TIME SERIES ANALYSIS – THE MANAGEMENT OF FINANCIAL CORRECTIONS APPLIED TO PROJECTS FINANCED BY THE OPACD

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Abstract:
It can be made a forecast regarding financial corrections applied to projects financed through the Operational Programme of Administrative Capacity Development (OPCAD)? A topic of actuality nowadays refers to gaining access European funds. A more actuality topic, but not so discussed in papers refers to the irregularities discovered in the implementation of the projects. The purpose of this paper is to see if a forecast regarding financial corrections applied to projects implemented by OPCAD can be realized and to analyze the issues that could prevent the realization of such estimates.

Keywords: EViews, OPCAD, ex-post, Box Jenkins, irregularities, stationarity, forecast

1. Introduction - about the Operational Programme of Administrative Capacity Development. The financial corrections applied

Operational Programme of Administrative Capacity Development (OPACD) represents a relevant document of programming that contributes to the implementation of the thematic priority "Building an Effective Administrative Capacity", established in the National Strategic Reference Framework (NSRF).

According to the NSRF, the general objective of the OPACD is to help create a government more efficient and effective in the socio-economic benefit of Romanian society.

OPACD is implemented through 3 priority axes. These are directly related to the specific objectives of the OPACD:

A. Priority Axis 1: Improving the structure and process of public policy management cycle

B. Priority Axis 2: Improving the quality and effectiveness of public services, with emphasis on decentralization

C. Priority 3: Technical Assistance

The total number of projects approved at the Managing Authority of OPACD was 476 of which a total of 20 projects were withdrawn / canceled (9 withdrawn in contracting projects and 11 contracts canceled).

Thus, of the 456 projects under implementation, for 211 projects were identified and established irregularities, with a total value of 29,519,456.04 lei.

In this paper, by applying financial corrections means, according to art. 2 para. 1 letter a) from the O.U.G. no. 66/2011, with further changes and additions, *administrative measures taken by competent authorities consisting in excluding from EU funding and / or national public funds expenditure related to an irregularity that has been detected.* Irregularity, based on the above mentioned legislative act, means *any deviation from legality, regularity and conformity with national* *and / or European provisions and stipulations of contracts or other legal commitments that enter into, under these provisions, resulting in an action or inaction of the beneficiary or the authority competent in the management of european funds, which harmed or could harm the EU budget / budgets of international public donors and / or their respective national public funds, by an amount unduly paid.*

Therefore, deficiencies established, based on findings from primary administrative acts (Note of establishing of irregularities and fixing financial corrections or Report of establishing irregularities and fixing budgetary debt) in the OPACD, had the following causes : Infringements of public procurement law, Infringements of the legislation on wages, Infringements of the legislation on the movement of staff within public institutions, Exceeding allocated budget for the project, Foreign exchange differences, Ineligible expenditures of the utilities, audit project or translation and interpretation, Failure of the indicators of the project / project objective, Other ineligible costs related to the implementation of projects.

This paper intends to reach a forecast regarding financial correction projects implemented by the OPACD, this forecast helping the Managing Authority to analyze possible financial corrections that could occur until the closure of the Operational Programme and possibly an overview on what might follow in the programming period 2014 - 2020 in terms of financial corrections. Mainly, using Box Jenkins model, it will be examined the possibility of existing such predictions, based on existing data.

2. Check the stationarity of simple monthly returns series associated to financial corrections of PODCA

Time series is a realization of a stochastic process that can be characterized by the average, dispersion and covariance. A stationary stochastic process $\{Y_t\}_{t \epsilon Z}$ has the following properties:

a) $E(Y_t) = \mu$ constant average

b) $Var(Y_t) = \sigma$ constant dispersion

c) $Cov(Y_t,\ Y_{t-j}) = \gamma_j$ the covariance depends on the numbers of delays

The three above characteristics define a weakly stationary stochastic process (stationary on average, dispersion and covariance, which are invariant in time).

There are two techniques for checking the stationarity of a time series:

A. Using the estimated auto correlation function (ACF estimated)

B. Unit-root tests - Tests Dicky Fuller

We will check the stationarity of simple monthly returns series associated to financial corrections established on projects financed through the Management Authority of PODCA. We work with 63 observations, the interval February 2010 - April 2015. Data were obtained from the Managing Authority under Law no. 544 of 12 October 2001 on free access to information of public interest.

