An Econometric model for the evolution of the Romanian Interbank Bid Rate (ROBID) in the context of the international financial crisis

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Abstract: *The paper presents the econometric modeling of overnight inter-banking interest rates (ROBID) in our country, the analyzed period is between 1999-2010. The international financial crises had a great impact on the level of inter-banking interest rates after 2007 and it reflects the new level of risk for the Romanian system banking. The econometric model used in modeling the interest rates is an autoregressive moving average (ARMA) model, the ARMA model is typically applied to time series data; the paper propose several ARMA models, applies econometric tests and based on them the analyzed series (the inter-banking interest rates) forecast will be made.*

Keywords*: ROBID, ARIMA model, financial crisis, forecast.*

1. INTRODUCTION

Our national banking system has been, after 1990, through a long process of consolidation, transition and refinement, the period of economic and social transition of our country has left its mark on our national banking system; it has been often troubled by scandals and bankruptcy (from the bankruptcy of The Dacia Felix Bank, Bancorex and The Romanian Discount Bank), but the Romanian National Bank's policy of strengthening the banking system and also opening the system to foreign investors, under the form of direct investments in order to create new banking networks or under the form of privatization (BRD, BCR, Agricola Bank, Bancpost), has created a healthy and modern banking system. During the 2000's almost 50% of the banking system's assets were held by state owned banks.

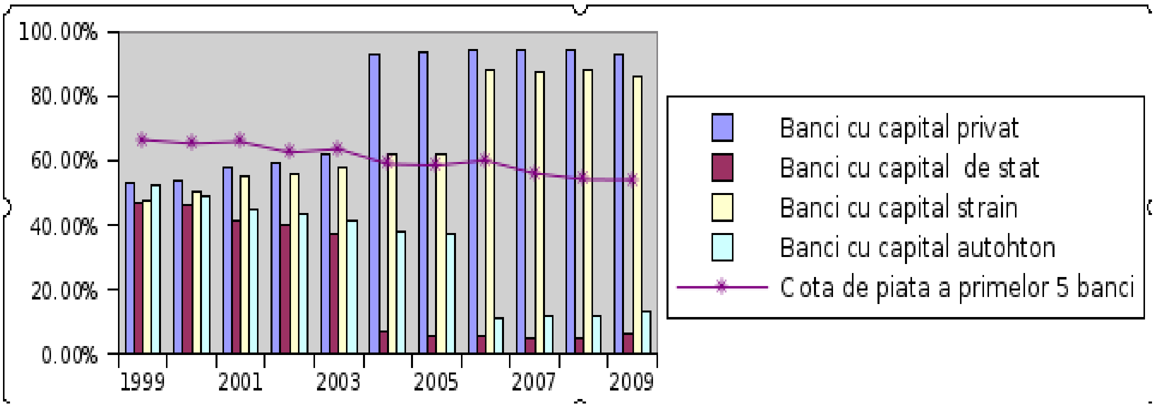

Fig.1. The balance of assets according to the source and structure of the capital (Data sources: Financial Stability Report, www.bnro.ro)

In 2009, less then 7% of the total bank assets were held by state owned banks and also, less then 7% of the total bank assets are owned by national or foreign owned banks.The presence of foreign investors on the Romanian market has had an initial positive effect, but as a result of the current economic and financial crisis, mother-banks of foreign Romanian banks, especially Greek and Austrian ones, are confronted with liquidity and reasonable interest rates finance issues. This has led to the occurrence of moral hazard, hence the Romanian National Bank and the Romanian Polity were faced with the necessity of signing the so called " gentlemen's agreement", with the main foreign owned banks in our country, a contract that stipulates agreements regarding the Romanian banking market and the way these banks will further follow the existing financing policies for the branches in our country, the contract was kept to and no massive capital call back was recorded on the Romanian bank market.

