GSJ: Volume 10, Issue 4, April 2022, Online: ISSN 2320-9186
www.globalscientificjournal.com

Intervention Analysis of Daily Canadian Dollar/Nigerian Naira Exchange Rates

[1]Gbenenee Christian Barikui, [2]Ette Harrison Etuk

[1]Department of Statististics, Rivers State Polytechnic, P.M.B. 20, Bori, Rivers State Nigeria, [2]Department of Mathematics, Rivers State University, Port Harcourt, Nigeria.

Email: gbeneneechristian@gmail.com

ABSTRACT

This research work focused on the exchange rates between a developed country (Canada) and a developing country (Nigeria) from 1st May to 31st October, 2017 using intervention analysis approach by Box and Tiao (1975). The work analyzed the data using Eviews 10 package. A look at the pre-intervention series also revealed an upward movement suggesting that the series is not stationary. The Augmented Dickey Fuller test value (-2.800661) was greater than critical values at 1% and 5% (-3.502238 and -2.892879 respectively) and again, ADF probability value (0.0620) was greater than 0.05, therefore its non stationarity status was established. The series was differenced to achieve stationarity. ADF value showed -11.10760 which is less than the critical values (-3.503049, -2.893230 and -2.583740) and the probability value showed 0.0001 which is now less than 0.05 implying a stationary series adequate for modeling. The correlogram of the stationarized data was plotted and ARMA (4, 1) were suggestive. From the suggested ARMA (4, 1) it was clearly seen that only MA (1) had a significant probability (i.e, probability less than 0.05). On that basis, MA (1) model was fitted with Eviews 10 package and it yielded $\nabla Xt = \varepsilon_t - 0.815930\ \varepsilon_{t-1}$. The model can fit the data reasonably well and good for forecasting purposes given the ARIMA (0, 1, 1) model $\nabla Xt = \varepsilon_t - 0.815930\ \varepsilon_{t-1}$, its adequacy plot, its forecasting and post intervention observation.

Keywords: Intervention, Canadian Dollar, Nigerian Naira, ARIMA Model

INTRODUCTION AND LITERATURE REVIEW

This research work is centered on the intervention of the Canadian Dollar and Nigerian Naira exchange rates. By intervention we mean a change to an existing believe or lay down rules or data set caused by a particular thing. Put in another way an event which happens and change the course of a time series in the process.

Naira (NGN) is the legal tender of Nigeria. It came into existence on 1st January 1973 with an initial value of two naira to the British pound sterling. The daily quantities of NGN per CAD from 1st May 2017 to 31st October, 2017 are the data for this work. It has been observed that the series moved from a value of 250.573 on the 3rd August, 2017 to 291.6517 on August 4th, 2017. This informed the choice of 4th August 2017 as the point of intervention. This sudden change is attributed to the current depression in the economy of Nigeria. The ARIMA/intervention analysis approach of Box and Tiao (1975) will be used in this research.

Box and Tiao (1975) studied the environmental and economical problems using intervention analysis. During their studies, they discussed the influence of interrupted series (also called intervention) on an independent variable in the presence of noise (dependent) structure. Separate equation model were used to denote the likely changeable behavior of both the noise and the interventions. Photochemical smog in Los Angeles and the other city with variances in the consumer price index were what they presented as their final applications.

Chung. *et al.* (1993) proposed a model that involves multiplicative aspect of time series that will control the random death pattern upon a long term nationwide death in U.S.A "before" a velocity range changed (from January 1975 to March 1987). Two year "after" information (from April 1987 to December 1989) was therefore employed in order to discover the likely influence pattern. Their result based on the interrupted series analysis indicated that the speed limit which was increased had significant effect on nationwide death rate.