Next, we will work with 62 observations – an observed value has been lost when the simple monthly returns were calculated. For financial corrections of PODCA we have represented simple monthly returns chart in Figure 1.

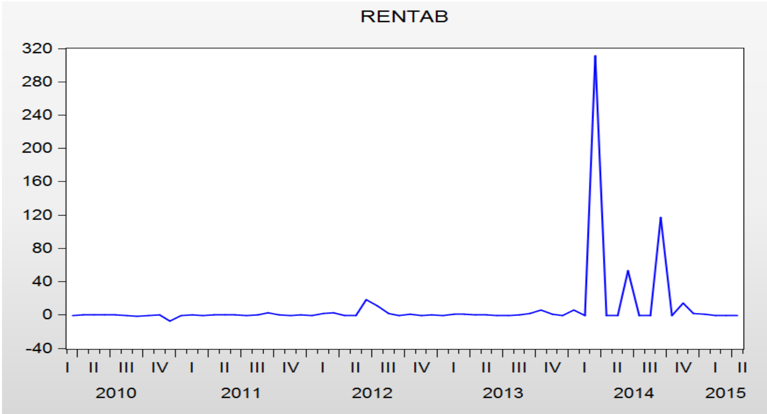
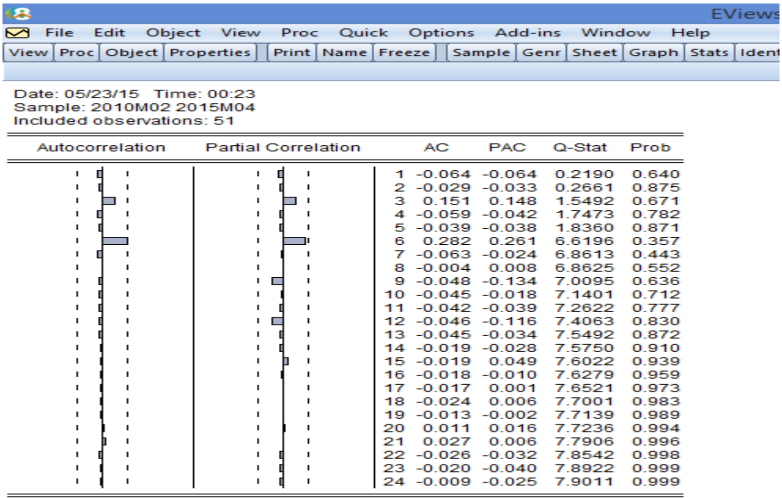


Figure 1. Simple monthly returns graph



Date: 05/23/15 Time: 00:23
Sample: 2010M02 2015M04
Included observations: 51

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.064	-0.064	0.2190	0.640
		2	-0.029	-0.033	0.2661	0.875
		3	0.151	0.148	1.5492	0.671
		4	-0.059	-0.042	1.7473	0.782
		5	-0.039	-0.038	1.8360	0.871
		6	0.282	0.261	6.6196	0.357
		7	-0.063	-0.024	6.8613	0.443
		8	-0.004	0.008	6.8625	0.552
		9	-0.048	-0.134	7.0095	0.636
		10	-0.045	-0.018	7.1401	0.712
		11	-0.042	-0.039	7.2622	0.777
		12	-0.046	-0.116	7.4063	0.830
		13	-0.045	-0.034	7.5492	0.872
		14	-0.019	-0.028	7.5750	0.910
		15	-0.019	0.049	7.6022	0.939
		16	-0.018	-0.010	7.6279	0.959
		17	-0.017	0.001	7.6521	0.973
		18	-0.024	0.006	7.7001	0.983
		19	-0.013	-0.002	7.7139	0.989
		20	0.011	0.016	7.7236	0.994
		21	0.027	0.006	7.7906	0.996
		22	-0.026	-0.032	7.8542	0.998
		23	-0.020	-0.040	7.8922	0.999
		24	-0.009	-0.025	7.9011	0.999

Figure 2. Correlogram for financial corrections of PODCA

The first step is to check the stationarity using the correlogram – auto correlation function chart. Using Eviews we generated correlogram for financial corrections of PODCA (Figure 2).