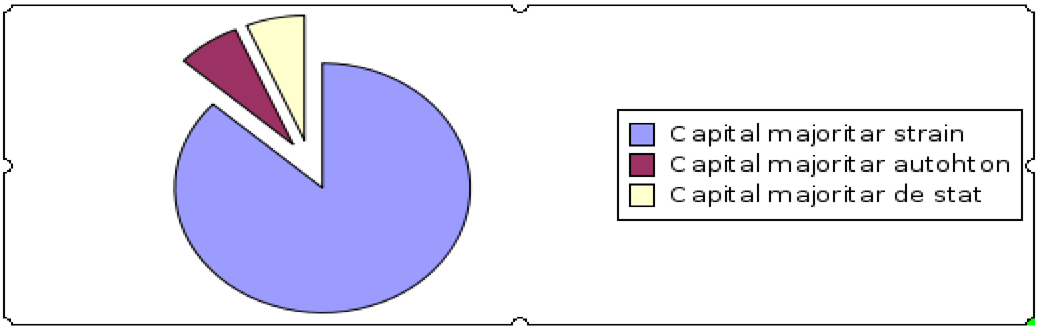

Fig. 2 The balance of assets in 2009 (Data sources: Financial Stability Report, www.bnro.ro)

Banks funds are normally formed like this [1]: owners' equity (often stockholders' equity), deposits, interbank lending markets, loans from the Central Bank, or from different financial markets. One of these markets is the interbank lending market, where banks offer and place their liquidities. In Romania, the main indicators for this market are:

1. ROBOR (Romanian Interbank Offer Rate) which is the average interest rate for interbank loans in lei and it is established by the National Bank.
2. ROBID (Romanian Interbank Bid Rate) which is the average interest rate for drawn interbank deposits also established by the National Bank.

The form of calculation is the following[2]: "the reference interest rates for the interbank market ROBID/ROBOR are calculated daily, by Reuters as an average of interest rates indicated by 10 commercial banks… using the following time limits (overnight, 1 day, 1 week, 1 month, 3 months, 6 months, 9 months, 1 year)…". The interbank interest rates are a fine receptor of available liquidity and of the level of trust between banking institutions, reacting fast on changes in the national or international economy and on the necessities of the banking system. The interest rate can be viewed from different points of view[3]: inter-temporal price, cost of capital etc., but for the commercial banks it is important to understand its evolution, the interest rate representing a cost and a return.

If we refer to the level of GNP, Romania has only been affected by the financial crisis in the fourth trimester of 2008, the level of interest rates for the ROBID/ROBOR indicators have signaled a trend alteration, as early as the summer of 2007, the ROBID interest rate grew over 3 times compared to the previous level. The level of 30% wasn't even reached when recession struck our country.

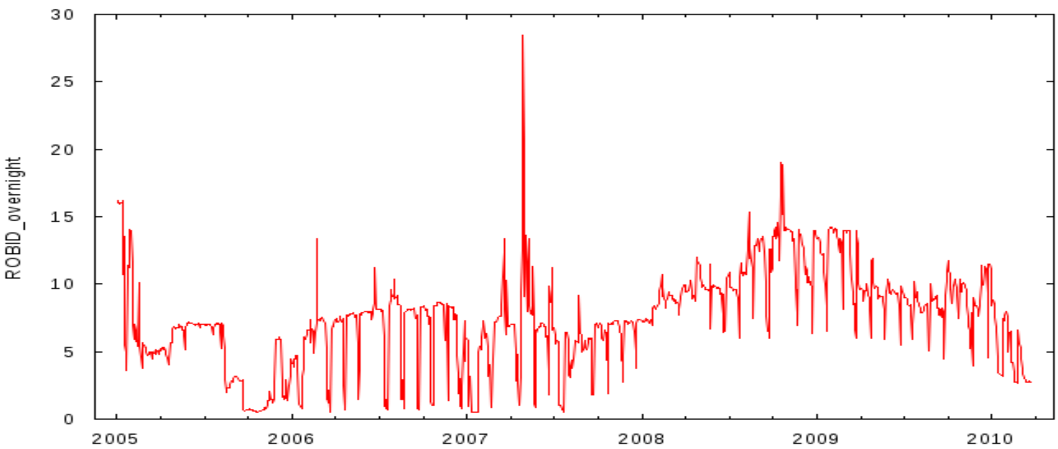

Fig.3. The evolution of the interbank interest rate ROBID 2005-2010 (Data sources: www.bnro.ro)