Yaacob *et al.* (2011) investigated the impact of integrated operations of the road safety commonly called Sikap on accidents occurring on the road of Malaysia using intervention analysis by investigating the interrupted impact as it compares ARIMA model, thus, to get the optimum model for prediction purposes. The findings revealed that there existed chop in the number of mortality that occurred on the road all through OPS Sikap II, VI, VIII, XII and XIV but the meaningful decrease was seen after OPS Sikap VII and XIV were enforced with about 1,227 and 1,484 decreases in accidents which is in line with the respective interventions.

Etuk and Nkombou (2014) modeled monthly exchange rates of XAF – Central African Franc and the US dollar (USD) by SARIMA techniques. The realization from January 1997 to march 2013 referred to as XDER in their work was analyzed. The time plot of XDER showed an overall upward secular trend with no obvious regular seasonal component. As expected, XDER was shown non stationary. 12-monthly seasonal differencing upon XDER yielded SDXDER which showed an overall horizontal trend, yet with no definite seasonal movement. When tested, the ADF test certified SDXDER as stationary. Its correlogram suggested an ARMA (1,5) model fit. A non seasonal differencing of XDXDER yielded the series DSDXDER which exhibited an overall horizontal trend. No seasonal components were discernible from the visual inspection of its time plot. However, its correlogram had a significant spike although negative at lag 12, comparable peak at lags 11 and 13, an indication of a 12 month seasonal moving average components of order one. They proposed and fitted two SARIMA models $(1, 0, 5) \times (0, 1, 0)_{12}$ and $(0, 1, 1) \times (0, 1, 1)_{12}$ and they concluded that SARIMA $(0, 1, 1) \times (0, 1, 1)_{12}$ was more adequate.

MATERIALS AND METHOD

Data:

This work is purely restricted to analysis of daily CAD/NGN exchange rates from 1^{st} May 2017 to 31^{st} October, 2017.

The data is extracted from www.exchangerates.org.uk/CHFNGN- exchange rate=history.html accessed 28^{th} September, 2019.

The ARIMA Model and Intervention Analysis

The intervention analysis developed by Box-Tiao in 1975 has been very powerful in studying intervention cases. Here the work will outline few assumptions of intervention analysis that will guide us in our subsequent analysis in chapter four.

The general intervention model combined with ARIMA becomes;

$$Xt - \mu = zt + \Theta(B)\ \Phi(B)wt \qquad (3.11)$$

Let's assume that the model for the ARIMA for X_t series when intervention is not involved.

$$X_t - \mu = \Theta(B)\ \Phi(B)wt \qquad (3.12)$$

If $Z_t = 0$ or $Z_t \neq 0$ after time T_t,

where,

T_t is the time of the intervention,

Computer Software

The work analyzed the data using Eviews 10 package.

RESULT AND DISCUSSION

The plot of their exchange rates data from 1st May to 31st October 2017 of a developed country (Canada) and a developing country (Nigeria) showed an upward movement was seen in Fig. 4.1 until around 4th August, 2017 when there was an intervention (recession), i.e, the series increased to 291.6517. In Fig. 4.2, non stationarity of the data was also backed up by the presence of the upward movement of the pre-intervention series. The test of stationarity for daily Canadian Dollar and Nigerian Naira exchange rates as presented in Table 4.1 was done using Augmented Dickey Fuller test and the fact that the series was not stationary was established.

The Augmented Dickey Fuller test value as seen on the table was -2.739529 and the probability was 0.0699 and the probability value needs to be less than 0.05. The non stationary status of the series was verified. After the 1st difference (which is given by $X_t - X_{t-1}$ which, if backshift operator is introduced will thus be ∇X_t or $(1-B)\ X_t$) the series was made stationary. Table 4.2, shows unit root test of the differenced series. ADF value showed -11.10760 which is less than all the critical values; 1% is -3.503049, 5% which is -2.893230 and 10% which is -2.583740 and its probability is 0.0001 which is also less than 0.05, thus the series is now stationary. The correlogram was plotted as shown in Fig. 4.5. This correlogram is made up of the ACF and PACF plot which usually act as a guide to choosing the model to be fitted in every analysis that aims at building or developing a model as in this study. ARMA (4, 1) was fitted as a guess as presented in Table 4.3 and only MA (1) was seen as being significant since only its probability value was seen being less than 0.05. On that basis MA (1) was concluded as being the best to modeling CAD/NGN exchange rates.

