# Interest rate modeling for Albania

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**Abstract** The success of monetary policy in stabilizing prices or inflation targeting depends in large measure by the immobility of market interest rates in response to changes in policy rates. Thus the rate of transmission of interest rate depends greatly on the conditions prevailing in the credit markets and deposits; and consequently, the monetary authorities should consider these conditions and the behavior of banks in determining their policies. A change in the policy rate is reflected in an almost immediate change in the same direction and with similar proportions of short-term interest rates of bank lending and deposits. The speed at which these rates are regulated, depends on the characteristics and depth of the market, the strength of competition among financial institutions, etc.. On the other hand, after changing the key, long-term interest rates could move in the same direction, so as in reverse. Changes in real interest rates affect income and expenses, through the replacement channel, wealth, income and cost of capital. Changes in interest rates may have contradictory effects, because they affect the behavior of savers, as well as that of the borrowers. This paper deals with the construction of a suitable model for interest rate, based on a time series of interest rate for a time period outreach from August 1995 to October 2014. The aim is this model to be used for forecasting interest rate in future periods. Box-Jenkins analysis is used for modeling interest rate series. ARIMA models and SARIMA will be used for the series of interest rate.

**Keywords**: interest rate; modeling; ARIMA.

## 1. INTRODUCTION

Interest rates have the power to influence people's lives: how willing are people to save and how much interest have businesses to invest? Affecting economic decisions that different people undertake, they serve as a determining factor for investment in the general level of the economy. When interest rates decline, investment increase as a result of lowering the cost of borrowing. In this case, people rush to buy a house, a car, and in this way they feel more optimistic about the future. Although people have such a relationship with interest rates, they do not always have proper knowledge about what they represent, or how are related different rates to each other. Why increase or decrease interest rates? Why some interest rates are higher or lower than others?

**RATE OF interest- price of borrowing**

To understand the economic forces that affect the volatility of interest rates, should first give a definition of them. The interest rate is a price, and like any other price it relates to an exchange or transfer of any goods or services between a buyer and a seller. This particular type of exchange is a loan or credit, which includes a lender and a borrower.
In the case of a loan, the borrower gets a lot of money to use for a period of time, while the lender gets the borrowers promise to repay this debt will in the future. The Borrower has the advantage of immediate use of the funds it receives, while the lender submits these funds up temporarily removing their use.

Because these lender sacrifice the immediate use of funds, they require an additional fee above the amount of money borrowed. This compensation is called interest or otherwise, the price that a borrower pays for using the founds of the lenders. In other words, interest rates are the price of borrowing.

**Demand and supply**

As with any other price, the interest rates are influenced by the forces of supply and demand, and in our case, of supply and demand for credit. If offers of credit from lenders is higher than with demand of borrowers, the price (interest rate) will fall, because lenders compete with each other to bring as many clients to them.

In cases where demand is higher than supply, the interest rate will increase because the borrowers compete to get funds which are insufficient for all. Many of us keep their savings in depository institutions such as banks, savings and credit unions or financial institutions such as insurance companies. And it is precisely the willingness of people and firms not to spend, in other words savings, which constitute the main source of supply of credit. On the other hand, stay those who with all the desire to spend or invest, do not have sufficient financial means to do so. So, the main source of demand for loans is our desire to spend and investment opportunities.

**The source of the demand:**

*The consumption*: at one time or another, all consumers, businesses and governments need loans to buy goods or services. In these conditions, the borrowers agree to pay interest to lenders because they intend to have goods and services immediately, and not wait until they have saved a lot of money to be able to make the purchase. To describe this desire to spend at the moment, is used the term "high rate of time preference". Expressed more simply, when a consumer has a high rate of time preference he is keen on purchasing goods or services now, and not wait to perform this purchase in the future.

*Investment*: in the use of funds for investment, time preference is not the main factor. In this case, consumers, businesses and governments borrow only if they think that of this loan they will generate a profit. So, they borrow hoping to create a profit opportunity from it. For example, the owner of a factory sees the opportunity to buy a new machinery, which is expected to increase revenues by 20 percent. The owner will apply for a loan only if it can deal with an interest rate of less than 20 percent. What borrowers are willing to pay, depends largely on the preference of the time for actual consumption and the expected rate of profit on an investment.

