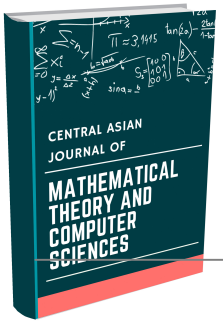

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INTERVENTION MODELLING OF THE EFFECT OF EXCHANGE RATE ON ECONOMIC RECESSION IN NIGERIA

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ABSTRACT

The paper sought to investigate the effect of the bureau de change (United State Dollar, USD) and Nigeria naira (NGN) exchange rate on economic recession using intervention analysis from June 2017 to March 2021. The data was taken from the website of the central bank of Nigeria (cbn.org). The study adopted augmented dickey fuller test for checking the stationarity. The pre-intervention data spectacles a negative slope and it was non-stationary but after the first difference occurred it became stationary.

The point of intervention is spotted at T=12 which was March 2020 from quarterly point of view. The pre-intervention plot indicates that there was an initial negative trend and later an upshot to positive trend which did not favour the Naira. The ACF and the PACF of the differenced exchange rate data indicated a white noise pattern which that the Correlogram of the 2020 pre intervention series of the difference of exchange rate is the autocorrelation structure of white noise (United State Dollar (USD) and Nigeria Naira (NGN) are independent and identically distributed within the zero mean but the same variance where each value has a zero correlation with all other values in the Differenced data). The correlogram also shows that an AR (1) model is be fit. The difference between the forecast and the post-intervention series was modeled after the intervention transfer function and was seen to be statistically significant which indicates model adequacy.

The comparison of the intervention forecasts and the post intervention data showed a close agreement between the curves is a testimony to the correctness on the intervention model thereby making the model fit to be used to help strengthen the Nigerian Naira. Hence, there is need for the government to apply appropriate monetary policy to stabilized the exchange rate thereby bring the economic back to its feet.

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Introduction

The Nigerian Naira has dropped significantly compared to other countries currency at the foreign exchange market thereby affecting the standard of living negatively. Recent research works has showed that the collapse in the value of the Nigerian naira has resulted to an increase in the pricing of products and services. In the case of the Naira (N), this is quite evident, with the value of the Naira being N1 to $1 (one US Dollar) in 1981, an average of N100 to $1 in the year 2000 (Okeke, 2000), over N128 to $1 in 2003, N118.29 to $1 in 2007, N150.48 to $1 in 2010, N196.99 to $1 in 2015, N305.22 to $1 in 2016, N381 to $1 in 2020, and currently 410.47 to $1. (BBC NEWS, 2021). After plunging to a new low of N570/$ on the parallel market,

the naira is entering one of the most difficult periods in its more than five-decade existence. A dark image of an uncertain future is painted by this situation, and immediate action is required to correct it (Nweze, 2021).

However, this decrease in the value of the Naira coincides with a time of inflationary increase in Nigeria, and it is an unwelcome phenomenon that has resulted in a significant reduction in the living standards of the typical Nigerian citizen. The government has been concerned about the dynamic character of the exchange rate in an economy for decades, and it has taken steps to intervene in order to stabilize the rate. More importantly, the development of currency rate stability is one of the most significant difficulties that underdeveloped and growing countries such as Nigeria are confronted with (Emenike, 2016). The exchange rate can be defined as the fewest number of units of one nation's currency that must be exchanged for one unit of another country's currency. Mathematical representation of one currency in terms of another may also be referred to as a currency exchange rate. According to the findings of (Anyanwu, Anawude & Okoye, 2017). As a consequence, exchange rate fluctuations have a huge influence on the whole economy, impacting growth, stability, and advancement in the economy. The exchange rate crisis in Nigeria had triggered recession

Omolua and Adeyemo (2021) define a recession as a widespread decline in economic activity around its long-term growth trend that lasts for at least two consecutive quarters. A country's GDP is reduced in the event of economic recession, according to Etuk (2017), who defines economic recession as a slowdown in economic activity (GDP). An economic recession occurs after two consecutive quarters of negative growth and is characterised by the following: low output and investment, abnormal increases in unemployment due to massive retrenchment, decreases in the availability of credit facilities, fluctuations on the forex market, liquidity issues, downsizing and layoffs, and a decrease in the amount of trillions in the economy. A recession is based on the failure of macroeconomic indices such as GDP, labour force participation, investment expenditure, capacity utilisation, household income, company income, aggregate demand, and aggregate supply, as well as a rise in unemployment and inflation. During a recession, many people lose their jobs, businesses fail, the stock market plummets, and decreases in the value of Nigerian naira.