The manifestation of the economic crisis that began in the fourth trimester of 2008, forced the interbank interest rates to climb to 20%, and taking into consideration that ROBID mirrors the relationship between banks, we can conclude that banks look at each other with distrust and the level of associated risk grew significantly compared to the precrisis period.

2. ECONOMETRIC MODEL OF THE ROBID INTERBANK INTEREST RATES

The data used represents the daily values of interbank interest rates ROBID from 04.02.1999 to 23.03.2010. The econometric model takes into consideration the fact that this type of data is a time array and uses specific testing will validate the most efficient model.

The procedure of estimating an ARMA model includes the following steps[4]:

1. Testing the array's stationarity. If it is not stationary it will be stationarised through differentiation.
2. Using the autocorrelation and the partial autocorrelation functions we determine the autoregressive start models for the analysis of the array. If there is a value of h equal to the value of q, from which the value of the autocorrelation function drops abruptly to zero, we will use a MA(q) or an ARMA (that has a MA(q) component) model for processing the data. If the partial autocorrelation function's value drops to zero, beginning with a value of the gap equal to p, then it is recommended that the time array be processed through an AR(p) model or through a model that also includes this component.
3. The ARMA parameters are estimated and the characteristics of the framed autoregressive models are tested. It is verified if the model's factors are statistically significant (not equal to zero), the autocorrelation of errors, the homoscedasticity attribute, the determination of parameters and the distribution of errors.
4. Based on the analysis criteria the model that has the greatest significance for the degree of correlation or the least variance or error dispersal is chosen, and also the analysis of the Akaike and Schwartz informational criteria (the lower the better).
5. Based on the selected model prognosis will be given.

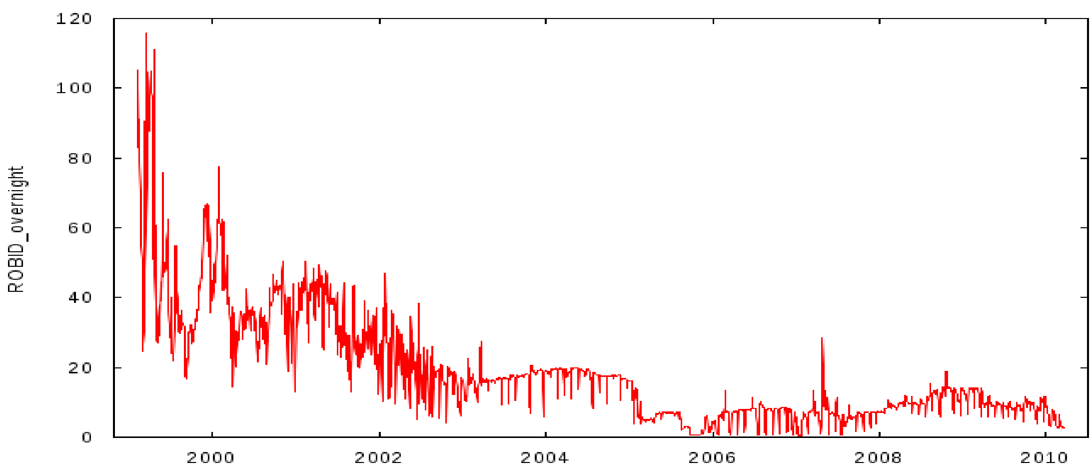

Fig.4. Evolution of ROBID from 1999 to 2010 (Data sources:www.bnro.ro)

Time arrays modeled using Box-Jenkins method can be phrased as followed[5]:

$$y_t = \underbrace{a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \ldots + a_p y_{t-p}}_{AR(p)} + \underbrace{\varepsilon_t + b_0 + b_1 \varepsilon_{t-1} + \ldots + b_q \varepsilon_{t-q}}_{MA(q)}$$

Where AR(p) is an autoregressive system of a degree equal to p, and MA(q) is a mobile average system of a degree equal to q, meaning that the evolution of the dependable variable is explained through the variance of its past values to which the eventual shocks that can take place in different points of time are added.