Correlogram analysis: auto correlation coefficients estimated (column AC) have positive and negative values, close to zero, indicating no or weak auto correlation for all the delays. Partial auto correlation coefficients estimated (column CAP) are positive or negative and close to zero.

Confidence interval that not depends on the lag: $\begin{cases} H_0: \rho_j = 0 \\ H_1: \rho_j \neq 0 \end{cases}$

For T=62 observations we can build the following confidence interval 95%: $(-1{,}96 * \frac{1}{\sqrt{T}}; 1{,}96 * \frac{1}{\sqrt{T}})$, meaning (-0,248920; 0,248920). Auto correlation coefficients that are found in this range can be assimilated to zero. Because the series is white noise (stationary) auto correlation coefficients must be zero (to approach zero, meaning to be found in the above range).

For this case, it is noted that ρ_6 is not found in the confidence interval 95%, with the value of 0.282, while the rest of the auto correlation coefficients are included in the above range. In this case, we accept the null hypothesis, so the series is stationary.

Confidence interval that depends on the lag (j): $\begin{cases} H_0: \rho_1 = \rho_2 = \cdots = \rho_m = 0 \\ H_1: există\ \ \rho_j \neq 0, \forall\, j \end{cases}$

The new confidence interval has the following form $(-1.96 * \sqrt{\frac{T-j}{T(T+2)}}; 1.96 * \sqrt{\frac{T-j}{T(T+2)}})$ and differs for each lag. The decision shall be based on test statistics Q which is present in Eviews output, using p-value. For small values of p-value, the error in rejecting the null hypothesis is small, so we can conclude that the series is non-stationary and for large p-value to accept the null hypothesis, so the series is stationary (derived from white noise). We notice that the lag 24 p-value has high values, so the risk assumed in rejecting the null hypothesis is too high, so we accept the null hypothesis: the series comes from a white noise process, so it is stationary.

The second step is to apply unit root tests. Dickey Fuller tests are based on the random walk hypothesis.

We apply the test on a random walk without drift model. The decision in Dickey Fuller test is the following:

$$\hat{t} < \tau_{critic}\ reject\ the\ null\ hypothesis, the\ series\ is\ not\ random\ walk$$
$$\hat{t} > \tau_{critic}\ accept\ the\ null\ hypothesis, the\ analysed\ series\ can\ be\ considered\ random\ walk$$

Dickey Fuller test results generated by Eviews are shown in Table 1.

Table 1. Results of Dickey Fuller test

Null Hypothesis: RENTAB has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=10)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-6.924260	0.0000
Test critical values:	1% level		-3.588509	
	5% level		-2.929734	
	10% level		-2.603064	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RENTAB)				
Method: Least Squares				
Date: 05/23/15 Time: 00:42				
Sample (adjusted): 2010M09 2015M04				
Included observations: 44 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.

RENTAB(-1)	-1.065615	0.153896	-6.924260	0.0000
C	12.93093	7.836907	1.650004	0.1064

R-squared	0.533050	Mean dependent var	0.041737
Adjusted R-squared	0.521932	S.D. dependent var	73.03249
S.E. of regression	50.49646	Akaike info criterion	10.72607
Sum squared resid	107095.5	Schwarz criterion	10.80717
Log likelihood	-233.9736	Hannan-Quinn criter.	10.75615
F-statistic	47.94538	Durbin-Watson stat	2.151935
Prob(F-statistic)	0.000000		

*$\hat{\tau}$ has the value of -6.924260 and it is much lower than the critical values corresponding thresholds trust of 1%, 5% or 10%. This means that we reject the null hypothesis, so the series is not random walk, this being stationary. The model can be written as: rentab = 12.93093 - 1.065615*rentab(-1) + wn*

3. Modelling techniques using ARMA time series

We will generate AR (1), AR (2), MA (1), MA (2), ARMA (1,1), ARMA (1,2), ARMA (2,1) and ARMA (2, 2) models for the stationary simple monthly returns series.

For exemplification, we will show the steps to follow only for the AR (1) model, for the other models following the same steps. In this case, the AR (1) model has the equation output presented in Table 2.