Statement of the Problem

Recent events in Nigeria naira have experienced the greatest depreciation of its currency in the country's history, as the Naira has fallen slightly against the United States dollar on the parallel market (Yusuf et, al., 2019). Recent research works have shown that the worldwide reduction in oil prices has resulted in a similar decline in the exchange rate, which has resulted in the loss of global oil reserves. Nigeria, which is heavily reliant on the money from crude oil sales, has seen a fall in its foreign currency receipts and is now struggling to fulfil the demand of its congested, import-dependent population, as a result of this loss. As a result of the continued depreciation of the official exchange rate, it is possible that the country will transit to a mix of several currency exchange rates. Because of increased demand for U.S. dollars, the naira has been under pressure as a result of foreign investors pulling out of the nation in the aftermath of the global health crisis, which has pushed oil prices plunging as a result. Consequently, the perpetual deterioration of the exchange rate has increased our debt burden, depleted our foreign exchange reserves, suppressed local production, suffocated the various government attempts to grow the industrial sector, and created an unreasonably high cost of living (Anyanwu, Anawude & Okoye, 2017), resulting in the economic contraction of Nigerian economy. It is based on this fact, that the study sought to investigate the effect of exchange rate on recession: A case study of intervention analysis of BDC(USD) and NGN.

Review of Related Literatures

Recent research by Maurya (2017) explores the influence of several economic factors on the Rupee-U.S. Dollar exchange rate. The impact of exchange rate fluctuations on GDP is also investigated using a distinct model. Money supply, short run yield differentials, the Canadian dollar, and inflation differential are not statistically significant exchange rate factors, according to the results. The regression model's R-square (fitness) is 86.5 percent. In addition, the influence of exchange rate on economic growth is analysed using GD mp as the indicator of economic growth. This is because the exchange rate has a favourable effect on import and export, which prevents a significant growth in GDP. Only if the rupee depreciation leads to a rise

in exports and a decline in imports will the GDP expand by a significant amount. However, as a result of the link between imports and currency rates, the net export value has declined (but positive).

Jakob (2015) examined the relationship between exchange rate and economic development. Inflation rate, gross capital creation (percentage of GDP), index of government expenditure, and index of human capital per person were used as the control variables in this analysis of 74 countries for the year 2012, which was collected from the World Bank database. The results suggest a favourable and statistically significant association between fixed exchange rate and GDP growth.

Umaru, Niyibu, and Davies (2018) investigated the impact of exchange rate volatility on the economic development of English-speaking West African nations. This study's macroeconomic data were gathered from the World Bank Data Stream between 1980 and 2017 and analysed using panel data regression analysis in Stata 14. The obtained results indicated that the independent variable (real exchange rate) is statistically significant and negatively related to the dependent variable (GDP) in English-speaking West African nations, excluding variables that are not affected by time.

Schmidhuber and Qiao (2020) investigate the difficulties of the Great Lockdown and Great Recession. According to the research, there are a number of similarities and distinctions between the approaching Great Lockdown of 2020 and the Great Recession of 2009. According to the analysis, there are notable similarities between these two crises in terms of economic activity decreases and subsequent increases in unemployment. High- and middle-income nations were hit the hardest by the Great Recession of 2009, although many low-income nations had negligible, if any, drops in GDP growth during the same period. Due to the present economic crisis, these results are in sharp contrast to what was anticipated. While the Great Lockdown will have a greater effect on the GDP of high-income countries (-6.1% in 2020) than on the GDP of low-income countries (-1% in 2020), the latest World Economic Outlook (April 2020) from the International Monetary Fund indicates that no country or group of countries will be exempt from the crisis's effects.

Etuk (2016) examined the British pound, GBP, and U.S. dollar utilising intervention analysis data from March 17 to September 12, 2016. The intervention point is June 23, 2016, after which the relative value of the GBP saw a substantial and statistically significant decline. The pre-intervention series was modelled using ARIMA (1, 1, 0).