1. **Testing the array's stationarity**. It is tested using the ADF Test (Augmented Dickey Fuller). Two hypothesis are tested:

H_0 : $\delta = 1$ (the array is not stationary)
H_1 : $\delta < 1$

Table 1. The ADF Test[6]

```
Augmented Dickey-Fuller test for v1
including 5 lags of (1-L)v1
sample size 2830
unit-root null hypothesis: a = 1

   test with constant
   model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
   1st-order autocorrelation coeff. for e: 0.006
   lagged differences: F(5, 2823) = 57.700 [0.0000]
   estimated value of (a - 1): -0.0225886
   test statistic: tau_c(1) = -5.05606
   asymptotic p-value 1.566e-05
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According to the ADF Test the hypothesis that the array has a unitary root close to zero, value of the ADF Test of -5.05 being a lot smaller than the correspondent tabular value for a probability of 99% of -3.4, so we cannot confute the H_1 hypothesis, leading to the next phase.

2. Calculating the autocorrelation function (ACF) and the partial autocorrelation function (PACF)[7]

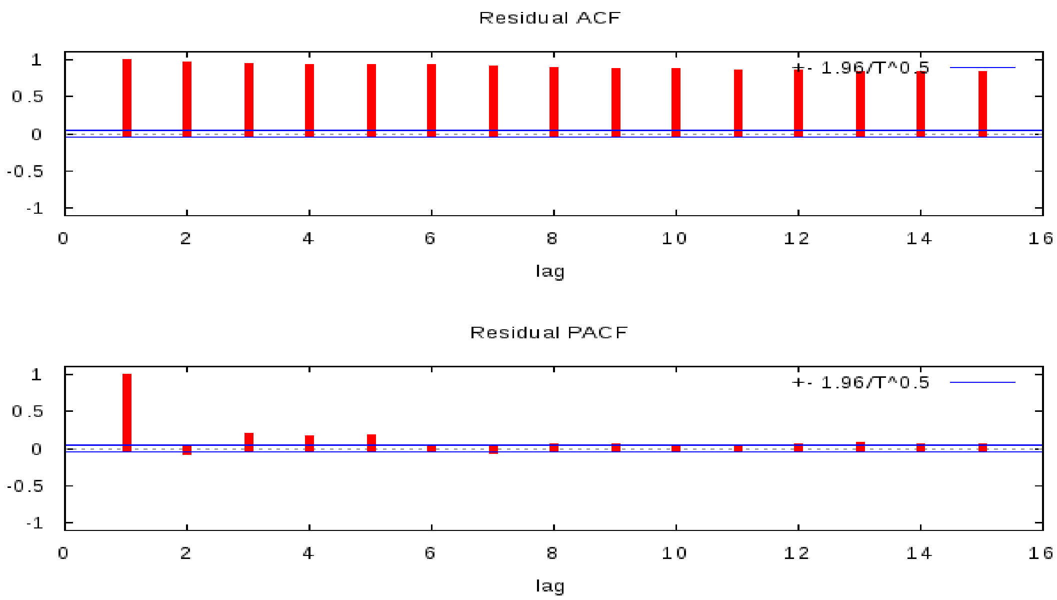

Fig.5 ACF and PACF functions

We can notice that the autocorrelation function has a constant downhill evolution, while the partial autocorrelation function drops down abruptly, which indicates the possibility of an AR(p) or

ARMA(p,q) model. Based on this information from the ACF and PACF functions we will test the models in order to choose the most eloquent of them.

Table 2. Selection criteria

No.	Model	R^2[8]	Akaike criteria	Schwarz criteria
