Prediction of Returns on All-Share Index of Nigeria Stock Exchange.

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ABSTRACT

The downward trend in the performance of the Nigerian stock market is primarily caused by low per capita income, which implies that people are living below the poverty line. This study focused on the returns on the All-Share Index of the Nigerian stock exchange on the Nigerian economy. A time plot was used to examine the trend, seasonality, and discontinuity of the data. Box Jenkins approach with R statistical package was used to examine the stationary of Nigeria All-Share Index. The parameters of the model were estimated using the maximum likelihood estimation techniques and Akaike Information Criteria (AIC) was used to check for the goodness of fit of the fitted model.

The time plot of monthly All Share Index of Nigerian Stock Exchange showed non–stationarity. Transformation was done by differencing once and ARIMA model (1, 1, 2) with AIC value of 3526.5 was fitted.

The optimal parameters of the fitted model are $\emptyset_1$ = -0.0702, θ_1 = -1.0462 and θ_2 **= 0.0463** with standard error of 0.3781, 0.3779 and 0.3778, respectively. Ljung-Box statistics give non-significant p-values, indicating that the residuals appeared to be uncorrelated. The fitted model is:

$$ASI_t = -0.0702ASI_{t-1} - 1.0462\varepsilon_{t-1} + 0.0463\varepsilon_{t-2}.$$

The forecasted value decreased for the first six months in 2015 and then remained constant for the next two and half years (i.e., July 2015 – Dec 2017). There is the need to implement prudent macroeconomic policies in order for a country to derive maximum benefits from Capital Market.

(Keywords: All-Share Index, Ljung-Box statistics, ARIMA model)

INTRODUCTION

The Nigerian Stock Exchange was established in 1960 and started operations in 1961. It was influenced by macroeconomic forces, which are outside the realm of capital market. Capital markets are generally believed to be the heartbeat of any economy given their ability to respond almost instantaneously to fundamental changes in the economy. The importance of the capital market as a barometer of economic performance can be inferred from daily news reporting. The reporting of the performance of different markets across the globe indicates the relative competitiveness of the underlying economies and stocks.

The changes in macroeconomic balances are often reflected by the magnitude and movement in stock prices, market indexes, and the liquidity of the market. This paper is focused on examining the long term trend, model fit, and forecast for future of the stock exchange All-Share Indexes with data that exists in the Nigerian Stock Exchange (NSE) All-Share Index between 2009 and 2014.

The Nigerian capital market has recorded a tremendous growth over the years until its recent crash which has been exceptional in its historic evolution since 1960 till date. The growth in the market has been influenced by government economic reforms, notably, with the establishment of the second-tier market (SSM) in 1985 and the deregulation of interest rates in 1987 which enabled many private enterprise investors to patronize equity markets.

All-Shares Index (ASI) is mostly used to determine the growth of the market as it captures the overall performance of the market such as market capitalization, liquidity, and turnover ratio. ASI is one of the major determinants of the market size of any stock exchange and its growth rate pose a major influence on the growth and development of the economy.

Many authors have used the Auto-Regressive Integrated Moving Average (ARIMA) methodology to analyze inflation dynamics, prices of commodities, water usage behavior, etc. like Stockton and Glassman, 1987; Samad, Ali and Hossain, 2002, Katimon and Demun, 2004, etc. Using autocorrelation function (ACF), partial autocorrelation function (PACF), and Akaike's Information Criterion (AIC), they concluded that ARIMA model provides a reasonable forecasting tool.

MATERIALS AND METHODS

The study period covers data on the Return on All-Share Index for the period of 2009 to 2014. Estimation is the important aspect of statistical inference, therefore in the light of this, this section is concerned with some details of the concept of Time Series Analysis. Time Series is studied importantly because of the purpose of predicting the future values of the variable.

Time Plot

The first step in analysis of a time series is to plot the observation against time, which can be monthly, quarterly, or annually, depending on the available data. This will show up important feature such as trend, seasonality, discontinuity and others (wild observation).

Method of Analysis

Method of analysis adopted in this research work is Box Jenkins approach with R statistical package to examine the stationary of Nigeria All-Share Index via Identification phase; estimation phase; and diagnostic check or verification phase and then forecasts were made based on the fitted model.

Model Estimation

After identifying the order of the tentative model, the parameter of the model are estimated using the maximum likelihood estimation to determine the AR and MA parameter, as well as Akaike information criteria (AIC) and all other parameter reported in the study.