Etuk and Eleki (2016) investigated the daily Yuan-Naira exchange rate from 1 May 2016 to 28 October 2016 using an intervention model. In this research, the pre-intervention data had a negative slope and was non-stationary prior to the first difference, when it became stationary. The findings demonstrate that the autocorrelation structure of an MA (2) is revealed by the pre-intervention data difference. The intervention transfer function was estimated using the difference between the model's predictions and the post-intervention observations. The analysis also demonstrates that this function's coefficients are statistically significant and that the intervention predictions closely match the relevant observations, indicating that the intervention impact is statistically significant.

Chung and Chan (2009) used data gathered by the China Statistical Databases of the National Bureau of Statistics of China from March 2005 to November 2008 to examine the effect of the financial crisis on the manufacturing sector in China using an ARIMA-intervention. The conclusion suggests that China's manufacturing sector may have to endure considerable negative effects of the global financial crisis over a period of time, with its gross industrial production value falling until equilibrium is reached.

Various macroeconomic variables, including industrial output and trade, capital flows, oil consumption, the employment rate, and per capita investment and consumption, are all influenced by the effect of the policy variable on economic recession (Mshelia, 2020). According to the conclusions of the research, the recession has had a negative influence on the country's GDP, exchange rate fluctuations, economic growth, and employment-related goals.

Methodology

Intervention analysis has come to stay since; it is application in many areas of studies. Intervention is all about the estimation of the effect of an external or exogenous intervention on a time-series. It focusses on the time series in which we know the specific point in the series at which an intervention occurred. A time series intervention analysis can be defined as a valuable tool for measuring the impact of some policy change or other intervention on the trend of some variable we are interested in. A unique event is evaluated using intervention analysis, according to Mosugu and Anieting (2016), and the time series of interest is the time series under consideration.

Adopting Box and Jenkins, the general form of intervention model is

$$Y_t = \sum_{j}^{m} V_j(D) X_{j,t-b} + N_t \qquad 1$$

where

$$V_j(D) = v_{j0}0 + v_{j1}D + v_{j2}D^2 + v_{j3}D^3 + \ldots + v_{jK}D^k \qquad 2$$

a situation where exchange is made of and j =1,...,m are transfer functions that relate exogenous input variables X_j to the output series Y_t and bj is a pure delay in parameter indicating the number of periods before a change in $X_{j,t}$ begins to affect Yt.

This process can be represented by ratios of moving average and autoregressive polynomials in the backshift operator, u_j (D) and $\boldsymbol{\sigma}_j$(D),

$$V_j(D) = \frac{u_{j0} + u_{j1}D + u_{j2}D^2 + u_{j3}D^3 + \ldots + u_pD^p}{1 - \sigma_{j1}D - \sigma_{j2}D^2 - \sigma_{j3}D^3 - \ldots - \sigma_{jq}D^q} = \frac{u_j(D)}{\sigma_j(D)} \qquad 3$$

for j = 1, ..., m

The noise process N_t can be modelled as

$$N_t = \frac{\theta(D)}{\phi(D)} w_t \qquad 4$$

where $\theta(D)$ is the MA polynomial, $\emptyset(D)$ is the AR polynomial, D is the backshift operator and w_t is a white noise process. The transfer function model with noise (1) can written as;

$$Y_t = \sum_{j=i}^{m} \frac{u_j(D)}{\sigma_j(D)} X_{j,t-b} + \frac{\theta(D)}{\phi(D)} w_t \qquad 5$$