Table 2. Equation output model AR(1)

Dependent Variable: RENTAB
Method: Least Squares
Date: 05/24/15 Time: 01:03
Sample (adjusted): 2010M09 2015M04
Included observations: 44 after adjustments
Convergence achieved after 3 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.13471	7.143887	1.698615	0.0968
AR(1)	-0.065615	0.153896	-0.426357	0.6720

R-squared	0.004309	Mean dependent var	12.13728
Adjusted R-squared	-0.019397	S.D. dependent var	50.01372
S.E. of regression	50.49646	Akaike info criterion	10.72607
Sum squared resid	107095.5	Schwarz criterion	10.80717
Log likelihood	-233.9736	Hannan-Quinn criter.	10.75615
F-statistic	0.181780	Durbin-Watson stat	2.151935
Prob(F-statistic)	0.672025		

Inverted AR Roots	-.07

AR(1) model has the following equation form: $y_t = 12.13471 - 0.065615y_{t-1}$.

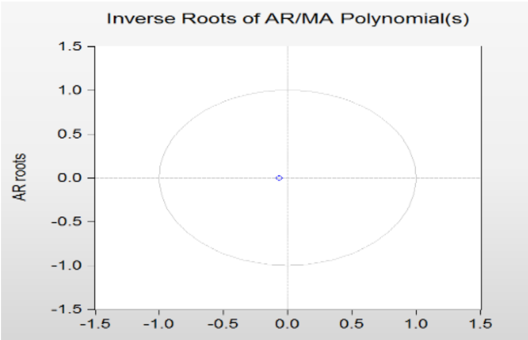


Figure 3. Inverse Roots of AR/MA Polynomial(s)

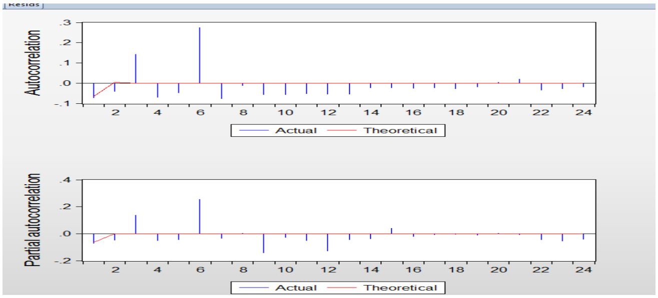
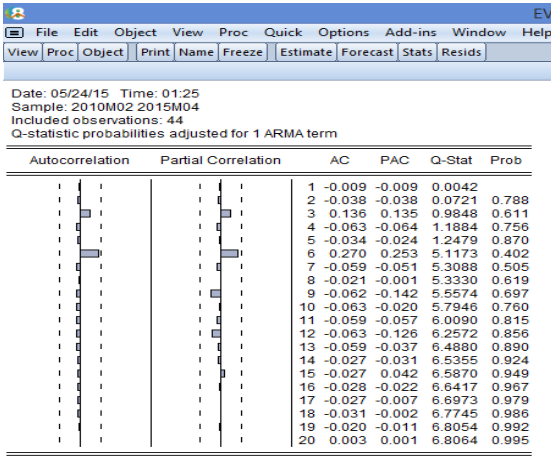


Figure 4. Correlogram for AR(1) process (ACF and PACF functions graphs)

It can be observed in the Figure 3 that the reverse root of the AR (1) process is less than 1, being inside the unit circle. This means that the AR (1) is stationary. Also, in Figure 4, is represented the correlogram (ACF graph of the function and the function PACF) for the AR process (1). The residual correlogram (in the equation output in EViews select: View -> Residual tests -> Correlogram – Q - statistics) is presented in Figure 5.



