

Autoregressive Integrated Moving Average (ARIMA) Model for Exchange Rate (Naira to Dollar)

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Abstract

Analysis of exchange rate using ARIMA model, was carried out to help those in charge of the economy who are carried out to help those in charge of the economy who are interested in the strange and irregular trend in the Nigerian exchange rate system, to identify the exchange rate model, estimate the model parameters and predict or forecast the future. In an effort to better understand how exchange rate can be modeled, this work applied ARIMA model to exchange rate (Naira to Dollar) within the periods 1982-2011, through Box-Jenkins methodology an AR(1): order one was generated model is preferred as it was proved through the diagnostic rate of Naira-Dollars based on its potentials for better prediction and computational requirements.

Keywords: Arima model, Exchange rate, diagnostic check.

1. Introduction

The exchange rate is a relative price that measures the worth of a domestic currency in terms of another currency. The currency in forecasting the foreign exchange rate or at least predicting the trend correctly is of crucial importance for any future investment.

Exchange rate prediction is one of the demanding applications of modern time series forecasting. The rates are inherently noisy, non-stationary and deterministically chaotic. Box et al (1994)

This characteristics suggest that there is no complete information that could be obtained from the past behavior, of such markets to fully capture the dependency between the future rates and that of the past. Since assumption has it that historical data is the major player in the prediction process, therefore; historical data incorporates all these behaviour. The exchange rate fluctuates and requires a statistical model that can approximately represent the variability. The fluctuation in exchange rate can be examined with a class of structural time series models in order to gain a better understanding of the underlying process and obtain more efficient estimates.

The main objective for this is to adopt a suitable autoregressive model for the analysis of Nigeria exchange rate for Naira versus dollars.

The study is expected to be used by government and policy maker in Nigeria in carrying out their task and it is of significant knowledge embodiment to the economist who are interested in the strange and irregular trend in the Nigeria exchange sector and as such, it is providing the most needed knowledge of different interaction in the Nigeria macro-economics.

2. Review of Related Literature

Akaike (1976) incorporates a money demand function with a partial adjustment mechanism, and finds that reformulated monetary approach can out perform the random walk model in an out-of-sample forecast exercise. Salan (1998) also finds that a monetary model with a large endogenous variables forecasts better than naive random-walk model. Finn (2010) finds that the simple flexible-price monetary model is not supported by the data while the rational-expectations monetary model is supported and performs as well as the random walk model.

It has long been believed that nominal exchange rate behavior is well described by the naive random-walk model. This means that there is no systematic economic forces in determining the exchange rates. Messes and Rogoff (1983) showed that none of the structural models (Frankel-Bilson's flexible monetary model, Dorabussh-Frankel's sticky-price monetary model) out perform a simple random-walk on the basis of root-mean-square-error (RMSE) and mean-absolute-

error criteria for forecast evaluation bias, sampling error, stochastic movement in the true underlying models.

C.B.N (2006) finds that domestic currency appreciation negatively affects domestic shares price for an export-dominant economy and positively affects share prices in an import dominant economy.

Harvey (2001) also found, using a multivariate co-integration technique that an unrestricted monetary model outperforms the random-walk other models in an out-of-sample forecasting experiment for the sterling-dollar exchange rate.

Since the 1970s, models have emphasized the role of exchange rate as asset price. The new work, looking at present value models of exchange rates, highlights the role of expectation in determining exchange rate movements. For many years the standard criterion for judging exchange rate has been, do they beat the random-walk model for forecasting changes in exchange rates? This criterion was popularized by the seminar work of Messes and Rogoff. They found that the empirical exchange rate models of the 1970s that seemed to fit very well in sample tended to have poor out-of-sample fit. The mean-squared error of the models prediction of the exchange rate (using realized values of the explanatory variables) tended to be lower than the mean-squared error of the naive model that predicts on change in the exchange rate.

Mark's (1995), found that empirical exchange rate models were helpful in predicting exchange rates at long horizons. Subsequent works has cast doubt on whether exchange rates can be forecast at long horizons, so there is a weak consensus that the models are not very helpful in forecasting. It is worth noting that there is a contingent that believes that non-linear models have forecasting power.

In the light of the above this article tends to determine an ARIMA model for the Naira to US dollar exchange rate.

3. Methodology

The general autoregressive integrated moving average (ARIMA) model introduction by Box and Jenkins (1976) includes auto-regressive as well as moving average parameters and explicitly includes differencing in the formulation of the model. Specifically, the three types of parameters in the model are: The autoregressive parameter (P), the number of differencing passes (d), and moving average parameters (q). In the notation introduced by Box and Jenkins, the models are summarized as ARIMA (p,d,q).

The ARIMA model, although a non stationary process exhibits homogeneity with respect to the class of series can occur in many ways. They could have non constant mean μ , time varying second moments such as on constant variance δ^2 , or have both of these properties.

Models useful for representing such behaviours can be obtained by supposing a suitable difference of the process in order to be stationary.

Fortunately, there are models that can be constructed from a single realization to describe this time dependent phenomenon. Two such models that are very useful is modeling non. Stationary in mean are the deterministic trend models. The class of ARIMA models derives its usefulness from the varieties of forecasting situations trend models, exponential smoothing, random walk models and auto regression can also be shown to be special cases of ARIMA models.

The Box-Jenkins ARIMA models has gained great popularity and are based on the idea that a time series in which successive values are highly dependent can be regarded as being generated from a series of independent shocks. Modeling such series lead to the class of auto regressive integrated moving average ARIMA model.