The normal process involves differencing the output and input series to ensure stationarity. The overall intervention model is;

$$Y_t = \frac{\theta_j(D) w_t}{(1-D)^d \phi(D)} TZ_{t-b} \qquad 6$$

where d is differencing

Results

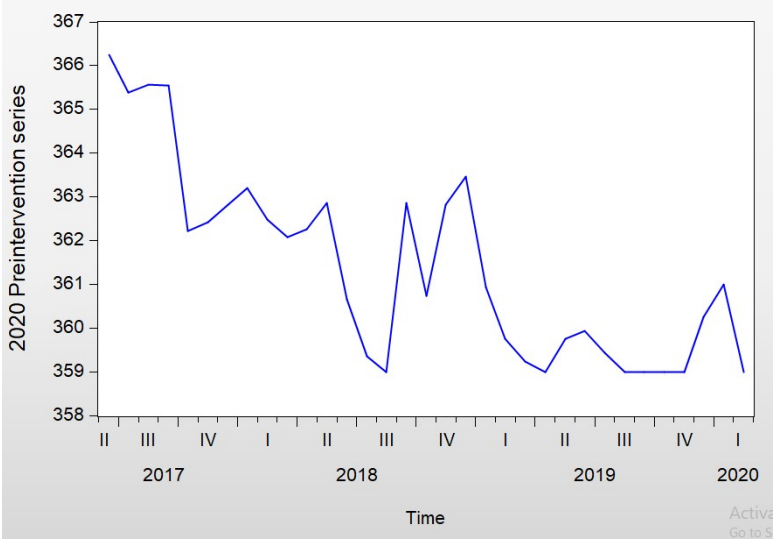


Figure 1: Time plot of the 2020 pre-intervention exchange rates

Table 1: Unit root test for the 2020 preintervention series

Null Hypothesis: BDCS has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=8)

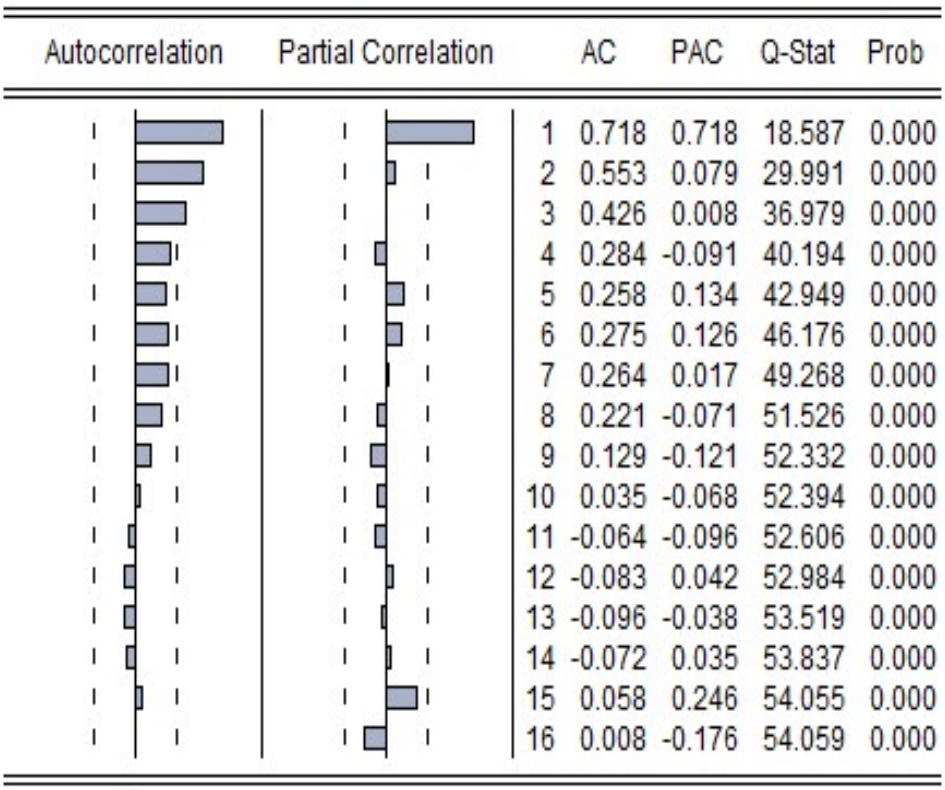
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.009854	0.0040
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BDCS)
Method: Least Squares
Date: 05/12/21 Time: 12:03
Sample: 2017M06 2020M02
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BDCS(-1)	-0.530661	0.132339	-4.009854	0.0005
D(BDCS(-1))	-0.053377	0.153310	-0.348168	0.7305
D(BDCS(-2))	0.104003	0.071862	1.447269	0.1598
D(BDCS(-3))	-0.008288	0.061328	-0.135145	0.8935
D(BDCS(-4))	-0.021659	0.037110	-0.583655	0.5645
D(BDCS(-5))	-0.060804	0.024123	-2.520537	0.0182
C	191.2865	47.76987	4.004334	0.0005

