International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 2, June 2020
http://www.casirmediapublishing.com

INTERVENTION ANALYSIS OF DAILY KENYAN SHILLING / NIGERIA NAIRA EXCHANGE RATES

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ABSTRACT

The research work is about an intervention on daily exchange rates of the Kenyan (KEN) Shilling and its Nigeria counterpart Naira (NGN) observed on 17th August, 2017. The realization of this time series studies span from 19th March, 2017 to 11th September, 2017. There is an abrupt jump or change in 4th August, 2017 which prompted an intervention modelling. The pre-intervention series was adjusted stationary by the Augmented Dickey Fuller test. Fitted on it is a series $X_t = 0.8633X_{t-1} + 0.01367X_{t-12} - 0.7480\varepsilon_{t-1} + \varepsilon_t$ And the estimated residual is the white noise process. On the basis of this model, the post intervention forecasts were obtained. The intervention produces closed relationship between the post intervention data and their forecast data.

Keywords: Kenyan shilling, Nigerian Naira, Exchange rates, Intervention modelling, ARIMA modelling.

INTRODUCTION

An economic time series of daily exchange rates are frequently affected by policy changes and others events that are known to have occurred at a particular point in time. Events of this type, whose timing are known, have been termed intervention. Intervention analysis was introduced by BOX and TIAO (1975). Ever since it has been widely and extensively applied by scholars in ascertaining various degree of any intervention necessary for a time series. Exchange rate which means the exchange of one currency for another price for which the currency of a country (Nigeria NGN) can be exchange for another country's currency e.g (Kenyan KEN) is very important in business transaction. Considering the daily exchange rate between Kenyan (KEN) and Nigeria (NGN) exchange rate from 19th March, 2017 to 11th September, 2017 shows an abrupt rise on 4th August, 2017 and has not reduced from that day onwards and not even after the Central Bank of Nigeria CBN has been pumping dollars into the foreign exchange market as a remedial measure in 2017. It is being speculated that this trend is brought about by the current economic recession bedevilling the nation's economy. This is an intervention analysis problem, the intervention being the economic recession where the point of intervention being 4th August, 2017. This research work is aimed at proposing an intervention model to explain the effect of economic recession on the KEN/NGN exchange rates. We shall employ the Box and Tiao (1975) This approach is well tested and successfully applied by many scholars. For instance, Appiah and Adetude (2011) conducted a research on forecasting exchange rate between Ghana Cedis and the dollar using time series analysis for the period of January 1994 to December, 2010. Their finding reveal that the predicted rates were consistent with the depreciating trend of the observed series, ARIMA (1, 1, 1) was found to be the best model. Etuk and Amadi (2016) working on intervention analysis of daily GDP, used exchange rates occasioned by BREXIT observed that the GDP has fallen sharply after relative to the USD. This fall is shown to be statistically significant. The pre-intervention series observed follow an ARIMA

(1, 1, 0). Etuk and Victor-Edema (2017) conducted on research on intervention modelling of monthly EUR – NGN exchange rate due to Nigeria economic recession from 2004 – 2006 reveals a series with a slight positive trend up to May, 2016, from 2016 there was an abrupt astronomical rise till the end of the year. Roberts et al, (2001) applied randomised intervention analysis to show the effect of vegetation availability on a certain group of dragon flies. This is to mention only a few.

Materials and Methods

Data

The data for this work is 138 daily KEN – NGN exchange rates from March 19, 2017 to 11th September, 2017 from the website www.exchangerates.org.uk/KEN-NGN-exchange-rate-history.html. They are to be read as the amounts of NGN in one KEN. The data series is provided in the appendix of this work.