**Types of rates of interest**

Nominal interest rates are determined in contracts between the parties concerned. Many interest rates are set taking into account the fact that any negotiation can bring a specific interest rate. So for example, apart from bank loans, an interest rate of particular importance to the economy is the interest paid on treasury bills. In a similar way, private, public or state companies, release securities issue, sets other nominal interest rate. Individuals earn interest from their bank accounts, which are typically higher in cases where money are blocked for a period of time (savings accounts or deposits) and lower when are kept in current account. On the other hand, individuals pay interest when they borrow for consumption purposes. The following graph summarizes and illustrates well what is said above, using arrows for each type of interest rate.

## 2. LITERATURE REVIEW

For successful development of monetary policy, it is important to understand the functioning of the money market and being aware of the key elements that define the interest rates on money market and the behavior of money market participants. In their interbank study market for overnight loans to major industrial countries, Batolini (2002) finds that the operative procedures of central banks and styles of intervention have a significant impact on the behavior of short-term interest rates every day.

Available literature in microstructure cash market that investigates daily segments usually is based on some important issues. The first is the relationship between changes in monetary policy and institutional environment and daily interest rate changes. Other questions often discussed are daily volatility of interest rates and factors that affect in it. (Palombini (2002), Durr and Nardelli (2006)); or how daily interest rate is influenced by central bank liquidity. Also the issue that is usually investigated is the existence of predictable models in daily interest rate changes. [Benito et al. (2006)]

Most of the research in the Eurozone money market focuses on the connection between instruments and procedures of monetary policy and daily interest rate. There are also many articles that analyze how institutional details of money market affect the behavior of daily interest rate. The first empirical analysis of microstructure of money market in the eurozone is made by Hartmann, Manna and Manzanares (2001). They focus on the institutional environment and its implications in daily volatility, quoting activity, trading volumes and price differences required for daily deposits. The results of the examination show that the volatility and differences are related to ECB monetary policy decisions and tend to be higher at the end of the reserve maintenance period for minimum reserve requirements

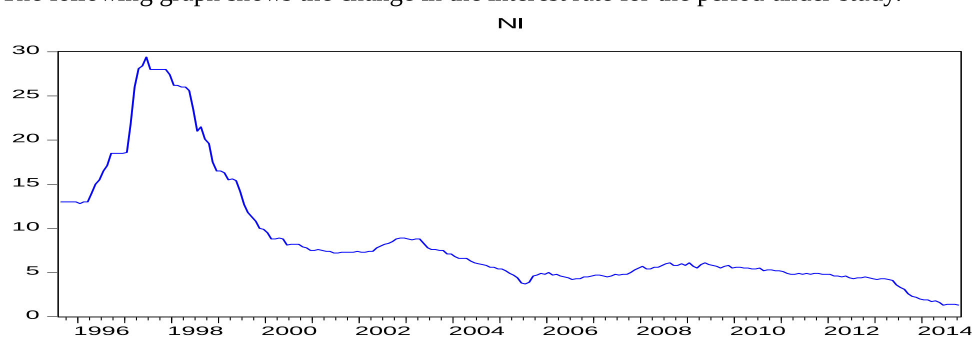
## 3. METHODOLOGY

The analysis is focused on the analysis of the interest rate for the period August 1995 to October 2014.

The banking system in Albania since after 90 years passed a long process of consolidation, transition and improvement. The period of economic and social transition of our country has left its traces in our banking system. It has often been associated with the banking corruption scandals but designed and implemented policies by the responsible institutions were constantly trying to keep under control and within a certain framework banking sector. The economy is specified of monetary policies implemented by the Central Bank. Monetary policy in Albania is stable because it uses its own currency, so the all.

The real interest rate is calculated as the difference between the interest rate of government debt (Treasury bond rate), compared to the inflation rate. She has followed the same trend as 1-year treasury bonds rate, since inflation has been fluctuating slightly, but under control. In 2009 the real interest rate was 5:41%, while the end of February 2014 was 1.86%. As a result an investor who buys one-year treasury bonds, real return is reduced by about 3.6%, while the contrary happens to the government, the real cost of borrowing is reduced by the same amount.

The following graph shows the change in the interest rate for the period under study.




Graph 1 – Trend of interest rate fluctuations

In the graph appears clearly the year 1997 when the Albanian economy passed major changes. After 2000 is not able stabilization of interest rates always with a downward trend.

### 3.1 Stationarity

A classic usable way to define the order of differentiation is the use of criteria for the existence of unitary root for series in the study, the interest rate. The order of differentiation will be determined by the number of unitary roots.