R-squared	0.878955	Mean dependent var	-0.772121
Adjusted R-squared	0.851021	S.D. dependent var	3.409919
S.E. of regression	1.316152	Akaike info criterion	3.573133
Sum squared resid	45.03864	Schwarz criterion	3.890574
Log likelihood	-51.95669	Hannan-Quinn criter.	3.679942
F-statistic	31.46600	Durbin-Watson stat	1.649971
Prob(F-statistic)	0.000000		



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.718	0.718	18.587	0.000
		2	0.553	0.079	29.991	0.000
		3	0.426	0.008	36.979	0.000
		4	0.284	-0.091	40.194	0.000
		5	0.258	0.134	42.949	0.000
		6	0.275	0.126	46.176	0.000
		7	0.264	0.017	49.268	0.000
		8	0.221	-0.071	51.526	0.000
		9	0.129	-0.121	52.332	0.000
		10	0.035	-0.068	52.394	0.000
		11	-0.064	-0.096	52.606	0.000
		12	-0.083	0.042	52.984	0.000
		13	-0.096	-0.038	53.519	0.000
		14	-0.072	0.035	53.837	0.000
		15	0.058	0.246	54.055	0.000
		16	0.008	-0.176	54.059	0.000

Figure 2: Correlogram of the 2020 preintervention series

Table 2: Estimation of the AR (1) model of the series

Dependent Variable: BDCS
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 05/12/21 Time: 12:07
Sample: 2017M06 2020M02
Included observations: 33
Convergence achieved after 28 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.999998	0.000129	7737.872	0.0000
MA(1)	-0.227290	0.187825	-1.210112	0.2364
MA(2)	-0.180760	0.161606	-1.118523	0.2728
MA(3)	-0.034195	0.166486	-0.205393	0.8388
SIGMASQ	1.711872	0.443178	3.862719	0.0006

R-squared	0.640284	Mean dependent var	361.4021
Adjusted R-squared	0.588896	S.D. dependent var	2.215326
S.E. of regression	1.420410	Akaike info criterion	4.024291
Sum squared resid	56.49177	Schwarz criterion	4.251034
Log likelihood	-61.40080	Hannan-Quinn criter.	4.100583
Durbin-Watson stat	1.963284		

Inverted AR Roots	1.00		
Inverted MA Roots	.61	-.19+.14i	-.19-.14i

Table 3: Computation of the intervention transfer function

Dependent Variable: Z
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 05/12/21 Time: 12:19
Sample: 2020M03 2021M03
Included observations: 13
Convergence achieved after 17 iterations
Coefficient covariance computed using outer product of gradients
Z=C(1)*(1-C(2)^(T-98))/(1-C(2))

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	35.08835	3.212006	10.92412	0.0000
C(2)	0.701524	0.035322	19.86061	0.0000

R-squared	0.913606	Mean dependent var	95.92538
Adjusted R-squared	0.905752	S.D. dependent var	28.82959
S.E. of regression	8.850635	Akaike info criterion	7.339494
Sum squared resid	861.6712	Schwarz criterion	7.426409
Log likelihood	-45.70671	Hannan-Quinn criter.	7.321629
Durbin-Watson stat	1.490098		