Intervention Modelling

Consider a time series $\{X_t\}$. Suppose that is experiences an intervention at time $t=T$. Box and Tiao (1975) propose that the pre-intervention part of the series be modelled by an ARIMA model. Let this model be an ARIMA (p, d, q). That is,

$$A(L)\nabla^d X_t = B(L)\varepsilon_t \qquad (1)$$

Where $A(L) = 1 - \alpha_1 L - \alpha_2 L^2 - \ldots - \alpha_P L^P$ and $B(L) = 1 + \beta_1 L^1 + \beta_2 L^2 + \ldots + \beta_q L^q$ are the autoregressive (AR) and the moving average (MA) operators respectively. The α'sand β's are constants such that the model (1) is stationary as well as invertible. L is the backshit operator defined by $L^k X_t = X_{t-k}$ and the symbol ∇ is the model (1) may be described as an autoregressive moving average (ARMA) model of the d^{th} difference $\{\nabla^d X_t\}$ of the time series $\{X_t\}$.Eventually

$$X_t = \frac{B(L)\varepsilon_t}{A(L)\nabla^d} \qquad (2)$$

On the basis of model (1) forecast are obtained for the post-intervention period. Suppose these are F_t, $t \geq T$. Then

$$Z_t = \frac{c(1)(1-c(2)^{(t-T+1)})}{(1-c(2))}, t \geq T \qquad (3)$$

Give the intervention transfer function

Hence the overall intervention model is given by

$$Y_t = \frac{B(L)\varepsilon_t}{A(L)\nabla^d} + \frac{c(1)*(1-c(2)^{t-T+1})I_t}{(1-c(2))} \qquad (4)$$

Where $I_t = 1$, $t > T$ and 1 otherwise.

The estimation of model (1) invariably begins with the determination of the orders p, d and q. The differencing order is the minimum order of the differencing such that the pre-intervention series is stationary. Stationary shall be tested using the Augmented Dickey Fuller (ADF) Test. The AR order p and the MA order q may be estimated by the cut-off lags of the partial autocorrelation function

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(PACF) and the autocorrelation function (ACF), respectively, of $\{\nabla^d X_t\}$. The α's and β's and c(1) and c(2) may be estimated by the least squares technique.

Computer Software

The computer software used is the statistical and econometric package Eviews 10

Results and Discussion

The time plot of the data is given below in figure 1 shows intervention at t=138, that is on 4th August, 2017.

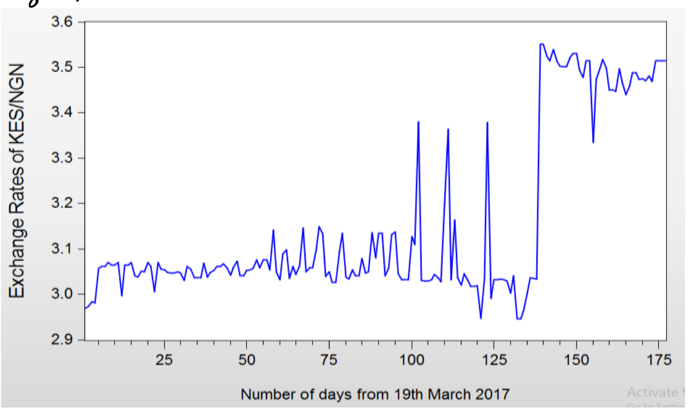

Figure 1: Time Plot of KEN/NGN exchange rate

The pre-intervention series whose time plot appears below in figure 2 shows a stationary time series as seen in the following table 1