For this is used Dickey- Fuller test. In the case of Dickey-Fuller test, is likely to appear the problem of autocorrelation. To avoid this problem, Dickey Fuller has created a test called the Augmented Dickey Fuller Test, as follows (Equations 1, 2, 3)

$dY_t = B_1 + ZY_{t-1} + a_i + e_t$ (First Equation) >only intercept

$dY_t = B_1 + B2_t + ZY_{t-1} + a_i + e_t$ (Second Equation) >trend and intercept

$dYt = ZY_{t-1} + a_i + e_t$(Third Equation) >or trend , or intercept

Build hypotheses:

H0: $\delta = 0$ series non stationary

Ha: $\delta = 1$ series stationary

To return series in stationary, should use the rule of differentiation, in our case the first difference.

| Series NI | Model | ADF t stat | t,1% | t,5% | t,10% | Null hypothesis |
|---|---|---|---|---|---|---|
| Level | With intercept | 0.89 | -3.45 | -2.87 | -2.57 | Non reject |
| | trend& intercept | -1.9 | -3.99 | -3.42 | -3.13 | Non reject |
| The first difference | With intercept | -21.5 | -3.45 | -2.87 | -2.57 | reject |
| | trend& intercept | -21.66 | -3.99 | -3.42 | -3.13 | reject |

Table 1- Table of results in first level and difference with combinations Trend & Intecept.

Series is not stationary, but return in stationary with a difference, so it has a unitary root.

Referring to the criteria mentioned above, the time series of interest rate is a variable non-stationary of first order, ARIMA (p, 1, q) or SARIMA.

The general format of the suggested models are for respectively:

$(1-\varphi_1 B- \varphi_2 B^2-...- \varphi_p B^p)(1-B)NI_t= (1+\theta_1 B+ \theta_2 B^2+...+ \theta_q B^q)*u_t$ or

$$(1-\Phi_1 B^{12} - \Phi_2 B^{24} - .... - \Phi_P B^{12P})(1-B^{12})^D (1-B)\ (1-\varphi_1 B - \varphi_2 B^2 - ... - \varphi_p B^p) DNI_t =$$
$$= (1+\Theta_1 B^{12} + \Theta_2 B^{24} + ...\Theta_Q B^{12Q})(1+\theta_1 B + ..... + \theta_q B^q) u_t$$

When- ut is white noise, ut ~ WN $(0, \sigma^2)$.

For the selection of the model will use selection criteria models: AIC, BIC and SBQ

Akaike Info Criterion (AIC) is an honor the most important criteria used for selection of models. This criterion was published for the first time by Hirotsugu Akaike in 1974. This criterion provides a relative measure of lost information of a model that attempts to describe reality

In the general case AIC criterion computes the following formula:

$$AIC = 2k - 2\ln (L)$$

Where k is the number of independent variables of the model, and L is the maximum value of the function of likelihood of that model.

BIC criterion was developed by Gideon E. Schwarz, who used a Bayesian argument for its adoption. BIC criterion is an asymptotic result that is derived under the assumption that the distribution of the data found in the exponential family. The formula for BIC criterion is:

$BIC = -2 \ln L + k \ln(n)$.

The model selected based on selection is:

| |
|---|
| MODEL FINALLY CHOSEN: SARIMA(1,1,1)(1,0,0) WITHOUT MEAN |

During the analysis were appeared some distant point. After a full analyses was developed , discovered some largest value which appear in the table 1.2 in appendix

The estimated model is:

METHOD OF ESTIMATION: EXACT MAXIMUM LIKELIHOOD

| PARAMETER | | ESTIMATE | STD ERROR | T RATIO | LAG |
|---|---|---|---|---|---|
| AR1 | 1 | -.93492 | 0.43724E-01 | -21.38 | 1 |
| AR2 | 1 | -.25420 | 0.70150E-01 | -3.62 | 12 |
| MA1 | 1 | -.74071 | 0.79304E-01 | -9.34 | 1 |

Table 2 The estimated model SARIMA

| OUTLIERS | |
|---|---|
| 227 AO | ( 6 2014) |
| 122 LS | ( 9 2005) |

According to Box-Jenkins analysis the selected model should be tested for its goodness . If the model is not good it should be reassessed or should be eliminated the appearing problems.

A SARIMA model would be good if his residual are white noise, graph 1.1 in appendix appears graphics of residual:

### a. **Autocorrelation**

To study whether the model Residual suffer from the problem of serial autocorrelation use Breusch-Godfrey test.

