where $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$ stationary series, $M(\varepsilon_t) = 0$, $M(\varepsilon_t^2) = \sigma^2$, $\mathrm{cov}(\varepsilon_t, \varepsilon_i) = 0 \; \forall t \neq i$ and p is the number of past values of X that are considered to predict its current value.

Using the delay operator L (Lag) and noting with: $\Phi(L) = 1 - \phi_1 L - \phi_2 L^2 - \ldots - \phi_p L^p$ equation (1) may be made in the form of: $\Phi(L) y_t = \varepsilon_t$. Characteristic polynomial attached to the *AR (p)* process is:

$$P(\lambda) = \lambda^p - \phi_1 \lambda^{p-1} - \phi_2 \lambda^{p-2} - \ldots - \phi_p \tag{3}$$

For $p = 1$ is obtained first-order autoregressive model AR(1): $y_t - \phi \, y_{t-1} = \varepsilon_t$.

The process (2) is stationary if the absolute values of the roots of its characteristic polynomial (3) are strictly less than 1.

In developing time series models, depending on how the process analyzed evolves, can meet and other processes, such as moving average models MP(q), defined by the relation:

$$y_t = \varepsilon_t - \theta_1 \varepsilon_{t-1} - \ldots - \theta_q \varepsilon_{t-q} \tag{4}$$

For $q = 1$ is obtained the moving average model $MA(1)$: $y_t = \varepsilon_t - \theta \varepsilon_{t-1}$

In practice, in most cases, do not meet the time series modeled by one of the two methods described above, but combinations thereof. One of the models used in such situations, is ARMA model, which combines both autoregressive lags of the dependent variable and the moving average process. The mathematical expression of such model with p autoregressive terms, and q moving average terms, denoted ARMA (p, q) is:

$$y_t = \phi_0 + \sum_{i=1}^{p} \phi_i y_{t-i} + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \tag{5}$$

For $p=1$ and $q=1$ is obtained the model ARMA(1,1) by the form

$$y_t = \phi_0 + \phi_1 y_{t-1} + \varepsilon_t - \theta\varepsilon_{t-1}. \qquad (6)$$

The study of time series with autoregressive and moving average models are cases where the roots of the characteristic polynomial of ARMA(p,q) models can take real or complex values whose module can be greater than or equal to 1 case which occurs the phenomenon of non-stationary. In such situations it is used ARIMA (p,d,q) model in which d is the order of differentiation of the original time series. Usually, the values of d are 1 or 2. For $d=0$, the ARIMA model is equivalent of ARMA model.

The analysis of data series have involve, in the first phase, the determination of indicators such as average, median, standard deviation, skewness, kurtosis. Also were analyzed both the seasonality of series, which in this study had a very small amplitude, as well as the stationary of data series. For this, the roots of the characteristic equation were determined and, in cases where $|\lambda_i| \geq 1$was made the transformation $y_t - y_{t-1} = u_t$. The new series was checked themselves in terms of stationary, stationary conditions being fulfilled.

Determination of the specification of ARIMA(p,d,q) and the estimation of the models parameter were performed repetitively, taking account of the ACF and PACF functions, up to getting some valid models and with statistically significant parameters.

Testing the validity of the model, and the statistical significance of coefficient values were performed using a number of statistical tests (F-statistic, t-statistic, Wald, Akaike, the Durbin-Watson and so on). Also have been studied the characteristics of series errors, analyzing the error autocorrelation (Breusch-Godfrey Serial Correlation LM test), homoscedasticity / heteroscedasticity (ARCH + LM test) and the distribution normality.

3. RESULTS AND DISCUSSION

During 2000 - 2013, ROBOR registered an trend with significant increases or decreases, determined by economic policies adopted by the governments of this period, by the legislative framework and its many transformations, by Romania's efforts for accession and integration to EU, by the processes and the phenomena recorded in this period in European and global level, and, not least, by the economic and financial crisis manifested in the last part of the period.

From the analysis of ROBOR evolution in January 2000 - December 2013 period [7], resulted three autoregressive and moving average models, made by considering the series of the data recorded in the whole period as well as in two most recent periods January 2006 - December 2013 respectively February 2009 - December 2013.