Date: 05/24/15 Time: 01:25
Sample: 2010M02 2015M04
Included observations: 44
Q-statistic probabilities adjusted for 1 ARMA term

	AC	PAC	Q-Stat	Prob
1	-0.009	-0.009	0.0042	
2	-0.038	-0.038	0.0721	0.788
3	0.136	0.135	0.9848	0.611
4	-0.063	-0.064	1.1884	0.756
5	-0.034	-0.024	1.2479	0.870
6	0.270	0.253	5.1173	0.402
7	-0.059	-0.051	5.3088	0.505
8	-0.021	-0.001	5.3330	0.619
9	-0.062	-0.142	5.5574	0.697
10	-0.063	-0.020	5.7946	0.760
11	-0.059	-0.057	6.0090	0.815
12	-0.063	-0.126	6.2572	0.856
13	-0.059	-0.037	6.4880	0.890
14	-0.027	-0.031	6.5355	0.924
15	-0.027	0.042	6.5870	0.949
16	-0.028	-0.022	6.6417	0.967
17	-0.027	-0.007	6.6973	0.979
18	-0.031	-0.002	6.7745	0.986
19	-0.020	-0.011	6.8054	0.992
20	0.003	0.001	6.8064	0.995

Figure 5. Residual correlogram

If we look at the graphs of the partial auto correlation functions (PACF) and the auto correlation (ACF) is can be observed that is no significant fluctuations. Auto correlation / partial auto correlation coefficients can be assimilated to zero. This means that the errors of this ARMA process are white noise. After modeling simple monthly returns series of financial corrections we obtained the following information shown in Table 3.

Table 3. Centralizing information after modeling the simple monthly series of returns

Model	Criteriul informațional Akaike	Criteriul informațional Schwarz	SE of regression	Adjusted R squared
AR(1)	10.72607	10.80717	50.49646	-0.019397
AR(2)	10.87145	10.99811	53.55807	-0.046408
MA(1)	***10.37814***	***10.44676***	***42.70305***	***-0.014393***
MA(2)	10.41040	10.51332	43.06335	-0.031583
ARMA(1,1)	10.42729	10.53110	43.41219	-0.032035
ARMA(1,2)	***10.10502***	***10.24343***	***36.66811***	***0.263711***
ARMA(2,1)	10.47317	10.61279	44.05656	-0.045907
ARMA(2,2)	10.46011	10.63464	43.43611	-0.016655

The informational criteria that helps us in decision making is calculated as follows (for choosing the best model):

- Schwarz (SBIC) criteria as low as possible
- Akaike (AIK) criteria as low as possible
- Standard error of regression relatively small
- Adjusted R squared high
- Residuals are white noise

Considering all the above criteria (Akaike, Schwarz, standard error of regression criteria, Adjusted R squared) we would choose the ARMA (1.2) model, but from the modeling analysis it is not considered the best model because: Estimated MA process is nonconvertible. Thus, also taking into account the criteria listed and eliminating the ARMA (1.2) model, we will choose the model MA (1).

4. Forecasting regarding financial corrections - Box Jenkins model

For financial corrections applied to projects implemented through PODCA we perform forecasting model MA (1) as indicated by the information criteria, after the elimination of ARMA (1,2) criteria.
An important step for the achievement of the forecasting using ARMA models is the validation of the model. Therefore, we are moving to the testing of residuals for MA (1) model, as shown in Figure 6.

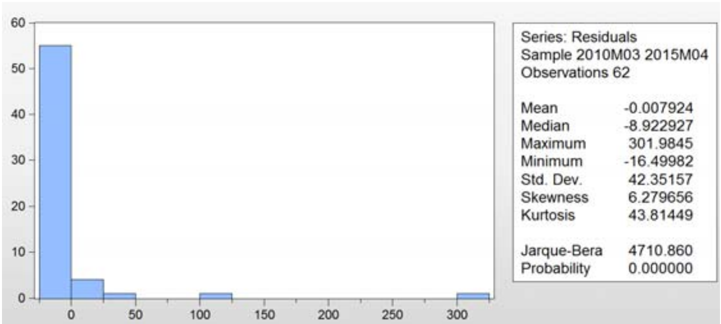


Figure 6. Residual graph for MA(1) model

Durbin Watson statistics it has the value of 1.998260 so we can say that the assumption of lack of correlation of the errors is satisfied. The test of normality reveals that the errors are not normally distributed (Figure 6).We will realize an ex-post forecast on the MA (1) model and we can check the credit worthiness of the forecast (for a certain number of observations we will have also observed values and predicted values). We have a total of 62 observations. Forecast horizon is represented by the first 45 observations (March 2010 - December 2013) and we will realize a forecast for the values from the moment 47 (January 2014) until the moment 62 (April 2015), meaning for 16 values.Given the fact that we make a forecast on a MA (1) model we can make null predictions only for 3 steps prediction. Dynamic forecast is represented in Figure 7.