According to this test null hypothesis test is built base model remains not suffer from autocorrelation. Test values are shown in the table below.

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 2.275583 | Prob. F(2,214) | 0.1052 |
| Obs*R-squared | 3.708731 | Prob. Chi-Square(2) | 0.1566 |

Referring to Fisher statistics is clear that null hypothesis stands if the value of p is greater than 5%.

### b. Heteroskedasticity

If the remains of the model have different variations, then the model suffers from heteroskedasticity. To set this testing we use our model White test, the results presented in the table below:

| | | | |
|---|---|---|---|
| F-statistic | 18.08591 | Prob. F(6,212) | 0.0000 |
| Obs*R-squared | 74.14584 | Prob. Chi-Square(6) | 0.0000 |
| Scaled explained SS | 617.4221 | Prob. Chi-Square(6) | 0.0000 |

Basic hypothesis builded , is that the waste the model are homoskedastcity . According to the test values and the values of p, this hypothesis swoop. To eliminate the appears problem is used for the evaluation of the model White heteroskedasticity-consistent standard errors & covariance. The estimated model is presented in Table 1.2 in the appendix.

### c. Normal distribution of residuals

To test the distribution of waste is used Jarque-Bera test.

The test is given as below:

$$JB = \frac{n}{6}\left[S^2 - \frac{(K-3)^2}{4}\right] \sim \chi_2^2$$

We build the hypothesis: $H_0 : u_i \sim N(\mu, \sigma^2)$

Test results and principal statistics waste are presented in the table below.

| |
|---|
| TEST-STATISTICS ON RESIDUALS |
| MEAN= -0.0027055 ST.DEV OF MEAN.= 0.0021650 |
| T-VALUE= -1.2497 |
| NORMALITY TEST= 5.092 ( CHI-SQUARED(2) ) |
| SKEWNESS= -0.3414 ( SE = 0.1640 ) KURTOSIS= 3.2859 ( SE = 0.3281 ) |
| SUM OF SQUARES= 0.2347131 DURBIN-WATSON= 2.0326 |
| STANDARD ERROR OF RESID = 0.3266309E-01 |
| MSE OF RESID.= 0.1066878E-02 |

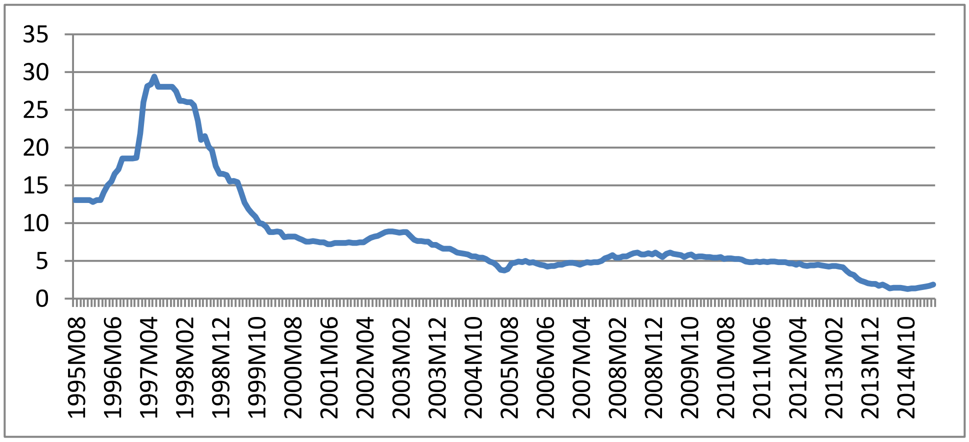
Table 3. Result of residuals statistics

Based on the value of statistics JB is 5092 and is lower than the critic value Hi-square test with 2 df. As a result, residues of model are white noise.

This model can be used for forecasting the interest rates in the coming periods.

In the table 1.3 in appendix are presented the realized predictions from the estimated model for interest rate.

The following graph presents values of the interest rate series and the forecast for June 2015




Graph 2. The forecast trend of interest rate.

By the realized forecast from the estimated model based on historical values of interests rate is clearly seen that the rate will stay in this level up to following year.