Both for the testing of the validity of the models, of the statistical significance of the coefficients, as well as of various tests used for hypothesis testing, we chose a significance level , $\alpha = 0.05$ corresponding to 95% confidence level.

3.1. THE MODEL R_1

For this first model was used the data series corresponding to monthly averages values of ROBOR for the period January 2000 - December 2013. For the stationary analysis of ROBOR_1 process was used Dickey-Fuller test whose results are shown in Figure no. 1. Given that the test value (-4.652519) is less than all three critical values, result that the null hypothesis is rejected and, therefore, the ROBOR_1 is stationary. This conclusion is underlined by the value of Prob.= 0.0002 <0.05, which corresponds to the usual significance level ($\alpha = 0.05$).

Augmented Dickey-Fuller Unit Root Test on ROBOR_1

Null Hypothesis: ROBOR_1 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.652519	0.0002
Test critical values:	1% level	-3.469691	
	5% level	-2.878723	
	10% level	-2.576010	

*MacKinnon (1996) one-sided p-values.

Figure no.1. Testing the stationarity of ROBOR_1 process
Source: Own elaboration using Eviews and data from
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=irt_st_m&lang=en

For the identification of the model corresponding to the ROBOR_1 process, as a result of the analysis of the series ACF and PACF and using the Least Square Method, three models were obtained (EQ01, EQ02, and EQ03) These fulfill the validity condition (F-statistic <0.05). Their characteristics are shown in Figure no. 2.

Workfile: ROBOR_1

Dependent Variable: ROBOR_1
Method: Least Squares
Sample(adjusted): 2000:09 2013:12
White Heteroskedasticity-Consistent Standard Errors & Covariance

Equation: EQ01

Included observations: 160 after adjusting endpoints
Convergence achieved after 13 iterations
Backcast: 2000:07 2000:08

Variable	Coefficient	Prob.
C	3.790193	0.4202
AR(1)	1.248583	0.0000
AR(3)	-0.327503	0.0043
AR(8)	0.058811	0.0480
MA(2)	-0.257468	0.0839

R-squared	0.988722
Adjusted R-squared	0.988431
Akaike info criterion	3.364920
Schwarz criterion	3.461019
F-statistic	3397.241
Prob(F-statistic)	0.000000

Equation: EQ02

Included observations: 165 after adjusting endpoints
Convergence achieved after 25 iterations
Backcast: 2000:03

Variable	Coefficient	Prob.
C	7.824785	0.0218
AR(1)	0.343774	0.0625
AR(2)	0.944607	0.0000
AR(3)	-0.338787	0.0627
MA(1)	0.997494	0.0000

R-squared	0.988159
Adjusted R-squared	0.987863
Akaike info criterion	3.552373
Schwarz criterion	3.646493
F-statistic	3338.088
Prob(F-statistic)	0.000000

Equation: EQ03

Included observations: 166 after adjusting endpoints
Convergence achieved after 10 iterations
Backcast: 1999:12 2000:02

Variable	Coefficient	Prob.
C	9.666173	0.0000
AR(2)	0.870040	0.0000
MA(3)	0.529587	0.0003

R-squared	0.964680
Adjusted R-squared	0.964247
Akaike info criterion	4.683661
Schwarz criterion	4.739902
F-statistic	2225.972
Prob(F-statistic)	0.000000

Figure no.2. The characteristics of EQ01, EQ02 and EQ03 models
Source: Own elaboration using Eviews

To test the statistical significance of the values of coefficients we used the t-statistic. In the case of EQ01 model, the constant C = 3.790139 is not statistically significant ($\Pr ob = 0.4202 > 0.05$) and, in these circumstances, can not be taken into account. The coefficient MA(2) = -0.25740 although it is statistically significant for significance level $\alpha = 0.1$ does not meet the condition imposed in this study specified above ($\alpha = 0.05$). The other coefficients satisfy the conditions imposed.