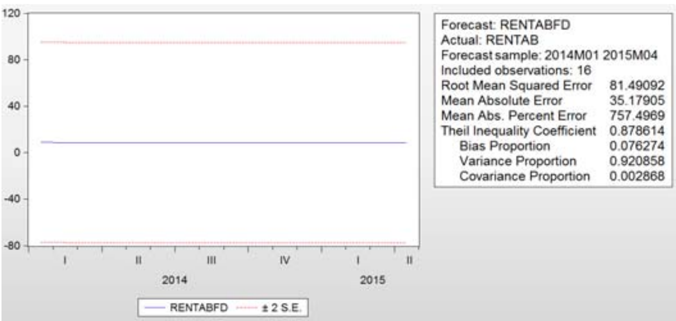


Figure 7. Dynamic forecast for MA(1) model

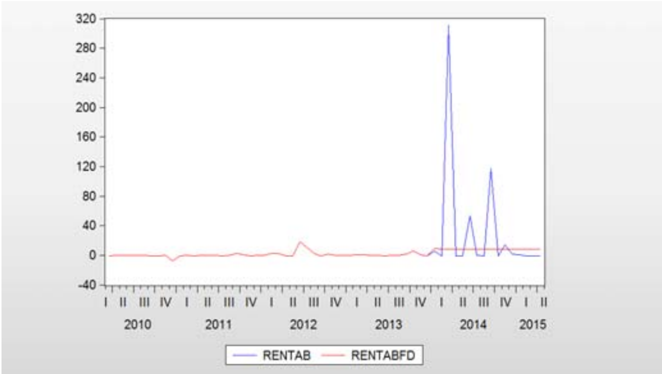


Figure 8. Dynamic forecast graph of forecasted and observed values series

Theil's indicator has a value of 0.878614 which indicates a weak adjustment. The forecast is not very good. Although Bias has a value very close to zero (actually favorable), the variance is 0.920858 (is high although it should be low) and covariance is 0.002868 (low though it should be high).

RMSE indicator is 81.49092 and MAE value is 35.17905. MAPE is equal to 757.49% (over 100%) which is not good (it is a percentage indicator that measures the credit worthiness of the forecast). It is desirable to be less than 100%. In Fig. 8 we graphed the forecasted series and the observed values series for dynamic forecasting. It is noted that the continuous line (forecast) often distances from reality (cloud of points). Static forecast is represented in Figure 9.

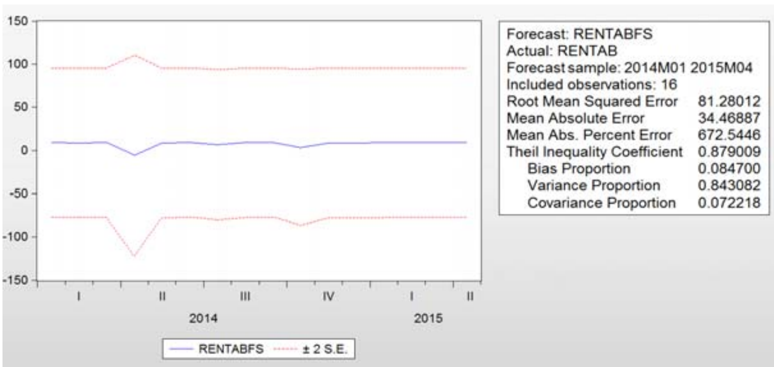


Figure 9. Static forecast for MA(1) model

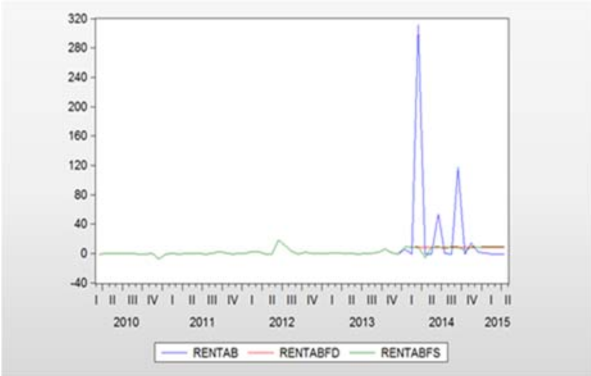


Figure 10. Static and dynamic forecast graph of forecasted and observed values series

Theil's indicator has a value of 0.879009 indicating a relatively weak adjustment, but better than the dynamic forecast. Although Bias has a value very close to zero (favorable fact), the variance is 0.843082 (is high although it should be low, but it is lower than the dynamic forecast) and covariance is 0.072218 (is low although it should be high, but it is higher than the dynamic forecast).