4. The General Arima Model

The general ARIMA model introduced by Box and Jenkins includes Autoregressive as well as moving average parameters. Specifically, the two types of parameter in the model are; the auto regressive parameter (p), and the moving average parameter (q). In the notation introduced by the Box and Jenkins, the models are summarized as ARIMA (p,d,q). The general form of the ARIMA (P,Q) process is of the form:

$$X_t: \mu + \sum \phi_1 X_{t-1} + \sum \theta_{j|e_{t-j}} + e_t$$

$$\text{ARIMA (1,1): } X_t: \mu + \phi_1 X_{t-1} + \theta_1 e_{t-1} + e_t$$

$$\text{ARIMA (2,2): } X_t: \mu + \phi_1 X_{t-1} + \theta_1 e_{t-1} + \theta_2 e_{t-2} + e_t$$

5. Analysis

5.1 Model Identification

The model identification according to Box and Jenkins (1994) involved using ACF, PACF, A/C etc the Box and Jenkins ARIMA models can be shown to be optimal and provides a systematic approach to model selection, utilizing all the information contained in the sample autocorrelation (ACF) and partial autocorrelation (PACF) function. The ACF and PACF are adopted here. Using the S. plus application software professional edition version 6.12 Microsoft windows 2002 and the sample autocorrelations (ACF) function. The results are computed using the Data table in the Appendix 2

5.2 Parameter Estimation

After the exchange rate of Naira to Dollar assumes autoregressive process of order (1), the parameter was estimated and the value of the coefficient for Naira-Dollar was 1.250374, hence we have the model equation as:

$$X_t = \phi X_{t-1} + E_t \dots \dots \dots \text{Exchange rate model (AR(1))}$$

Since $\phi = 1$, exchange rate model is:

$$X_t = X_{t-1} + E_t$$

$$X_t - \phi X_{t-1} = E_t$$

$$(1-1.250374\beta) = E_t$$

5.3 Diagnostic Checking

Diagnostic $X_t = 1.25037 X_{t-1} + E_t$ checking procedures are based on the examination of the residuals. The variance is such that if the model is satisfactory, the residuals which are estimates of the error components E_t should be approximately normally distributed mean zero.

ARIMA (1,0,0) has the most preferred AKaike (1976) information criterion autocorrelation coefficient statistics of 1964.28496 for Naira-US Dollars data, then the model of order (1) is the most suitable model i.e, AR(1).

5.4 Summary of Result

Statistic	Nair-Dollar
Stationary	Non-stationary
Model identification	ARIMA (1,0,0) = AR(1)
Model coefficient	1.250374
Model equation	$X_t = 1.250374X_{t-1} + E_t$
A/c	1964.28496

6. Conclusion

We discovered the following

- Residual is negligible
- Since the model is ARIMA (1,0,0); AR(1) then $\phi = 1$ i.e. the variance covariance matrix.
- Since the AR is of order 1, then it is a random walk model.

Foreign exchange has been described as the means of affecting, payments of international transactions with convertible currencies that are generally accepted for the settlement of international trade and other external obligations.

Different models were fitted though AR(1) and AR(2) have the same structural features, the best fit is AR(1) model because it has the most suitable A/C. This was achieved through the diagnostic checking which identified it as the best fit. The ARIMA model that I have presented in this paper can provide a better understanding of the underlying system if appropriately parameterized.

Depreciation of exchange rate will make import more expensive than before if the country cannot cutback into import or improve on the volume and value of her export, unfavourable balance of trade occurs, ceteris paribus, this can have serious effect on the balance of payment which may further lead to depreciation of the domestic economy.

Therefore, the government should be able to curtail or limit inflation. Increase savings and make more resources

available for further productions.

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Appendix 1

Table 1	Sample	
LAG	ACF	PACF
0	1.0000	0.9922
1	0.9922	0.9922
2	0.9840	-0.0266
3	0.9673	-0.0009
4	0.9673	-0.0334
5	0.9585	-0.0200
6	0.9499	-0.0136
7	0.9413	-0.0051
8	0.9327	-0.0047
9	0.9241	-0.0047
10	0.9154	-0.0067
11	0.9667	-0.0084
12	0.8980	0.0027
13	0.8910	0.1021
14	0.8847	0.0423
15	0.8785	-0.0056
16	0.8722	-0.0078
17	0.8659	-0.0140
18	0.8659	-0.0047
19	0.8530	-0.0164
20	0.8465	0.0038
21	0.8400	-0.0049
22	0.8335	-0.0051
23	0.8269	-0.0062
24	0.8202	0.0203
25	0.8131	-0.009
26	0.8530	-

Sample Acf and Pacf

Appendix 2

Table 2: Average yearly exchange rate for Dollars in Naira (1992-2011).

Year	Yearly average
1982	0.5464
1983	0.6100
1984	0.6729
1985	0.7241
1986	0.7649
1987	0.8938
1988	2.0206
1989	4.0179
1990	4.5367
1991	7.3916
1992	8.0378
1993	9.9095
1994	17.2984
1995	22.0511
1996	21.8861
1997	21.8861
1998	21.8861
1999	21.8861
2000	21.8861
2001	92.6934
2002	102.1052
2003	111.9433
2004	120.9702
2005	129.3565
2006	133.5004
2007	132.1470
2008	128.6516
2009	125.8331
2010	118.5669
2011	148.9017

Source: Data abstracted from Central bank of Nigeria (C.B.N) statistical bulletin in their official website (www.cbn.org).