1	AR(1)	0.94	15759	15771
2	AR(2)	0.94	15749	15767
3	AR(3) cu lag (1,2,5)	0.95	15427	15451

Based on these criteria regarding the autocorrelation degree R^2, Akaike and Schwartz, we select the AR(3) model with a 1,2 and 5 lag for the following test and prognosis.

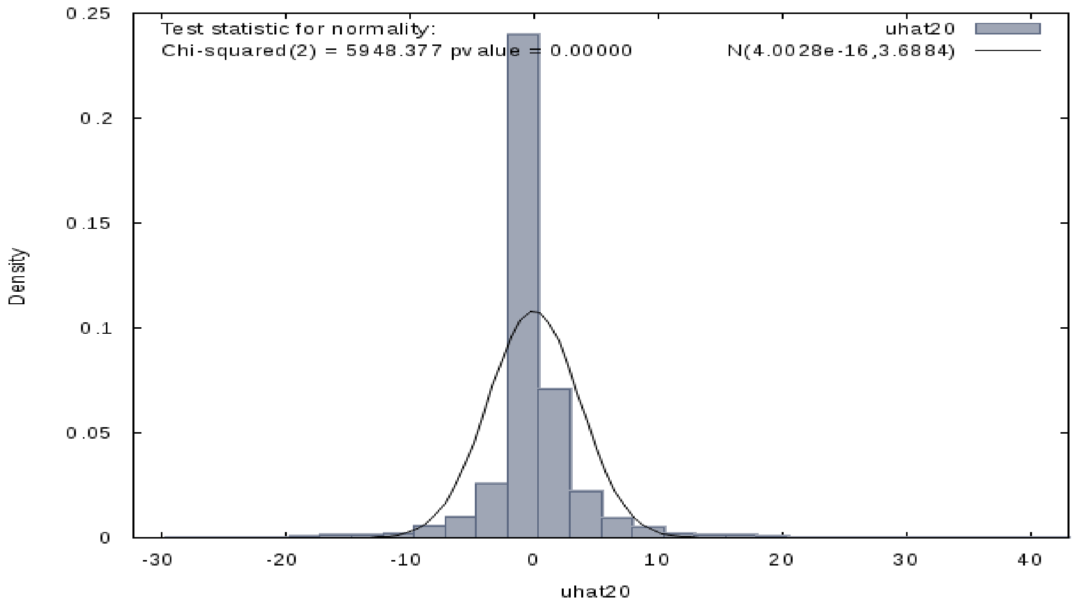

Fig.6 Representation of the normality of errors

We note that the errors follow an approximately normal distribution law N(m,q), so we can make predictions based on the model created. The model will be AR(3) with lag 1,2,5.

3. The equation form:

Table 3. ARMA Model

Model 20: ARMA, using observations 1999/02/11-2010/03/23 (T = 2831)
Estimated using least squares (conditional ML)
Dependent variable: ROBID_overnight

	coefficient	std. error	t-ratio	p-value	
const	0.408508	0.108665	3.759	0.0002	***
phi_1	0.954716	0.0182722	52.25	0.0000	***
phi_2	−0.165030	0.0190549	−8.661	4.69e-18	***
phi_5	0.185766	0.0110665	16.79	3.07e-63	***

Mean dependent var	18.70354	S.D. dependent var	15.77970
Mean of innovations	4.00e-16	S.D. of innovations	3.688362
Log-likelihood	−7709.985	Akaike criterion	15427.97
Schwarz criterion	15451.76	Hannan-Quinn	15436.55

	Real	Imaginary	Modulus	Frequency
AR				
Root 1	1.0155	0.0000	1.0155	0.0000
Root 2	0.7421	-1.1205	1.3439	-0.1569
Root 3	0.7421	1.1205	1.3439	0.1569
Root 4	-1.2498	-1.1717	1.7132	-0.3801
Root 5	-1.2498	1.1717	1.7132	0.3801

The equation will be:
ROBID = 0.4085 + 0.9545*ROBID(-1) - 0.1650*ROBID(-2) + 0.1857 ROBID(-5)

4. Prognosis based on the ARMA Model