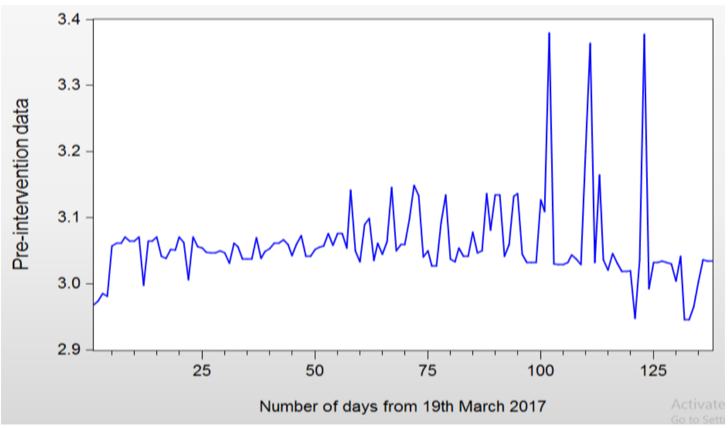

Figure 2: Time plot pre-intervention series

Table 1: Shows the unit root Test for the pre-intervention series

Null Hypothesis: KENN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.572101	0.0000
Test critical values:	1% level	-3.478547	
	5% level	-2.882590	
	10% level	-2.578074	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(KENN)
Method: Least Squares
Date: 05/29/19 Time: 05:05
Sample (adjusted): 2 138
Included observations: 137 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
KENN(-1)	-0.801382	0.083721	-9.572101	0.0000
C	2.452092	0.256174	9.571990	0.0000

R-squared	0.404303	Mean dependent var	0.000480
Adjusted R-squared	0.399890	S.D. dependent var	0.078794
S.E. of regression	0.061039	Akaike info criterion	-2.740103
Sum squared resid	0.502984	Schwarz criterion	-2.697476
Log likelihood	189.6971	Hannan-Quinn criter.	-2.722780
F-statistic	91.62512	Durbin-Watson stat	2.024817
Prob(F-statistic)	0.000000		

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Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.198	0.198	5.5521	0.018
		2	0.063	0.025	6.1244	0.047
		3	0.029	0.012	6.2417	0.100
		4	-0.057	-0.069	6.7083	0.152
		5	-0.020	0.002	6.7691	0.238
		6	0.019	0.029	6.8243	0.337
		7	-0.027	-0.034	6.9285	0.436
		8	0.044	0.052	7.2119	0.514
		9	0.145	0.134	10.382	0.320
		10	0.003	-0.052	10.384	0.407
		11	0.096	0.093	11.790	0.380
		12	0.253	0.235	21.620	0.042
		13	0.059	-0.021	22.152	0.053
		14	-0.023	-0.067	22.232	0.074
		15	-0.002	0.017	22.233	0.102
		16	0.062	0.121	22.833	0.118
		17	0.033	-0.014	23.006	0.149
		18	-0.026	-0.084	23.117	0.186
		19	-0.125	-0.100	25.636	0.141
		20	-0.015	0.013	25.675	0.177
		21	0.181	0.158	31.072	0.072
		22	-0.033	-0.112	31.252	0.091
		23	0.081	0.055	32.353	0.093
		24	-0.074	-0.190	33.279	0.098
		25	-0.089	-0.058	34.620	0.095
		26	-0.080	-0.023	35.714	0.097
		27	-0.061	-0.014	36.370	0.107
		28	0.024	0.027	36.475	0.131
		29	0.085	0.028	37.768	0.128
		30	-0.058	-0.098	38.372	0.140
		31	-0.096	0.003	40.038	0.128
		32	0.023	0.032	40.136	0.153
		33	0.003	-0.041	40.138	0.183
		34	-0.037	-0.020	40.391	0.209
		35	0.062	0.124	41.106	0.221

Figure 3: Correlelogram of the pre-interventions series

Table 2: An ARIMA (12, 12) model for the pre-intervention series

Dependent Variable: KENN
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 05/29/19 Time: 05:14
Sample: 1 138
Included observations: 138
Failure to improve objective (non-zero gradients) after 11 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.863266	0.061873	13.95219	0.0000
AR(12)	0.136724	0.003120	43.82868	0.0000
MA(1)	-0.747971	0.064070	-11.67436	0.0000
MA(12)	0.097840	0.064745	1.511158	0.1331
SIGMASQ	0.003686	0.000220	16.72034	0.0000
R-squared	0.044205	Mean dependent var		3.059053
Adjusted R-squared	0.015459	S.D. dependent var		0.062326
S.E. of regression	0.061842	Akaike info criterion		-2.615807
Sum squared resid	0.508652	Schwarz criterion		-2.509747
Log likelihood	185.4907	Hannan-Quinn criter.		-2.572707
Durbin-Watson stat	1.796847			
Inverted AR Roots	1.00	.83+.37i	.83-.37i	.49+.70i
	.49-.70i	.06+.82i	.06-.82i	-.37+.72i
	-.37-.72i	-.68-.42i	-.68+.42i	-.80
Inverted MA Roots	.90+.19i	.90-.19i	.65+.55i	.65-.55i
	.27+.77i	.27-.77i	-.16+.78i	-.16-.78i
	-.54+.57i	-.54-.57i	-.75-.21i	-.75+.21i