RMSE indicator is 81.28012 and MAE value is 34.46887. MAPE is equal to 672.54% (over 100%) which is not good, but it is better than the dynamic forecast

In Figure 10 we graphed the forecasted series and the observed values series in terms of both predictions, the static and the dynamic. It is noted that the continuous line (dynamic forecast) often departs from reality (cloud of points) and in the static forecast case the line is closer to the reality, observed values.

Given the fact that we are dealing with a series that is stable in time, for better forecasting, we will try also an **Automatic ARIMA selection from EViews Add-ins**. Using this option we obtained the output from Table 4 for **AR (4), MA (3), SAR (12) and SMA (12),** with the dynamic forecasting represented in Figure 11.

Table 4. Equation output model AR(4), MA(3), SAR(12) și SMA(12)

Dependent Variable: RENTAB
Method: Least Squares
Date: 06/22/15 Time: 10:00
Sample: 2011M08 2015M04
Included observations: 45
Convergence achieved after 23 iterations
MA Backcast: 2010M05 2011M07

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	23.85912	9.089628	2.624873	0.0128
AR(1)	0.089513	0.590174	0.151673	0.8803
AR(2)	-0.154960	0.209682	-0.739024	0.4648
AR(3)	0.350599	0.204462	1.714740	0.0952
AR(4)	-0.152660	0.176289	-0.865965	0.3924
SAR(12)	0.472968	0.156743	3.017482	0.0047
MA(1)	-0.213212	0.578834	-0.368347	0.7148
MA(2)	0.127659	0.261765	0.487684	0.6288
MA(3)	-0.299918	0.259460	-1.155933	0.2555
SMA(12)	-0.908756	0.053210	-17.07867	0.0000

R-squared	0.292505	Mean dependent var	11.98637
Adjusted R-squared	0.110577	S.D. dependent var	49.44656
S.E. of regression	46.63265	Akaike info criterion	10.71561
Sum squared resid	76111.15	Schwarz criterion	11.11709
Log likelihood	-231.1012	Hannan-Quinn criter.	10.86528
F-statistic	1.607811	Durbin-Watson stat	2.004536
Prob(F-statistic)	0.151268		

Inverted AR Roots	.94	.81-.47i	.81+.47i	.47-.81i
	.47+.81i	.44+.22i	.44-.22i	.00+.94i
	.00-.94i	-.40+.68i	-.40-.68i	-.47+.81i
	-.47-.81i	-.81+.47i	-.81-.47i	-.94
Inverted MA Roots	.99	.86+.50i	.86-.50i	.68
	.50+.86i	.50-.86i	.00+.99i	-.00-.99i
	-.23-.62i	-.23+.62i	-.50+.86i	-.50-.86i
	-.86+.50i	-.86-.50i	-.99	

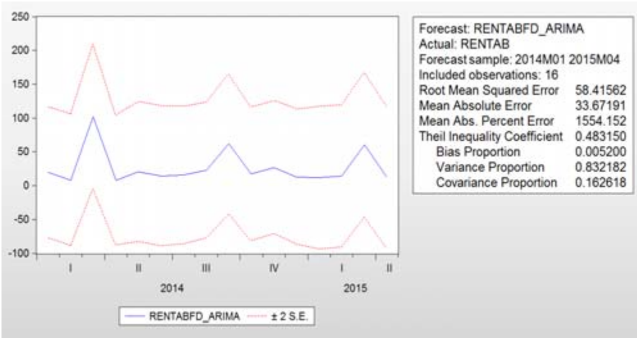


Figure 11. Dynamic forecast for AR(4), MA(3), SAR(12) and SMA(12) model

In the Figures 12, 13 and 14 we graphed the forecasted series and the observed values series in terms of both dynamic forecast and the comparison of the static and dynamic predictions made. It is noted that of the 3 projections taken, the more accurate is the one performed with the help of the Automatic ARIMA selection (Figure 14), but also this line often distances from the reality (cloud of points). In Figure 12 it could be observed the trend of the forecast to approach the reality and in Figure 13 is observed the difference between the prediction made by Automatic ARIMA selection and the dynamic forecasting performed using MA (1) model, both compared with actual observations line.