We will carry out a prognosis based on the proposed ARMA lag(1,2,5) model, with a probability of 95%, dynamic method (out of sample)[9] which implies a chained time forecast model, in which the next forecast value is based on the new forecast value.

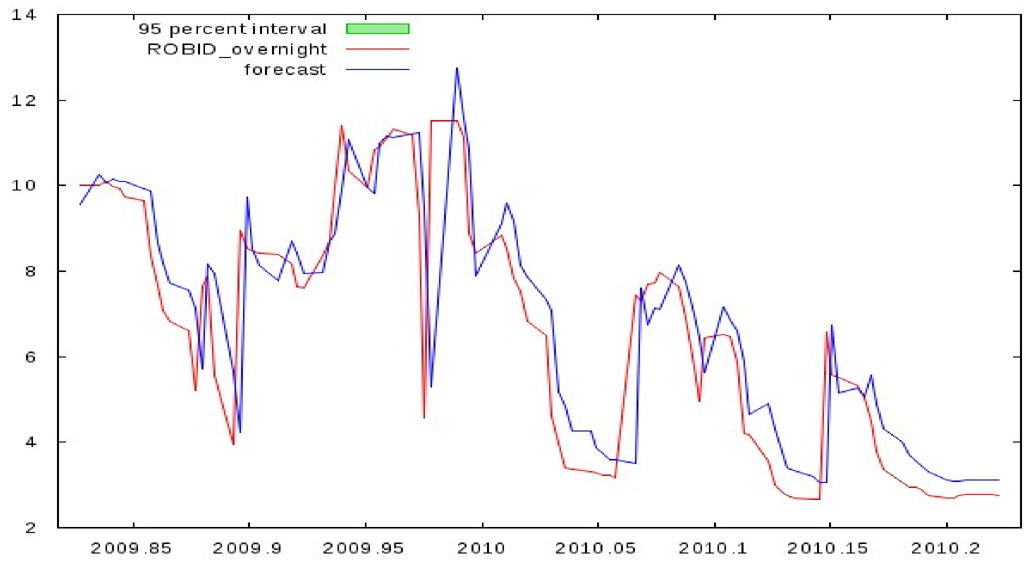

Fig.7 Prognosis for the next 5 days

Table 4. Prognosis of the interbank interest rate ROBID for the next 5 days

For 95% confidence intervals, z(0.025) = 1.96

Obs	ROBID_overnight	prediction	std. error	95% interval
2010/03/17	2.75	3.10		
2010/03/18	2.77	3.12		
2010/03/19	2.79	3.11		
2010/03/22	2.78	3.12		
2010/03/23	2.76	3.11		
2010/03/24		3.10	3.688	-4.13 - 10.32
2010/03/25		3.42	5.099	-6.57 - 13.42
2010/03/26		3.68	5.795	-7.67 - 15.04
2010/03/29		3.88	6.146	-8.17 - 15.92
2010/03.30		4.01	6.327	-8.39 - 16.41

3. Conclusions

A model for the time arrays, especially data arrays from the financial markets that do not respect the N(m,z) law because, in general, series with leptokurtic distributions are inclined to extreme movements, is very difficult to build up; the methods for analysing and modeling are in a continuous improvement process, besides ARIMA models there are other models such as ARCH and generalizations of this model.

The goal of this particular paper is to present an analysis model of the ROBID interbank interest rate fluctuations, by offering a prognosis model usefull to the banking institutions and which can be used by the financial and prognosis departments in order to assure placement and drawing of liquidities in optimal market conditions.

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