Diagnostic Checking

The diagnostic stage of Box-Jenkins ARIMA process is to examine whether the fitted model follows a white noise process. This can be done by studying the autocorrelation value (r_k) one at a time, and to develop a standard error formula to test whether a particular r_k value is significantly different from zero.

Theoretically, it is envisaged that all autocorrelation coefficients for a series of random number be zero. However, because of the presence of finite sample, each sample autocorrelation might not be exactly zero.

The ACF coefficients of white noise data is said to have a sampling distribution that can be approximated by normal curve with mean zero and standard error of $\frac{1}{\sqrt{n}}$, where n gives the number of data points in the observed series.

For a white noise process, 95% of all sample autocorrelation values must lie within a range specified by the mean plus or minus 1.96 standard errors. In this case, since the mean of process is zero and the standard error is $\frac{1}{\sqrt{n}}$ one should expect about 95% of all sample autocorrelation value r_k to be within the range of $\pm 1.96\sqrt{n}$ or $(-1.96\sqrt{n} < r_k < 1.96\sqrt{n})$.

If this condition does not hold, then the model fitted do not follow a white noise process, or the residuals are not white noise. The correlogram of ACF would therefore show lines at the critical value of $\pm 1.96\sqrt{n}$ for easily verification.

The Ljung-Box test is a modified version of the portmanteau test statistics developed by Ljung and Box (1978) is also used. The modified Ljung-Box Q statistic tests whether the model's residuals have a mean of zero, constant variance and serially uncorrelated values r_k (a white noise check).

The test statistic is given by:

$$Q = n(n+2)\sum_{k=1}^{k}\frac{r^2}{(n-k)}$$

where n denotes the number of data points in the series, r_k^2 is the square of the autocorrelation at lag k, and h is the maximum lag being considered.

The hypothesis to be tested is formulated in the form;

Ho: The set of autocorrelations for residuals is white noise (model fit data quite well)

H_1: The set of autocorrelations for residuals is different from white noise.

The test statistic (Q) is compared with a chi-square distribution written a $Q > \chi^2_{\alpha(h-p-q)}$, where α is taken to be 5% (0.05).

h is the maximum lag being considered, and p and q are the AR and MA processes, respectively.

The decision is to accept the null hypothesis (Ho) if $Q > \chi^2_{\alpha(h-p-q)}$.

The ARIMA approach combines two different specifications (called *processes*) into one equation. The first specification is an *autoregressive* process (AR) and the second specification is a *moving average* (MA). ARIMA modeling advocates that there is correlation between a time series data and its own lagged data.

A *p*th-order autoregressive process expresses a dependent variable as a function of past values of the dependent variable, the moving average of past error terms that can be added to the mean of *Y* to obtain a moving average of past values of *Y* would be a "*q*th-order" moving-average process equation.

To create an ARIMA model, we began with an econometric equation with no independent variables ($Y_t = \beta_0 + \varepsilon_t$) and added to it both the autoregressive (AR) process and the moving-average (MA) process.

Autoregressive process Moving average process:

$$Y_t = \beta_0 + \emptyset_1 Y_{t-1} + \emptyset_2 Y_{t-2} + \cdots + \emptyset_p Y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} \dots + \theta_q \varepsilon_{t-q}$$

where the $\emptyset$s and θs are the coefficients of the autoregressive and moving-average processes, respectively.

Following Box and Jenkins (1976), an autoregressive moving average (ARIMA) model may be specified as thus:

$$ASI_t = \beta_0 + \emptyset_1 ASI_{t-1} + \emptyset_2 ASI_{t-2} + \cdots \emptyset_p ASI_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q}$$

where $ASI_t$is the All-share index series and β_0, $\emptyset$, and θ are the parameters to be estimated. Before this equation can be applied to a time series, however, it must be assumed that the series is *stationary*. If a time series is non-stationary, further steps must be taken to convert the series into a stationary one before ARIMA can be applied.

Forecasting

Forecasting can be said to be a statement about what will happen in the future based on the information or data that is available now. In general, given the series $X_1, X_2, \dots, X_t$ the forecasting problem is to predict the value of $X_{t=l\,(l=1,2,\dots)}$ of the series that will be observed at time $t+l$ in the future. According to the minimum mean square error criterion of forecasting, this value is $\ddot{X}_t(l)$ which minimizes the conditional mean square error:

$$E\left[(X_{i+l} - \bar{X}_t(l))^2 / X_1, X_2, ... X_t\right]$$

Differentiating this with respect to $\bar{X}_t(l)$, equating the derivatives to zero, and solving the resultant equation for $\bar{X}_t(l)$ gives:

$$\bar{X}_t(l) = E\left[(X_{i+l} / X_1, X_2, ... X_t\right]$$

Hence the minimum mean square error forecast of the value X_{i+l} is given as:

$$\bar{X}_t(l) = E\left[(X_{i+l} / X_1, X_2, ... X_t\right]$$

$$= \alpha_1 E\left[(X_{i+l} / X_1, X_2, ... X_t\right] + \alpha_2 E\left[(X_{i+l} / X_1, X_2, ... X_t\right] + \ldots + \alpha_p E\left[(X_{i+l-p} / X_1, X_2, ... X_t\right] - \beta_1 E\left[(X_{i+l} / X_1, X_2, ... X_t\right] - \beta_2 E\left[(X_{i+l} / X_1, X_2, ... X_t\right] - \ldots - \beta_q E\left[(X_{i+l-q} / X_1, X_2, ... X_t\right]$$

Therefore;

$$\bar{X}_t(l) = \alpha_1 \bar{X}_t(l-1) + \bar{X}_t(l-2) + \cdots + \alpha_p (l-p) - \beta_1 E\left[(X_{i+l} / X_1, X_2, ... X_t\right] - \beta_2 E\left[(X_{i+l} / X_1, X_2, ... X_t\right] - \ldots - \beta_q E\left[(X_{i+l-q} / X_1, X_2, ... X_t\right]$$

RESULTS AND DISCUSSION

Model Identification

This involves plotting the time-plot, ACF, PACF of the data for stationarity, differencing and model selection through ACF and PACF.

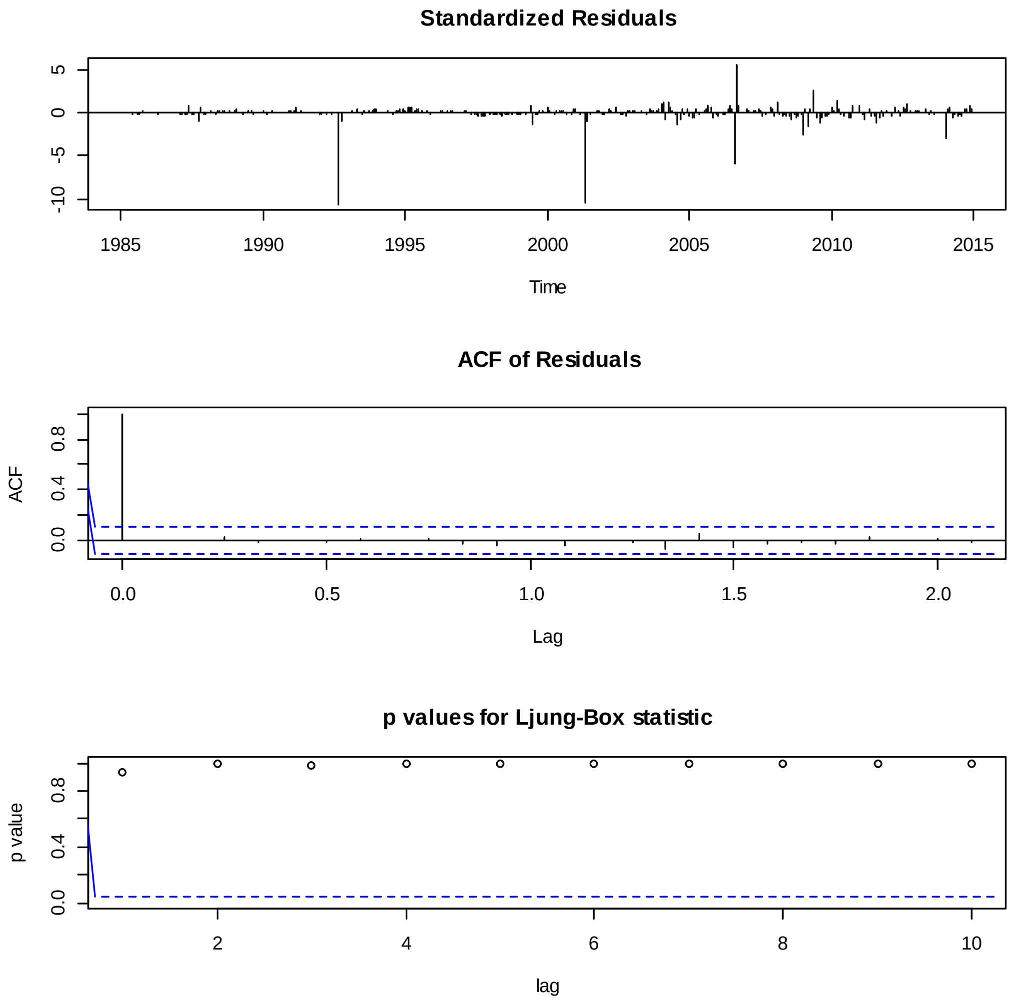
The time series plot of monthly return share index of Nigerian Stock Exchange between 1985 and 2014 suggests non – stationarity. This is because the data contains trend and random fluctuations at different levels of the year, the ACF and PACF plot of difference series indicates that the first difference has removed the disturbances that somehow affect the level of return of share index.