In the case of EQ02 model, for significance level $\alpha = 0.1$, both the constant C and the all coefficients are statistically significant. The model can be considered for a probability of 90%. Note that the number of iterations until convergence is 25 compared to 13 in the case of the EQ01.

On the other hand, taking into account the values of Akaike info criterion and Schwaez criterion, the model EQ02 is better (more efficient) than the model EQ01.

Taking into account the results obtained was tested a third model (EQ03). In the case of its both the constant coefficients C and AR (2) and MA (3) satisfy the conditions imposed in this study and, therefore, they are statistically significant for a probability even higher than 95%. Although the R-squared = 0.964680 is lower than the other two models the values of Akaike info criterion (4.683661) and Schwarz criterion (4.739902) certifies the superiority of this model to the other. Consequently for the data series ROBOR_1, R_1 model is given by EQ03 and is a model ARMA(2,3):

$$\begin{aligned} y_t &= 9.666173 + u_t \\ (1 - 0.87004L^2)u_t &= (1 + 0.529587L^3)\varepsilon_t \end{aligned} \tag{7}$$

respectively

$$y_t = 1.256215 + 0.87004 y_{t-2} + \varepsilon_t + 0.529587\varepsilon_{t-3} \tag{8}$$

The application of the tests on homoscedasticity and autocorrelation of errors, reject the null hypothesis indicating both the existence of heteroscedasticity and of the presence of serial correlation. Therefore, the model R_1 should be used with cautions.

3.2. THE MODEL R_2

For this model was used data series corresponding to the monthly average values of ROBOR from January 2006 - December 2013. The data series was named ROBOR6. For the stationarity analysis was used Dickey-Fuller test. Since the t-statistic was greater than any of the critical values, the null hypothesis is accepted. ROBOR6 process is non-stationary.

To get from ROBOR6 a stationary series, its first difference was determined by the relationship:

$$drobor6 = robor6 - robor6(-1) \tag{9}$$

Obtained series called DROBOR6 is stationary as Augmented Dickey-Fuller value test (-8.871059), lower than any of the critical values, the value of *Prob*, corresponding to this, being 0.

For the DROBOR6 data series, two models have been identified (figure no. 3). Both models are valid. Also, all their coefficients are statistically significant (all P values are much lower than significance level).

Given the values of Akaike info criterion (2.416891, EQ04 model, respectively 2.268298, EQ5 model) and the Schwarz criterion (2.565768, EQ04 model, respectively 2.384869, EQ5 model) model R_2 can be made from the model EQ04. It should be noted also that while the model EQ04 value of Durbin-Watson test is d = 1.824579 for $\alpha = 0.05, d \in (1.78; 2.43)$, resulting in the acceptance the null hypothesis (no errors autocorrelation) for EQ05 model, Durbin-Watson test is inconclusive.

Equation: EQ04 Workfile: ROBOR_2

Dependent Variable: DROBOR6
Method: Least Squares
Sample(adjusted): 2007:05 2013:12
Included observations:80 afteradjusting endpoints
Convergence achieved after 36 iterations
Backcast: 2006:05 2007:04

Variable	Coefficient	Prob.
AR(6)	-0.873194	0.0000
AR(15)	-0.098073	0.0004
MA(2)	-0.037428	0.0192
MA(6)	1.603227	0.0000
MA(12)	0.668686	0.0000

R-squared	0.312809
Adjusted R-squared	0.276159
Akaike info criterion	2.416891
Schwarz criterion	2.565768
Durbin-Watson stat	1.824579

Equation: EQ05 Workfile: ROBOR_2

Dependent Variable: DROBOR6
Method: Least Squares
Sample(adjusted): 2007:02 2013:12
Included observations:83 afteradjusting endpoints
Convergence achieved after 30 iterations
Backcast: 2006:02 2007:01

Variable	Coefficient	Prob.
AR(6)	0.364379	0.0000
AR(12)	-0.605778	0.0000
MA(6)	-0.227789	0.0051
MA(12)	0.936693	0.0000

R-squared	0.371674
Adjusted R-squared	0.347814
Akaike info criterion	2.268298
Schwarz criterion	2.384869
Durbin-Watson stat	1.687554

Figure no. 3. The characteristics of EQ04 and EQ05 models
Source: Own elaboration using Eviews

To test the error autocorrelation for EQ04 model (figure no. 4) was used Breusch-Godfrey test. Since the probability values corresponding to $F-statistic = 0.746313$ and $ObsR-squared = 1.262099$ are greater than significance level $\alpha = 0.05$, the null hypothesis is accepted and there is therefore no serial correlation.