In Table 4.4, Eviews 10 package presented the output of MA (1) fitted model of daily pre-intervention CAD/NGN exchange rates. MA (1) model is given by;

$\nabla X_t = \varepsilon_t - 0.815930\ \varepsilon_{t-1}$.The negative value signifies that there would be a decrease in the high value of the exchange rate.

Table 4.5 presents the output of the transfer function of the Canadian dollar and Nigerian Naira exchange rates computed with Eviews 10 package. The transfer function values are given thus;

$$P_t = \frac{34.94487\,[1-(0.001190)^{t-95}]}{0.99881}, \quad t > 95.$$

The forecasting was on the basis of the model being adequate, done. Fig.4.6 shows the intervention forecast and the post intervention observations plotted together. From the graph, it could be seen that the actual observation is not far from the forecast. The researcher has accordingly suggested/recommended ways forward to Nigerian government in order to come out of recession.

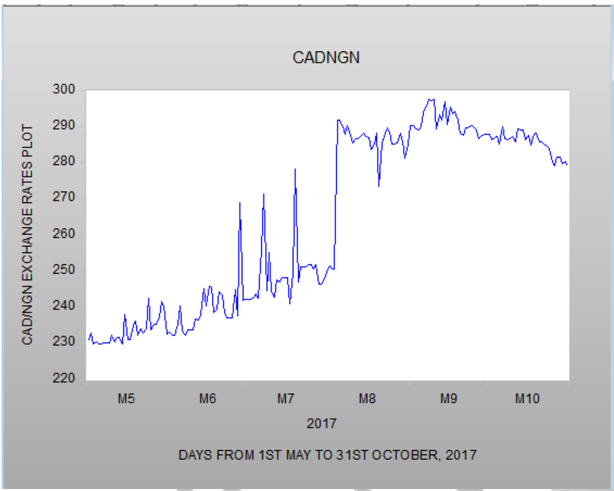


Fig. 4.1: Time plot of CAD/NGN exchange rates from 1st May to 31st October, 2017

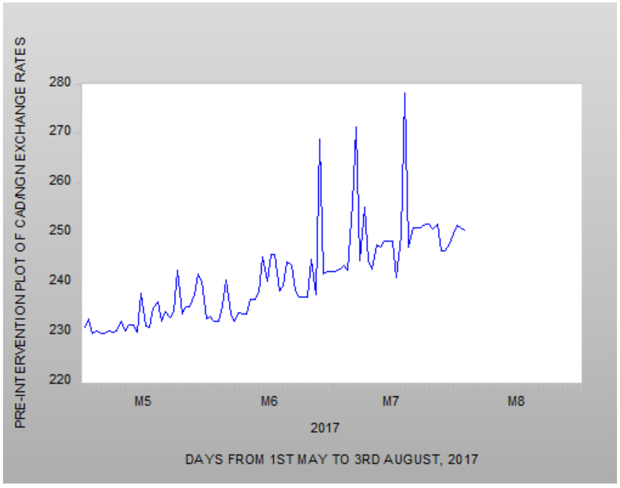


Fig 4.2: Pre-intervention Plot of Daily CAD/NGN Exchange Rates

Table 4.1: ADF test for daily pre-intervention CAD/NGN exchange rates.