## CONCLUSIONS

The interest rate is the borrowing price. It is determined by supply and demand for loans (debt). If the offer of borrowing is greater than the demand for borrowing, then borrowing price, the interest rate, is low, because the lender aims to attract as many clients as possible. After analysis of the monthly data for the rate of interest for the years 1995-2014 was discovered that this series is I(1). The suitable models for it were thought to be ARIMA or SARIMA model. After analyzing some ARIMA models and comparing them based on the criteria of selection of ideals, it turns out that the most appropriate model for the rate of interest is SARIMA (1,1,1) $(1,0,0)_{12.}$ The model showed heteroskedasticity problem and it was eliminated with the use of White heteroskedasticity-consistent standard errors & covariance. The model was tested for the problem of autocorrelation and as a conclusion its residues are white noise. The model was used to assess the interest rate forecasts in the following periods. According to the forecast is expected to have low levels of interest rates. This prediction should be taken into account for making the correct decisions in order to support the promotion of loans as well. The last one is a major problem in the second tier banks in Albania as the level of bad loans is at high levels. In addition to this, public debt the country has ,is at high levels and internal debt is growing .

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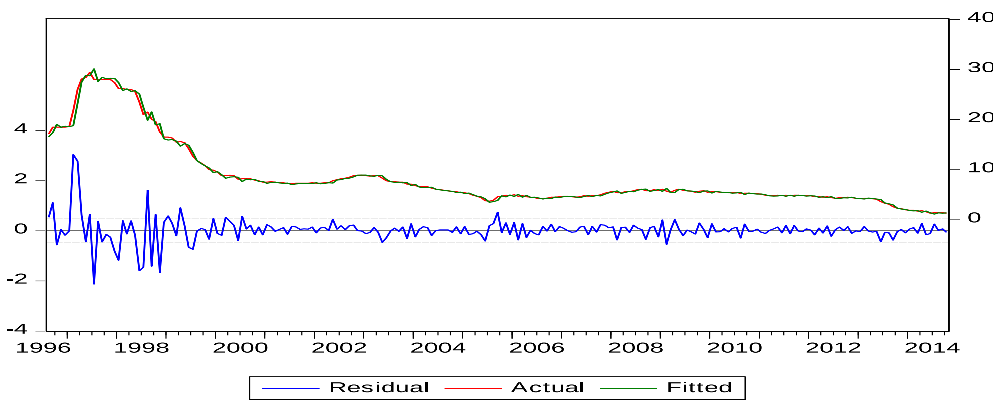
**Appendix**




Graph11. Fitted and actual interest rate

Dependent Variable: NI
Method: Least Squares
Sample (adjusted): 1996M08 2014M10
Included observations: 219 after adjustments
Convergence achieved after 10 iterations
White heteroskedasticity-consistent standard errors & covariance
MA Backcast: 1996M07

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| AR(1) | 1.049181 | 0.024362 | 43.06587 | 0.0000 |
| AR(12) | -0.058161 | 0.021269 | -2.734524 | 0.0068 |
| MA(1) | 0.360855 | 0.172116 | 2.096576 | 0.0372 |

| | | | |
|---|---|---|---|
| R-squared | 0.994766 | Mean dependent var | 8.373059 |
| Adjusted R-squared | 0.994718 | S.D. dependent var | 6.590162 |
| S.E. of regression | 0.478954 | Akaike info criterion | 1.379180 |

| | | | |
|---|---|---|---|
| Sum squared resid | 49.54977 | Schwarz criterion | 1.425606 |
| Log likelihood | -148.0202 | Hannan-Quinn criter. | 1.397930 |
| Durbin-Watson stat | 1.896049 | | |

| | | | | |
|---|---|---|---|---|
| Inverted AR Roots | .96-.02i | .96+.02i | .64-.49i | .64+.49i |
| | .27-.72i | .27+.72i | -.14-.73i | -.14+.73i |
| | -.50-.54i | -.50+.54i | -.71+.20i | -.71-.20i |
| Inverted MA Roots | -.36 | | | |

Table 1.1 The estimated model for interest rate.

OUTLIERS :

227 AO ( 6 2014)

122 LS ( 9 2005)

20 LS ( 3 1997)

19 LS ( 2 1997)

225 AO ( 4 2014)

119 TC ( 6 2005)

218 LS ( 9 2013)

Table 1.2 The largest value of interest rate.

| | |
|---|---|
| 2014M10 | 1.3 |
| 2014M11 | 1.274473 |
| 2014M12 | 1.297109 |
| 2015M1 | 1.350685 |
| 2015M2 | 1.42393 |
| 2015M3 | 1.509473 |
| 2015M4 | 1.602492 |
| 2015M5 | 1.699839 |

| | |
|---|---|
| 2015M6 | 1.799463 |

Table 1.3 The predictions from the estimated model for interest rate.