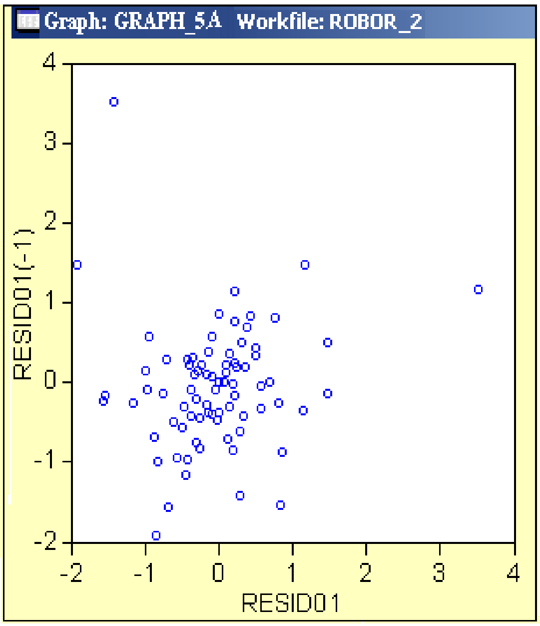

Table: TABLE_5B Workfile: ROBOR_2

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.746313	Probability	0.477694
Obs*R-squared	1.262099	Probability	0.532033
R-squared		0.015776	
Durbin-Watson stat		1.971536	

Table: TABLE_5C Workfile: ROBOR_2

ARCH Test:

F-statistic	3.244833	Probability	0.075564
Obs*R-squared	3.194496	Probability	0.073887
R-squared		0.040436	
F-statistic		3.244832	
Prob(F-statistic)		0.075563	

Figure no. 4. Residual tests for EQ04
Source: Own elaboration using Eviews

To test homoscedasticity / heteroscedasticity, was used ARCH test (autoregressive conditional heteroscedasticity). Since, in this case, the $\Pr ob.$ values corresponding to the values of $F-statistic = 3.244833$ and $ObsR-squared = 3.194496$ are greater than significance level $\alpha = 0.05$, the null hypothesis is accepted and therefore the variances of the residues do not differ significantly (homoscedasticity hypothesis is accepted).

For DROBOR6 data series, the chosen model is ARIMA(15,1,12). The R_2 is obtained from EQ04:

$$du_t = y_t - y_{t-1}$$
$$(1-0.873194L^6)(1+0.098073L^{15})du_t = (1-0.037428L^2)(1+1.603227L^6)(1+0.668686L^{12})\varepsilon_t \quad (10)$$

respectively:

$$y_t = y_{t-1} - 0.873914y_{t-6} + 0.873914y_{t-7} - 0.098073y_{t-15} + 0.098073y_{t-16}$$
$$- 0.085673y_{t-21} + 0.085673y_{t-22} + \varepsilon_t - 0.037428\varepsilon_{t-2} + 1.603227\varepsilon_{t-6}$$
$$- 0.600055\varepsilon_{t-8} + 0.668686\varepsilon_{t-12} - 0.025027\varepsilon_{t-14} + 1.072554\varepsilon_{t-18} - 0.401248\varepsilon_{t-12}$$

3.3. THE MODEL R_2

R_3 model was developed based on corresponding to data series of the monthly averages values of ROBOR for the period February 2009 - December 2013. The data series was named ROBOR9. For stationarity analysis of the process was used Dickey-Fuller test whose results are presented in Table 6. For $\alpha = 0.05$ significance level the value of t-statistic (-3.390803) is less than the critical value -2.913549 (5% level) and therefore the null hypothesis is rejected and the alternative hypothesis is accepted. ROBOR9 process is stationary.