Null Hypothesis: CADNGN has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.800661	0.0620
Test critical values:	1% level	-3.502238	
	5% level	-2.892879	
	10% level	-2.583553	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CADNGN)
Method: Least Squares
Date: 01/28/20 Time: 05:57
Sample (adjusted): 5/03/2017 8/03/2017
Included observations: 93 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CADNGN(-1)	-0.238545	0.085175	-2.800661	0.0062
D(CADNGN(-1))	-0.358427	0.098473	-3.639851	0.0005
C	57.74641	20.52639	2.813277	0.0060

R-squared	0.290119	Mean dependent var	0.191999
Adjusted R-squared	0.274344	S.D. dependent var	8.017931
S.E. of regression	6.830108	Akaike info criterion	6.712284
Sum squared resid	4198.534	Schwarz criterion	6.793981
Log likelihood	-309.1212	Hannan-Quinn criter.	6.745271
F-statistic	18.39095	Durbin-Watson stat	2.170320
Prob(F-statistic)	0.000000		

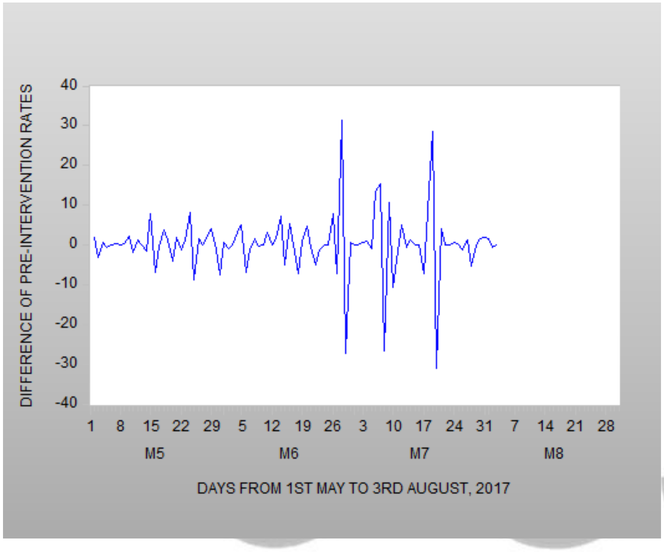


Fig 4.3: Difference of Pre-intervention Series of daily CAD/NGN Exchange Rates

Table 4.2; Unit Root Test for difference of the Pre-intervention Series of CAD/NGN Exchange Rates

Null Hypothesis: DCADNGN has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

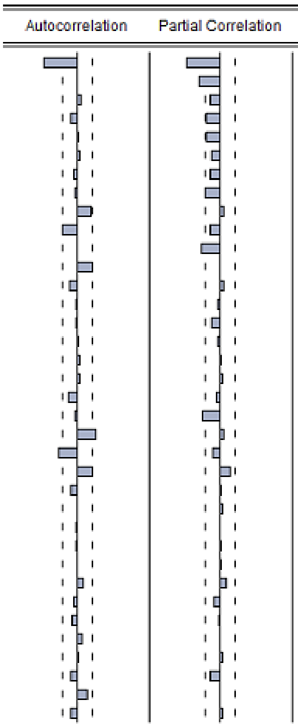
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.10760	0.0001
Test critical values:	1% level	-3.503049	
	5% level	-2.893230	
	10% level	-2.583740	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DCADNGN)
Method: Least Squares
Date: 01/28/20 Time: 06:39
Sample (adjusted): 5/04/2017 8/03/2017
Included observations: 92 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DCADNGN(-1)	-1.926778	0.173465	-11.10760	0.0000
D(DCADNGN(-1))	0.304326	0.100891	3.016373	0.0033
C	0.415616	0.711619	0.584043	0.5607

R-squared	0.763148	Mean dependent var	0.031574
Adjusted R-squared	0.757826	S.D. dependent var	13.85204
S.E. of regression	6.816753	Akaike info criterion	6.708709
Sum squared resid	4135.663	Schwarz criterion	6.790941
Log likelihood	-305.6006	Hannan-Quinn criter.	6.741898
F-statistic	143.3814	Durbin-Watson stat	2.093515
Prob(F-statistic)	0.000000		