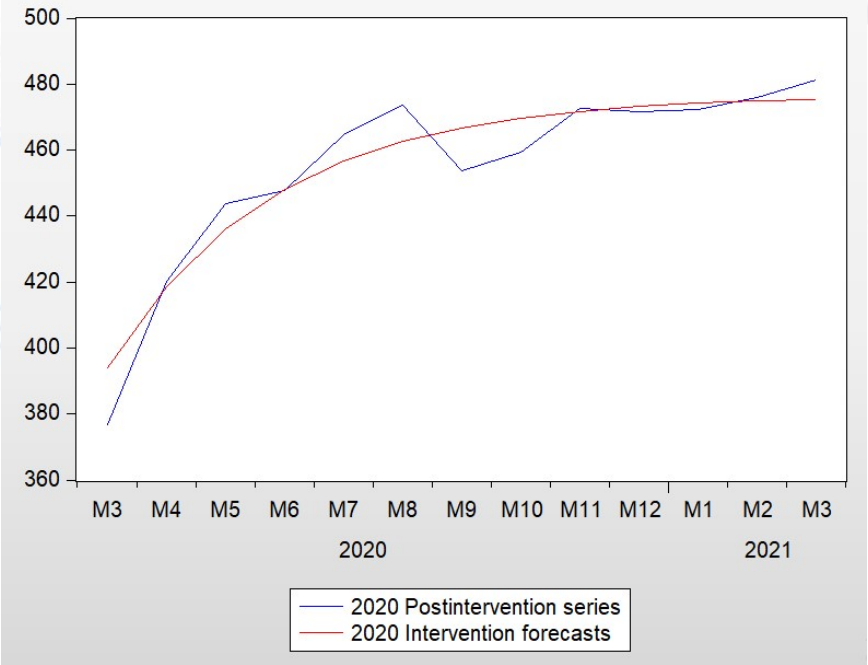


Figure 4: Comparison of the post intervention data with the intervention forecasts

2020 pre intervention period 2017m06 to 2020m02

2020 post intervention period 2020m03 to 2021m03

Discussion

Figure 1 displays Time plot of the 2020 Pre-Intervention Series of the exchange rate of United State Dollar (USD) and Nigeria Naira (NGN). The pre-intervention period is from April, 2017 to April 2020 with the intervention exchange rate of #420.15. There is a generally negative trend to the 2020 pre-intervention series. The figure showed a pattern three intervention analysis of the time series. The Time Series plot showing download trend following a gradual decrease in the mean level.

Table 1 reveals that the null hypothesis that both United State Dollar (USD) and Nigeria Naira (NGN) exchange rate has a unit root. The Augmented Dickey-Fuller Test Statistics before the adjustment difference of the 2020 pre-intervention exchange rate between United State Dollar (USD) and Nigeria Naira (NGN) was -4.009865 which is less than the t-value of -3.646342 for 1% critical level. Again the value -4.009865 is less than the t-value of -2.954021 for 5% critical value and the value -4.009865 is less than the t-value of -2.615871 for 10% critical level. The p-value 0.0040 is less than 0.05 critical levels. Therefore, the null hypothesis that there is unit root must be rejected. That is The Augmented Dickey-Fuller Test Statistics for the exchange rate between United State Dollar (USD) and Nigeria Naira (NGN) is significant.

The Augmented Dickey-Fuller Test Statistics after adjustment difference of the pre-intervention of exchange rate between United State Dollar (USD) and Nigeria Naira (NGN) show P-value 0.0005 is less than 0.05 critical level and the c-curve of 0.0439. Therefore, the differenced series of the pre-intervention exchange rate between United State Dollar (USD) and Nigeria Naira (NGN) is stationary.

Figure 2 shows that the differenced series follows a white noise process (i.e., there is no spikes of any of the lags under consideration). This implies that the Correlogram of the 2020 pre intervention series of the difference of exchange rate is the autocorrelation structure of white noise (United State Dollar (USD) and Nigeria Naira (NGN) are independent and identically distributed within the zero mean but the same variance where each value has a zero correlation with all other values in the Differenced data). The correlogram shows that an ARMA (1,3) model should be fit.

The Auto regression of all lag 1(AR) and Moving Average (MA) of all lag 3.

Table 2 estimation shows that the model is

$X_t = X_{t-1}$, t = 99, 100, 111

This means that the forecasts for the post intervention period are fi=359.24. With

Z= USD/NGN-fi,

the estimation of the transfer function is in Figure 3.

From table 3, this result of the white noise model of the differenced of pre-intervention data, forecasts are obtained for the post intervention period. This is given as

$$Z_t = X_t - F_t$$

where X_t is the original series at time t and F_t is the forecast at t

$$Z_t = C(1) * \frac{(1 - C(2))^{(T-98)}}{(1 - C(2))}$$

The above equation is equation is the transfer function which can be written as;

$$= 35.08835 * \frac{(1 - 0.701524)^{\wedge} (t-98)}{(1-0.701524)}$$

From the above figure 3, it can be observed that the close agreement between the curves is a testimony to the correctness on the intervention model.