Table 6a Workfile: ROBOR_3

Augmented Dickey-Fuller Unit Root Test on ROBOR9

Null Hypothesis: ROBOR9 has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.390803	0.0154
Test critical values:	1% level	-3.550396	
	5% level	-2.913549	
	10% level	-2.594521	

*MacKinnon (1996) one-sided p-values.

Table 6 b Equation: EQ06 Workfile: ROBOR_3

Dependent Variable: ROBOR9
Method: Least Squares
Sample(adjusted): 2009:03 2013:12
Included observations: 58 after adjusting endpoints
Convergence achieved after 25 iterations
Backcast: 2008:11 2009:02

Variable	Coefficient	Prob.
C	3.990445	0.0000
AR(1)	0.937521	0.0000
MA(1)	0.275651	0.0000
MA(4)	-0.934632	0.0000
MA(3)	-0.252254	0.0000

F-statistic 424.3381 Prob(F-statistic) 0.000

Figure no. 5. Testing ROBOR9 stationarity and identification the model EQ06
Source: Own elaboration using Eviews

For ROBOR9 process was chosen only one model, EQ06 (figure no. 5). Given that Prob (F-statistic) = 0.000 resulting model is valid. Also, because both for the constant C and for the coefficients AR (1), MA (1), MA (3) and MA (4), $\Pr ob. = 0.0000$ result that they are statistically significant.

The results of testing the series of residues (RESID01) EQ06 for the model are shown in Figure no.6. After Breusch-Godfrey test application resulted that for $F-statistic = 0.681106$ and $ObsR-squared = 1.231775$ the values $\Pr ob. = 0.5106$ and $\Pr ob. = 0.540161$, respectively, are much higher than significance threshold $\alpha = 0.05$, and in conclusion, we accept the null hypothesis: there is no serial correlation.

The results of ARCH test are shown in Table 7b. Since, , the $\Pr ob.$ values corresponding to the values of $F-statistic = 1.513485$ and $ObsR-squared = 3.025513$ are 0.229502, respectively 0.220302, are greater than significance level $\alpha = 0.05$, the null hypothesis is accepted and therefore the variances of the residues do not differ significantly (homoscedasticity hypothesis is accepted).

Table: TABLE7a Workfile: ROBOR_3

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.681106	Probability	0.510600
Obs*R-squared	1.231775	Probability	0.540161
F-statistic	0.184436		
Prob(F-statistic)	0.979878		

Table: TABLE 7b Workfile: ROBOR_3

ARCH Test:

F-statistic	1.513485	Probability	0.229502
Obs*R-squared	3.025513	Probability	0.220302
F-statistic	1.513485		
Prob(F-statistic)	0.229502		

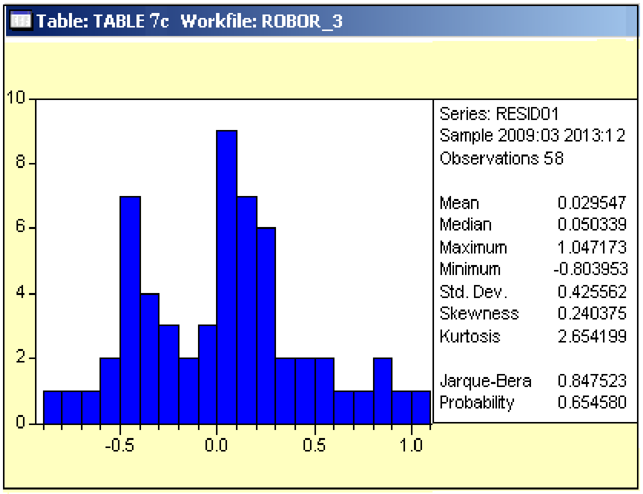

Figure no. 6. Residual tests for EQ06
Source: Own elaboration using Eviews

Also, the $Mean = 0.029547$, $Std.Dev. = 0425569$, $Skewness = 0.240375$ and $Kurtosis = 2.654199$ suggests that the residues have a normal distribution. This is confirmed by the Jarque-Bera test value (0.847523) for that $\Pr obability = 0.65458 > 0.05$. In conclusion, we accept the null hypothesis: the distribution of residues does not differ significantly from the normal distribution.