Lag	AC	PAC	Q-Stat	Prob
1	-0.478	-0.478	22.138	0.000
2	-0.007	-0.305	22.143	0.000
3	0.043	-0.152	22.328	0.000
4	-0.093	-0.203	23.187	0.000
5	0.013	-0.198	23.205	0.000
6	0.041	-0.126	23.375	0.001
7	-0.049	-0.153	23.627	0.001
8	-0.027	-0.224	23.703	0.003
9	0.192	0.051	27.607	0.001
10	-0.224	-0.145	33.017	0.000
11	0.003	-0.278	33.018	0.001
12	0.209	-0.006	37.824	0.000
13	-0.107	0.046	39.111	0.000
14	-0.023	-0.043	39.171	0.000
15	-0.015	-0.130	39.198	0.001
16	0.019	-0.038	39.240	0.001
17	0.026	0.023	39.322	0.002
18	0.027	0.026	39.408	0.003
19	-0.117	-0.056	41.053	0.002
20	-0.041	-0.247	41.262	0.003
21	0.273	0.054	50.482	0.000
22	-0.272	-0.099	59.761	0.000
23	0.214	0.139	65.585	0.000
24	-0.094	0.021	66.727	0.000
25	0.004	0.031	66.729	0.000
26	-0.023	0.002	66.798	0.000
27	-0.021	0.019	66.855	0.000
28	-0.001	0.020	66.855	0.000
29	0.084	0.085	67.844	0.000
30	-0.054	-0.082	68.250	0.000
31	-0.067	-0.019	68.887	0.000
32	0.077	0.000	69.753	0.000
33	0.020	0.031	69.813	0.000
34	-0.096	-0.144	71.191	0.000
35	0.139	0.001	74.163	0.000
36	-0.083	0.025	75.228	0.000

Fig. 4.4: Correlogram of Differenced CAD/NGN Exchange Rates

Table 4.3: Fitted values of ARMA (4, 1)

Dependent Variable: DCADNGN
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 01/30/20 Time: 05:30
Sample: 5/02/2017 8/03/2017
Included observations: 94
Convergence achieved after 41 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-0.001059	0.329508	-0.003214	0.9974
AR(2)	-0.020371	0.273571	-0.074464	0.9408
AR(3)	-0.027242	0.277190	-0.098281	0.9219
AR(4)	-0.124842	0.281905	-0.442852	0.6590
MA(1)	-0.787494	0.301341	-2.613301	0.0105
SIGMASQ	37.98756	2.423609	15.67396	0.0000

R-squared	0.396502	Mean dependent var	0.208797
Adjusted R-squared	0.362212	S.D. dependent var	7.976370
S.E. of regression	6.370057	Akaike info criterion	6.615327
Sum squared resid	3570.831	Schwarz criterion	6.777665
Log likelihood	-304.9204	Hannan-Quinn criter.	6.680900
Durbin-Watson stat	2.028650		

Inverted AR Roots	.41+.45i	.41-.45i	-.41-.41i	-.41+.41i
Inverted MA Roots	.79			

Table 4.4: The Eviews 10 output of Fitted MA (1) Model

Dependent Variable: DCADNGN
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 01/30/20 Time: 05:38
Sample: 5/02/2017 8/03/2017
Included observations: 94
Convergence achieved after 19 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MA(1)	-0.815930	0.067811	-12.03248	0.0000
SIGMASQ	38.58772	2.183431	17.67297	0.0000

R-squared	0.386967	Mean dependent var	0.208797
Adjusted R-squared	0.380304	S.D. dependent var	7.976370
S.E. of regression	6.279060	Akaike info criterion	6.545022
Sum squared resid	3627.246	Schwarz criterion	6.599135
Log likelihood	-305.6161	Hannan-Quinn criter.	6.566880
Durbin-Watson stat	1.958232		