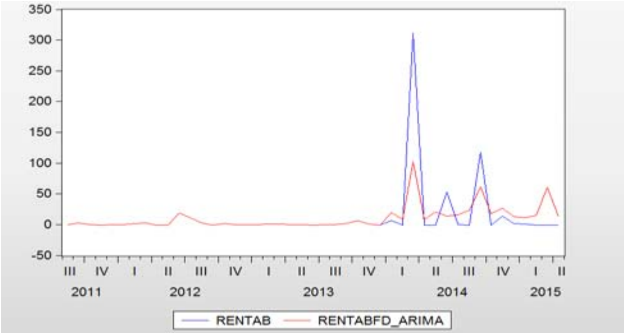


Figure 12. Dynamic forecast graph of forecasted and observed values series for AR(4), MA(3), SAR(12) and SMA(12) model

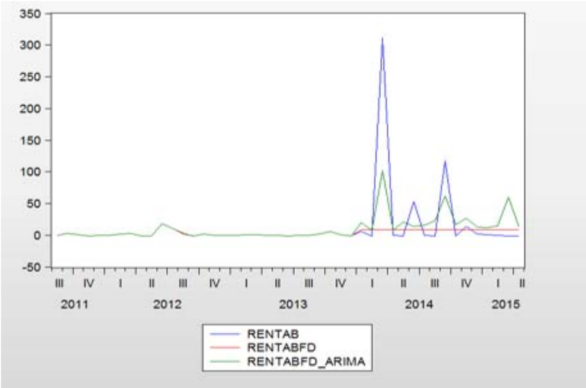


Figure 13. Dynamic forecast graph for MA(1) model (fig. 13)

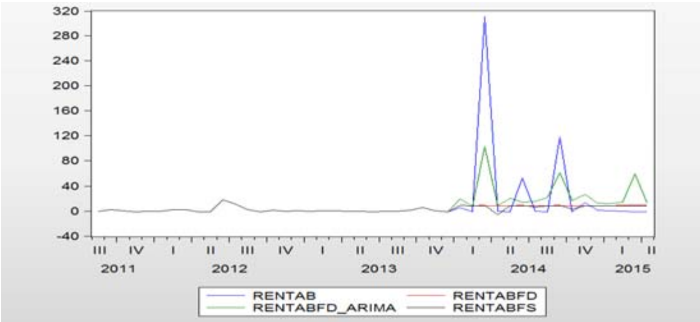


Figure 14. Static and dynamic forecast graph of forecasted and observed values series for MA(1) model and dynamic forecast graph for AR(4), MA(3), SAR(12) and SMA(12) model

5. Conclusions

The econometric analysis performed on simple monthly returns series related to financial corrections, applied to the beneficiaries of the Operational Programme of Administrative Capacity Development, showed that a realistic forecast is difficult to make, given the historical data. This can be confirmed by the fact that they cannot anticipate the types of checks / checks carried out on projects implemented by the OP, how cannot therefore be anticipated the values of the corrections applied. It is observed significant deviations in January, February, March, April 2014, in those months being established irregularities arising from suspected irregularities / recommendations / findings, following verification of the Managing Authority / Certifying and Payment Authority / Audit Authority, on projects financed under OPACD, with values much higher than previous months.

Compared to the dynamic prediction performed using MA (1) model, which analyzes existing data from a specific point in time (in our case January 2014), static forecast is closer to the reality (observed values series), where the data is being analyzed at each moment in time (January 2014, February 2014, March 2014), while the forecast was made on the remaining time.

On the other hand, compared with the two projections realized by using the MA (1) model mentioned above, the prediction made with the help of Automatic ARIMA selection is much closer to reality.

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