Conclusion

From the research findings, it was discovered that the fall in Nigerian naira in respect to United State dollar has results to a slowdown in economic activities which had leads to economic recession in Nigeria. In order to over these challenges from displaying it ugly face in the future and solved the present problems, the government should make appropriate fiscal policies and laws that enable the Nigeria currencies to be able to stand in the foreign market. Based on the findings, we concluded that exchange rate has a huge effect on the recession.

References

1. Ajao, M. G. (2015), The determinants of real exchange rate volatility in Nigeria. *Ethiopian Journal of Economics*, *24*(2), 43-62.
2. Anyanwu, F. A., Anawude, A. C., Okoye, N. T., (2017). Exchange rate policy and Nigeria's Economic Growth: A Granger causality impact assessment. *International Journal of Applied Economics*, *Finance and Accounting, 1*(1), 1-13.
3. BBC News, (2021). Naira to dollar: How CBN Naira – Dollar exchange rate crash from 55 kobo to 1. Timeline. www.timeline.com.
4. Box, G. E. P. & Tiao, G. C. (1975). Intervention analysis with applications to economic and environmental problems." *Journal of the American Statistical Association,* 70(1), 70-79.
5. Chung, R. C. P., Ip, W. H. & Chan S. L., (2009). An ARIMA-intervention Analysisi model for the financial crisis in China's Manufacturing industry. *International Journal of Engineering Business Mangement.* 4(5), 27-38.
6. Essien S. N., Uyaebo, S. O. U. & Omotosho B. S., (2017). Exchange rate misalignment under different exchange rate regimes in Nigeria. *Journal of Applied Statistics, 8*(1), 1-21.
7. Etuk, H. E. & Eleki A (2016). Intervention analysis of daily Yuan-Naira exchange rate. CARD International Journal of Science and Advanced Innovative Research (1) SAIR, 1(3), 1-6.
8. Jakob, B. (2015) "Impact of Exchange Rate Regimes on Economic Growth," Undergraduate Economic Review, 12(1), Article 11. Available at: http://digitalcommons.iwu.edu/uer/vol12/iss1/11
9. Maurya, S (2017). Factors affecting Exchange Rate and its Impact on Economy of India Sheetal Maurya. *Asian Journal of Research in Business Economics and Management, 7*(8), 324-34.
10. Mosugu, J. K. & Anieting A. E., (2016). Intervention analysis of Nigeria's foreign exchange rate. *Journal Applied Science Environment Management, 20*(30), 891-894.
11. Mshelia, I. A., (2020). *Diagnosis and prognosis of the Nigerian recession*. Available at SSRN: https://ssrn.com/abstract=3555511 or http://dx.doi.org/10.2139/ssrn.3555511
12. Nicita, A., (2013). *Exchange rate, international trade and trade policies*. United nations
13. Nweze, C., (2021). Tough time for naira as dollar scarcity persist. www.thenation.com. The Nation.
14. Oke D. M., Bokana K. G. & Soluade, A., (2017). Re-examining exchange rate regimes and inflation nexus: An ARDL analysis for Nigerian case. *Acta Universitatis Danubius. OEconomica, Danubius University of Galati, 13*(6), 253-266.
15. Schmidhuber, J. & Qiao, B., (2020). Comparing crises: Great lockdown versus great recession. Rome, FAO. https://doi.org/10.4060/ca8833en
16. Umaru, H., Niyi A. A., & Davies, N. O., (2018) the effects of exchange rate volatility on economic growth of West African English speaking countries. *International Journal of Academic Research in Accounting, Finance and Management Sciences, 8*(4), 131–143,
17. Omoluna, R. O. & Adeyemo, O. O., (2021). Economics recession and economic growth in Nigeria from 1980-2020. *International Journal of Economics and financial management, 4*(9), 20-40.
18. Yusuf, W. A., Oyegoke. E. O., Jelilov G., Haruna, T. M., (2019). Determinant of exchange rate in Nigeria: A comparison of the official parallel market rates. *The Economics and Finance Letters*, *6*(9), 179-199.