Inverted MA Roots	.82

Lag	AC	PAC	Q-Stat	Prob
1	-0.011	-0.011	0.0118	
2	-0.038	-0.038	0.1503	0.698
3	-0.051	-0.052	0.4084	0.815
4	-0.156	-0.160	2.8582	0.414
5	-0.077	-0.089	3.4644	0.483
6	-0.029	-0.052	3.5529	0.615
7	-0.067	-0.098	4.0176	0.674
8	-0.005	-0.053	4.0199	0.777
9	0.114	0.073	5.3926	0.715
10	-0.160	-0.197	8.1386	0.520
11	0.024	-0.018	8.1993	0.609
12	0.202	0.187	12.702	0.313
13	-0.042	-0.044	12.902	0.376
14	-0.064	-0.112	13.358	0.421
15	-0.044	-0.042	13.574	0.482
16	0.010	0.069	13.587	0.557
17	0.024	0.001	13.652	0.625
18	-0.018	-0.064	13.689	0.689
19	-0.116	-0.088	15.308	0.641
20	0.023	-0.014	15.371	0.699
21	0.247	0.230	22.912	0.293
22	-0.081	-0.033	23.740	0.306
23	0.152	0.139	26.688	0.223
24	-0.054	-0.101	27.070	0.253
25	-0.069	-0.011	27.686	0.273
26	-0.092	-0.030	28.817	0.272
27	-0.073	-0.005	29.536	0.287
28	-0.008	-0.020	29.544	0.335
29	0.055	-0.028	29.968	0.365
30	-0.059	-0.121	30.455	0.392
31	-0.064	0.036	31.048	0.413
32	0.064	-0.018	31.648	0.434
33	0.036	-0.040	31.839	0.475
34	-0.030	-0.088	31.978	0.518
35	0.102	0.098	33.566	0.489
36	-0.053	-0.030	33.998	0.516

Fig. 4.5: The Correlogram of the Residuals of the Pre-intervention MA (1) Model

Table 4.5: The Transfer Function of the CAD/NGN Exchange Rates

Dependent Variable: Z
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 01/30/20 Time: 07:58
Sample (adjusted): 8/04/2017 10/31/2017
Included observations: 89 after adjustments
Convergence achieved after 25 iterations
Coefficient covariance computed using outer product of gradients
Z = (C(1)*(1-C(2))^(T-95))/(1-C(2))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	34.94487	0.920486	37.96352	0.0000
C(2)	0.001190	0.000450	2.646721	0.0096

R-squared	0.078103	Mean dependent var	37.14982
Adjusted R-squared	0.067506	S.D. dependent var	4.195712
S.E. of regression	4.051620	Akaike info criterion	5.658326
Sum squared resid	1428.159	Schwarz criterion	5.714251
Log likelihood	-249.7955	Hannan-Quinn criter.	5.680868
Durbin-Watson stat	0.593944		

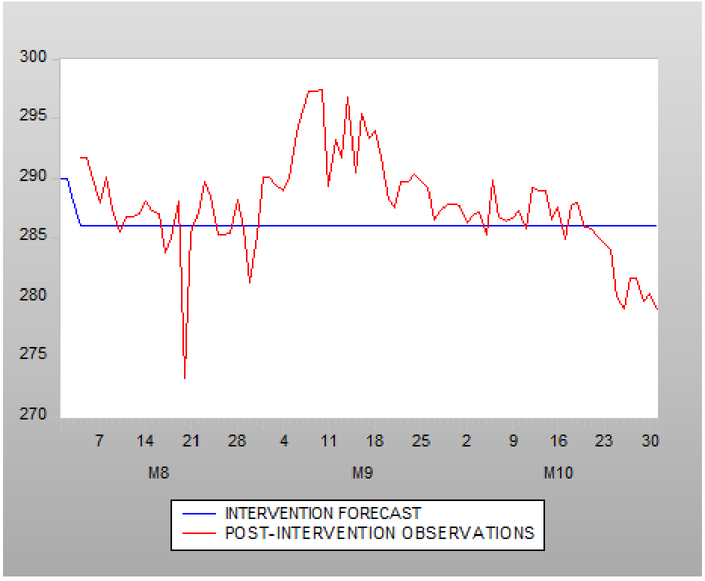


Fig. 4.6: Post-intervention data and the forecasts of CAD/NGN exchange rates

The Functional form of the Model is given as:

$CADNGN_t(1\text{-}L) \; = DCADNGN_t = -0.81593\varepsilon_{t-1} + \varepsilon_t$

$$CADNGN_t = \frac{(1-0.81593L)\varepsilon t}{1-L}$$

This is the random part of the intervention.

∴ The intervention model is

$$Y_t \; = \frac{(1-0.81593L)\varepsilon t}{1-L} + I_t * \frac{34.94487[1-(0.001190)t-95]}{0.99881}$$

Where L is the back shift operator and (ε_t) is the white noise and It = 0 if $t \leq 95$

=1 if t>95

CONCLUSION

Given the ARIMA (0, 1, 1) model **∇Xt** $= \varepsilon_t - 0.815930\ \varepsilon_{t-1}$, its adequacy plot, its forecasting and post intervention observation. The model can be concluded to fit the data reasonably well and good for forecasting purposes.

We recommendations that Nigerian government should develop more business relationship with developed country like USA or Canada just as Canada did, government should utilize her natural resources like Canada and actively participate in international trade, they should crave for peace, order and less corrupt government as these are part of founding principles of Canadian government.

REFERENCES

Abdalla, E. H. (2006). Measuring the Impact of a New Policy on Industry in Gaza. *An-Najah, Universal Journal Resources*, 2(2),70-90.

Akinlo, A. and Yunusa, D. (2007); Exchange Rate Versus Capital Accounts Liberalization in Nigeria; some important issues.*CBN Economic and Financial Review*. 45(4), 69-89.

Box, G. E. P and Tiao, G. C. (1975). Intervention Analysis with Applications to Economic and Environmental Problems. *Journal of the American Statistical Association,* 7(34), 70-79.

Chung, C. P., Roy. Ip, W. H and Chan, S. L. (1993). Intervention analysis for the impacts of the MPH speed limit on Rural intersects highway fatalities. *Journal of Safety Research,* 241, 33-53.

Chung, C. P. R., Ip, W.H and Chan, S. L. (2009). An ARIMA Intervention Analysis Model for The Financial Crisis in China's Manufacturing Industry. *International Journal of Engineering Business Management*, 1, 15-18.

Etuk, E. H (2017). Statistics the most used and the most abused subject. *Inaugural Lecture Pamphlet of Rivers State University, 48 series.* 11th October, 2017.

Etuk, E. H and Eleki, A.G (2016). Intervention analysis of Daily Yuang – Naira Exchange Rates. *CARD international Journal Of Science And Advanced Innovative Research (IJSAIR).* ISSN:2536-7315(print) 2536-7323(online) vol.1, Number 3, December 2016.http://www.casirmediapublishing.com

Etuk, E.H. and Igbudu, R. C. (2013). A Sarima Fit To Monthly Nigerian Naira –British Pound Exchange Rates. *Journal of Computations and Modeling.* 2(1), 133-144.

Etuk, E.H. and Nkombou, C. (2014). Monthly XAF-USD Exchange Rates Modeling By SARIMA Techniques*: Euro-Asian Journal Of Economics And Finance*. ISSN: 2310-0184(Print) ISSN:2310-4929(Online). Volume 2, Issue 1(January 2014) Pages 1-12©Academy Of Business And Scientific Research.

Exchange Rates UK (2017). www.exchangerates.org.uk/CAD-NGN-exchange-rate-history. html-accessed January, 2020.