The first sample ACF coefficient is significantly different from zero. The remaining autocorrelations are small, this suggests an MA (2) model. The first PACF coefficient is significantly different from zero, but none of the other partial autocorrelations approaches significance, this suggests an AR (1).Therefore, we try ARIMA (1, 1, 2) or ARMA (1, 1) which is the combination of MA (1) and AR (1) models.

Estimation of the Parameters

This involves starting with a preliminary estimate and refining the estimate iteratively until the sum of squared errors is minimized. Parameters that are significantly different from zero are retained in the fitted model. The Ljung-Box statistic gives non-significant values for efficient model.

DIAGNOSTIC STAGE



The plot of monthly All share index of Nigerian Stock Exchange between 1985 and 2014 suggests non – stationarity. Transformation was done by differencing once and model (1, 1, 2) has its Akaike Information Criteria (AIC) = 3526.5. The optimal parameters were $\emptyset_1$ = -0.0702, θ_1= -1.0462 and θ_2= **0.0463** with standard error of 0.3781, 0.3779 and 0.3778, respectively.

This implies that, both coefficients AR (1) & MA (2)] are definitely non-zero. Ljung-Box statistics give non-significant p-values, indicating that the residuals appeared to be uncorrelated. Hence, the formulated model,

$$ASI_t = -0.0702ASI_{t-1} - 1.0462\varepsilon_{t-1} + 0.0463\varepsilon_{t-2}$$

fits the data well.

CONCLUSION

The forecasted value decreased for the first six months in 2015 and then remained constant for the next two and half years (i.e., July 2015 – Dec 2017).

In order to enhance the growth of the Nigerian capital market that would facilitate the developmental progress of the Nigerian economy, the following policy suggestions are recommended:

1. There is need for the government to articulate appropriate incentives and policies to ensure that lending rate is

keep at one digit in order to encourage investors to borrow money from bank and inject it into capital market.

2. There is the need to implement prudent macroeconomic policies in order for a country to derive maximum benefits from Capital Market

REFERENCES

1. Brown, K. and F. Reilly. 2008. *Analysis of Investments and Management of Portfolios 9th edition*. South Western Centage: Toronto, Canada.

2. Ekpenyong, D.B. 1994. *Investing in Securities in Nigeria: Investors Guide.* Iinnet Paul Publications: Ibadan, Nigeria.

3. El-Mefleh, M.A. and M. Shota. 2008. "A Contribution to the Analysis of the Economic Growth of Qatar". *Applied Econometrics and International Development Journal*. 8(1):18-35.

4. Hanke, J.E. and D.W. Wichern. 2005. *Business Forecasting (8th ed.)*. Pearson Educational Incorporated: New York, NY.

5. Jeremy, J.F., B. Emma, and Y. Christian. 2006. *Understanding and Using Advanced Statistics*. SAGE Publications, Ltd.: New Delhi, India.

6. Katimon, A. and A.S. Demun. 2004. "Water Use at University of Technology Malaysia: Application of ARIMA Model". *Journal Technology*. 41(B):47-56.

7. Ogundiran, A.A. 2003. *Fundamentals of Statistics*. Has-Fem Nigeria Enterprise: Shomolu-Lagos, Nigeria.

8. Onoh, J.K. 2002. *Dynamics of Money, Baking and Finance in Nigeria: An Emerging Market*. Astra Median, Publishers: Aba, Nigeria.

9. Samad, Q.A., M.Z. Ali, and M.Z. Hossain. 2002. "The Forecasting Performance of the Box-Jenkins Model: the Case of Wheat and Wheat Flour Prices in Bangladesh". *The Indian Journal of Economics*. LXXXII (327):509-518.

10. Stockton, D. and J. Glassman. 1987. "An Evaluation of the Forecast Performance of Alternative Models of Inflation". *Review of Economics and Statistics*. 69 (1):108-117.

11. Valle, H.A.S. 2002. *Inflation forecasts with ARIMA and vector autoregressive models in Guatemala*. Economic Research Department, Guatemala: Banco de Guatemala.

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