

Analysis and Forecasting of Georgian Lari Exchange Rate with Respect to American Dollar with Special Programming Software MATLAB

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Abstract

In the presented, analysis and forecasting of Georgian exchange rate with respect to American dollar has been done. For the data, we collected last two-year's information about exchange rate. One month forecast has been done with the help of Matlab programming software and special mathematical method ARMA modeling.

Keywords: ARMA, ARIMA, forecasting, autocorrelation, partial autocorrelation.

Introduction

Exchange rates are extremely important for a trading economy as it is one of the basic indicators of country development. During the last two years, the economy of Georgia has been dramatically changing and consequently, Georgian has been becoming worse and worse with respect to other countries' currency. It has a negative effect for the country like as it is mostly importer, most of its product is imported from outside and consequently, devaluation of its native currency has huge damage to the economy. Therefore, given the vital importance of analyzing and prediction of exchange rate, a deep analysis of tendency of Georgian's Lari has been done with one-month ahead prediction.

Methodology

ARMA (Autoregressive Moving Average)

Our methodology is based on special parametric method for time series analysis-called Autoregressive Moving Average model (ARMA). While ARMA model represents classical approach for many time series, it should be mentioned that in majority of cases, observed time series represents nonstationary one and ARMA assumes time series to be stationary, that means their joint distribution does not change with the shift of time and have constant statistical parameters, like mean, variance, and covariance.

ARIMA

(Autoregressive Integrated Moving Average)

Therefore for nonstationary time series, we need to introduce additional parameter-integrated part, which means that original time series is differentiated several times in order to achieve stationarity. This new part is involved into new form of ARMA-called ARIMA(p,d,q) where d stands for integrated order, which means that we need to differentiate original time series from finite difference method d times to make original time series stationary. After that using autocorrelation and partial autocorrelation functions, relevant order of ARMA(p,q) are chosen and corresponding parameters are estimated. Also, special Matlab code is introduced and explained during the practical part (datuashvili & darakhvelidze, 2016).

Practical Part

For the practical experiment, last two years' data were collected; exchange rates were taken from the national bank of Georgian starting from 2017-01-27 to 2017-10-28 including 189 data. In the graph below tendencies of exchange rate are shown.

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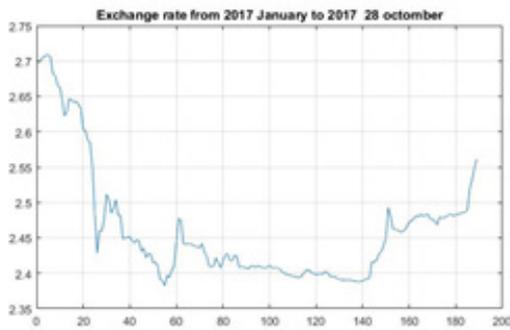


Fig.1. Exchange rate from 2017 January to 2017 28 October

It is clear from figure 1 that time series is characterized first with decreasing trend, then increasing again, which indicates nonstationarity. Such type of nonstationarity can be easily removed using first order difference method, which in Matlab can be easily implemented by

```
dy=diff(Y);
```

where Y is observed exchange rate. Let us check if dynamic trend has been removed after the first order difference.



Fig. 2. removing of dynamic trend using first order difference

It can be seen that after removing mixed trend, time series is a bit more stationary, detection of relevant Autoregressive and Moving Average orders are generally done. On the basis of autocorrelation and partial autocorrelation method general guidelines can be formulated as follows:

The lag at which the auto-correlation function (ACF) cuts off is the indicated number of MA terms.

The lag at which the partial auto correlation function (PACF) cuts off is the indicated number of AR terms.

But instead of analyzing directly ACF and PACF and inspecting relevant orders graphically and in some cases those detection are a bit more subjective, we decided to write a computer program which selects best orders on the basis of special criteria Bayesian information criterion, which is a criterion for model selection among a finite set of models; the model with the lowest BIC is preferred. It is partly based on the likelihood function and is closely related to another popular criterion for model selection called: Akaike information criterion (AIC) (Chatfield, 2013), (Hamilton, 1994).