So that the pre-intervention series is modelled by $X_t = 0.8633X_{t-1} + 0.1367X_{t-12} - 0.7480\varepsilon_{t-1} + \varepsilon_t$ on the basis of this model forecast and made for the post-intervention series Z_t which are obtained and modelled on the basis of (4).

Table 3: Intervention transfer function modelling

Dependent Variable: Z
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/30/19 Time: 07:34
Sample: 139 177
Included observations: 39
Convergence achieved after 12 iterations
Coefficient covariance computed using outer product of gradients
Z=C(1)*(1-C(2)^(T-138))/(1-C(2))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.513265	0.048436	10.59687	0.0000
C(2)	-0.101787	0.105021	-0.969200	0.3387
R-squared	0.029872	Mean dependent var		0.466936
Adjusted R-squared	0.003653	S.D. dependent var		0.049513
S.E. of regression	0.049422	Akaike info criterion		-3.126914
Sum squared resid	0.090374	Schwarz criterion		-3.041603
Log likelihood	62.97482	Hannan-Quinn criter.		-3.096305
Durbin-Watson stat	0.956280			

Hence, the intervention model is given by $Y_t = \frac{(1-0.7480B)\varepsilon_t}{1-0.8633-0.1367B^2} + I_t \frac{0.5133+(1-(-0.7018)^{t-138}}{1.1018}$

Where $I_t = 0, < 138, \quad I_t = 1 \geq 139$

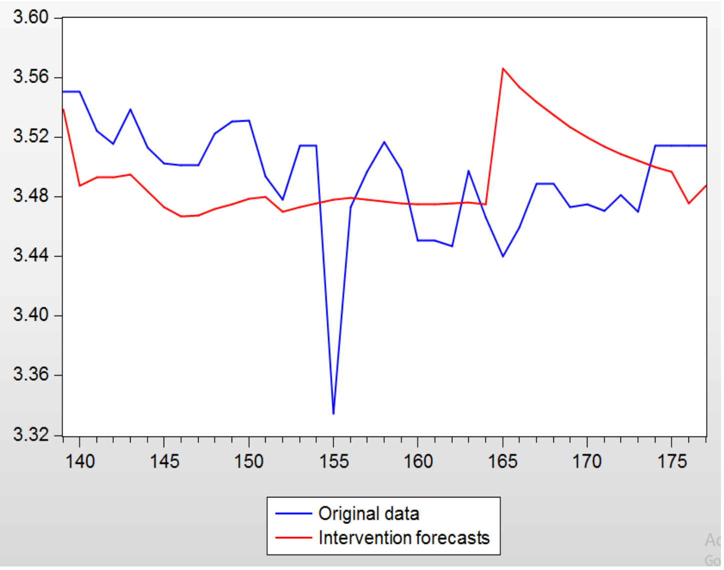

Figure 4: Comparison between the post-intervention data and their intervention forecasts

CONCLUSION

It may be concluded that the daily KEN-NGN exchange rates is an intervention model. This model may be the basis for an intervention by the relatively ailing economy to salvage the economic.

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DATA ON KENYAN
MARCH,2017

1 KES= 2.9687 NGN
2.9731 2.9847 2.9813 3.05763.0614 3.0614
3. 07093.064 3.064 3.07042.9973 3. 0641

APRIL, 2017
3.0641 3.0705 3.0411 3.03793.0518 3.0504
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MAY, 2017
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AUGUST, 2019
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3.4631 3.4398 3.4596

SEPTEMBER, 2017

International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 2, June 2020
http://www.casirmediapublishing.com

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