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The total number of projects approved at the Managing Authority of OPACD was 476 of which a total of 20 projects were withdrawn / canceled (9 withdrawn in contracting projects and 11 contracts canceled).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 \( \{Y_t\}_{t \in \mathbb{Z}} \) 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.
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:

\[ \rho_j = 0 \]  
\[ \rho_j \neq 0 \]

For T=62 observations we can build the following confidence interval 95%:

\(-1.96 \times \frac{1}{\sqrt{T}}; 1.96 \times \frac{1}{\sqrt{T}}\), 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 $\rho_6$ 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):

\[
H_0: \rho_1 = \rho_2 = \cdots = \rho_m = 0
\]

\[
H_j: \exists j \neq 0, \forall j
\]

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:

\[
\hat{t} < t_{\text{critic}} \text{ reject the null hypothesis, the series is not random walk}
\]

\[
\hat{t} > t_{\text{critic}} \text{ accept the null hypothesis, the analysed series can be considered random walk}
\]

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

**Table 1. Results of Dickey Fuller test**

<table>
<thead>
<tr>
<th>Null Hypothesis: RENTAB has a unit root</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exogenous: Constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Length: 0 (Automatic - based on SIC, maxlag=10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-6.924260</td>
<td>0.0000</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-3.588509</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-2.929734</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-2.603064</td>
<td></td>
</tr>
</tbody>
</table>

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
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:\[\text{rentab} = 12.93093 - 1.065615\times\text{rentab}(-1) + wn\]

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)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>12.13471</td>
<td>7.143887</td>
<td>1.698615</td>
<td>0.0968</td>
</tr>
<tr>
<td>AR(1)</td>
<td>-0.065615</td>
<td>0.153896</td>
<td>-0.426357</td>
<td>0.6720</td>
</tr>
</tbody>
</table>

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 47.94538 Durbin-Watson stat 2.151935
Prob(F-statistic) 0.000000

Inverted AR Roots -.07
AR(1) model has the following equation form: $y_t = 12.13471 - 0.065615 y_{t-1}$.

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.
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>
<thead>
<tr>
<th>Model</th>
<th>Criteriu informațional Akaike</th>
<th>Criteriu informațional Schwarz</th>
<th>SE of regression</th>
<th>Adjusted R squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR(1)</td>
<td>10.72607</td>
<td>10.80717</td>
<td>50.49646</td>
<td>-0.019397</td>
</tr>
<tr>
<td>AR(2)</td>
<td>10.87145</td>
<td>10.99811</td>
<td>53.55807</td>
<td>-0.046408</td>
</tr>
<tr>
<td>MA(1)</td>
<td><strong>10.37814</strong></td>
<td><strong>10.44676</strong></td>
<td><strong>42.70305</strong></td>
<td><strong>-0.014393</strong></td>
</tr>
<tr>
<td>MA(2)</td>
<td>10.41040</td>
<td>10.51332</td>
<td>43.06335</td>
<td>-0.031583</td>
</tr>
<tr>
<td>ARMA(1,1)</td>
<td>10.42729</td>
<td>10.53110</td>
<td>43.41219</td>
<td>-0.032035</td>
</tr>
<tr>
<td><strong>ARMA(1,2)</strong></td>
<td><strong>10.10502</strong></td>
<td><strong>10.24343</strong></td>
<td><strong>36.66811</strong></td>
<td><strong>0.263711</strong></td>
</tr>
<tr>
<td>ARMA(2,1)</td>
<td>10.47317</td>
<td>10.61279</td>
<td>44.05656</td>
<td>-0.045907</td>
</tr>
<tr>
<td>ARMA(2,2)</td>
<td>10.46011</td>
<td>10.63464</td>
<td>43.43611</td>
<td>-0.016655</td>
</tr>
</tbody>
</table>

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](image)

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](image)
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.
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)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>23.85912</td>
<td>2.624873</td>
<td>0.0125</td>
<td></td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.090513</td>
<td>0.590174</td>
<td>0.155128</td>
<td>0.6593</td>
</tr>
<tr>
<td>AR(2)</td>
<td>0.151256</td>
<td>0.256428</td>
<td>0.9552</td>
<td>0.3524</td>
</tr>
<tr>
<td>AR(3)</td>
<td>0.360599</td>
<td>0.204462</td>
<td>1.71740</td>
<td>0.0952</td>
</tr>
<tr>
<td>AR(4)</td>
<td>-0.152586</td>
<td>0.195829</td>
<td>0.796965</td>
<td>0.4304</td>
</tr>
<tr>
<td>MA(1)</td>
<td>-0.213512</td>
<td>0.517834</td>
<td>-0.501347</td>
<td>0.6149</td>
</tr>
<tr>
<td>MA(2)</td>
<td>0.127659</td>
<td>0.291705</td>
<td>0.437684</td>
<td>0.6399</td>
</tr>
<tr>
<td>MA(3)</td>
<td>-0.293918</td>
<td>0.259480</td>
<td>-1.155253</td>
<td>0.2555</td>
</tr>
<tr>
<td>SMA(12)</td>
<td>-0.906726</td>
<td>0.093213</td>
<td>10.07872</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

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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