The EQ06 is a model ARMA (1, 4). The model R_3, for ROBOR9 data series is:

$$y_t = 3.990445 + u_t$$
$$(1 - '973521L)u_t = (1 + 0.275651L)(1 - 0.252254L^3)(1 - 0.934632L^4)\varepsilon_t \qquad (12)$$

respectively

$$y_t = 0.104662 + 0.937521y_{t-1} + \varepsilon_t + 0.275651\varepsilon_{t-1} - 0.252254\varepsilon_{t-3} - 1.004166\varepsilon_{t-4}$$
$$- 0.01754\varepsilon_{t-5} + 0.236031\varepsilon_{t-7} - 0.064988\varepsilon_{t-8}$$

3.4. Acomparison between the performance of the models in 2011 – 2013 period

The results obtained by simulation of the ROBOR evolution, using the models identified in comparison to the evolution of the values ROBOR, in the period January 2010 - December 2013, are shown in Figure no. 7..

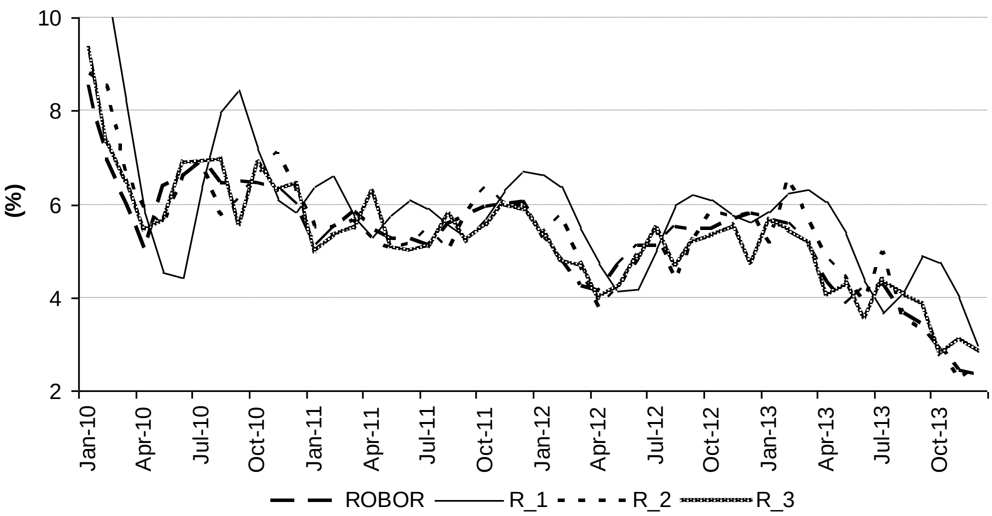

Figure no. 7.. ROBOR evolution and the results of the models simulation in the period January 2010 - December 2013
Source: Own elaboration using Eviews

R_3 and R_2 models simulate quite well the ROBOR evolution during 2010-2013, the most advanced development model being R_3. Even so the model should be improved because in some periods the simulated values differ significantly from those recorded.

4. CONCLUSIONS

Modeling the financial banking processes, for periods in which turbulences occur (reform, restructuring, crisis, etc) is a difficult work, the achieved models can being used in forecasts only with reserves and more precautions. This is the case of the model R_1, which, although the entire period, approximates well the ROBOR evolution, its convergence in the periods of "relative peace" is pretty weak.

For the periods crossed by turbulent phenomena, uncharacteristic to unfolding processes under normal conditions in the financial markets, we consider it preferable to the development of models defined on sub periods with trends relatively stable (no major discontinuities). The results of the simulations of R_2 and R_3 models support this assertion.

An improvement of the results in the study of economic phenomena and processes using autoregressive and moving average models can be obtained by supplementing them using the factorial analysis to highlight the impact of various factors (exogenous variables) on analyzed dependent variables..

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