Matlab Program

First part of the code starts with the reading of time series from the user

```
function [yF, AR_order,MA_order]= complete_arma1(Y)
%% if not specific input from user, use default time series
```

After that we are calculating the length of given time series and also plotting its autocorrelation and partial autocorrelation functions (Fan, 2008).

```
n=length(Y);
% Y is the observed time series
%% graphical representation of time series
subplot (3,1,1);
plot(Y);
title ('original time series');
%%autocorrelation/partial autocorrelation of given signal
subplot (3,1,2);
autocorr(Y);
subplot(3,1,3);
parcorr(Y);
hold off
```

Next part of the code starts with asking the user to enter necessary order of differencing and also - indication maximum number of AR order testing.

```
%% entering necessary parameters for Arima Testing
d=input ('enter necessary order of differencing : ');
M=input ('maximum order of lag for ARMA simulation : ');
```

In our case, first order differencing was enough, so $d=1$, as for M, we entered 3, that means that at maximum lag=3 has been tested for AR and MA order. After that two main important line of codes come, first is actual simulation of ARMA model

```
%% simulate ARIMA model on the base of given input
LOGL = zeros (M, M); %Initialize
PQ = zeros (M, M);
for p = 1:M
    for q = 1:M
        mod = arima(p,d,q);% for each pair generate new ARIMA model
        [~,~,logL] = estimate(mod,Y,'print',false);
        LOGL (p, q) = logL;
        PQ (p, q) = p+q;
    end
end
```

Now final part consists of calculation relevant orders on the basis of minimum BIC criterion.

```
%% calculate BIC
n=length(Y);
LOGL = reshape(LOGL,M*M,1);
PQ = reshape(PQ,M*M,1);
[~,bic] = aicbic(LOGL,PQ+1,n);
bic=reshape(bic,M,M);

%% determine order of ARIMA by finding minimum element
from matrix bic and corresponding indeces
[AR_order,MA_order]=find(bic==min(min(bic)));
```

Last step is on the basis of estimated relevant orders, forecast exchange rate, one month horizon of forecasting has been chosen, also confidence intervals has been estimated.

```
%% prediction
t=input('enter horizon for forecasting : ');
Mdl = arima(AR_order,d,MA_order);
EstMdl = estimate(Mdl,Y);
[yF,yMSE] = forecast(EstMdl,t,'Y0',Y);
```

This line asks the user for entering horizon for forecasting, after that model with corresponding AR_order and M_order has been created and simulated, finally forecasting has been done, confidence interval was estimated on the basis of supposing of Gaussian distribution.

```
UB = yF + 1.96*sqrt(yMSE);
LB = yF - 1.96*sqrt(yMSE);
```

Let us analyze the result. On the basis of the program, ARIMA (1,1,1) model has been created. The coefficients are given in Figure 3.

```
ARIMA(1,1,1) Model:
-----
Conditional Probability Distribution: Gaussian
```

Parameter	Value	Standard Error	t Statistic
Constant	-0.000627262	0.00108584	-0.577674
AR(1)	0.105497	0.129762	0.813003
MA(1)	0.209456	0.14507	1.44383
Variance	0.00013105	7.66868e-06	17.089

Fig. 3. estimated coefficients of ARMA model

It can be inspected from Figure 3 that auto-regressive order was chosen 1 and for moving average order 1 has been determined. Let us plot also predicted values. Figure 4 analysis reveals that decreasing tendency in predicted values can be inspected; for instance, tomorrow's value of exchange rate was predicted as 2.5632.

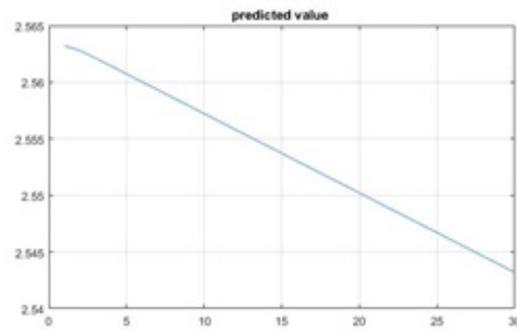


Fig. 4. Predicted Value of exchange rate

Conclusion

In the given article, complete analysis of modeling and forecasting of Georgian exchange rate has been done.

With the help of special programming software-Matlab and corresponding methods of time series analysis-ARMA model, we detected the model that corresponds to the given time series.

On the basis of presented forecasting, we can also determine possible variation of exchange rate, as we know exact forecasting of stochastic process is impossible; therefore, possible range of variation gives us useful information about tomorrow's tendency of one of the most important indicators of country's development.

References

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