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Intervention analysis of Daily Brazilian Real / Nigerian Naira Exchange Rates Because of the 2020 Nigerian Recession

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ABSTRACT
This paper is an attempt to model intervention between daily Brazilian real (BRL) and Nigerian naira (NGN) exchange rates. A look at the time plot of the exchange rates series shows that there is an intervention believed to have been caused by the announced economic recession of the year 2020 in Nigeria induced by the advent of covid-19 pandemic. The data are therefore from September 2020 to December 2020. It is clear that the exchange rates rose sharply from November 20 up to 31 December, 2020. The pre-intervention data are non-stationary. This necessitates its differencing; the first differences are now stationary. The correlogram of the differences shows an autocorrelation structure of a white noise process. Post-intervention forecasts of the model are each equal to the last pre-intervention rate of 72.2711. The transfer function of the model has been estimated and the fitted model has been shown to closely agree with the post-intervention data. This is a testimony to its adequacy. Pearson chi-square goodness-of-fit test confirms its adequacy. It may be found useful by planners and administrators.

Keywords: Brazilian real, Nigerian naira, exchange rates, intervention, 2020 Nigerian recession, covid-19

INTRODUCTION
Brazilian real (BRL) is the legal tender of Brazil whereas the Naira (NGN) is that of Nigeria. Bilateral relations are on the basis of how much one currency goes for another. The year 2020 was phenomenal for Nigeria with the incident of covid-19 in February which brought about the Nigerian economic recession that year (Aljazeera, 2020). It is believed that the recession made the intervention happen. This is the basis of this work. The approach of intervention adopted is that of Box and Tiao (1975) who proposed the use of Box-Jenkins (1976) ARIMA modeling.
A lot of authors have used this approach to solve intervention problems. These include Gilmour *et al.* (2006), Nkwocha (2019), Rosales-Lopez *et*

al. (2018), Okereke *et al.*(2016), Oreko *et al.* (2017), Mrinmoy *et al.* (2014), Yaacob *et al.* (2011) and Jarrett and Kyper (2011). Etuk *et al.* (2021) studied the intervention witnessed of the BRL/NGN exchange rates as a result of the 2016 Nigerian recession.

MATERIALS AND METHODS

Data

The data for this work came from the website https://www.exchangerates.org.uk/BRL-NGN-exchange-rates-history.html. They are the daily BRL/NGN exchange rates from 1 September 2020 to 31 December 2020. They are to be read as the amount of NGN in one BRL.

Intervention Analysis

The method adopted for this intervention analysis is the one proposed and demonstrated by Box and Tiao (1975). It was based on the autoregressive integrated moving average (ARIMA) modeling technique of Box and Jenkins (1976).

Suppose that $X_1, X_2, \dots, X_n$ is a realization of a time series $\{X_t\}$. Let there be an intervention at t=T where $T < n$. Model the pre-intervention part of the series with an ARIMA model. Suppose the order of the ARIMA is (p, d, q).

That means for $t < T$

$$\nabla^d X_t = \alpha_1 \nabla^d X_{t-1} + \alpha_2 \nabla^d X_{t-2} + \cdots + \alpha_p \nabla^d X_{t-p} + \cdots + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \cdots + \beta_q \varepsilon_{t-q} \quad \dots\dots (1)$$

That is.

$$\nabla^d (1 - \alpha_1 L - \alpha_2 L^2 - \cdots - \alpha_p L^p) X_t = (1 + \beta_1 L + \beta_2 L^2 + \cdots + \beta_q L^q) \varepsilon_t \quad \dots\dots (2)$$

where $\{\varepsilon_t\}$ is a white noise series, ∇ is the difference operator and L is the backshift operator defined by $LX_t = X_{t-1}$.

The model (2) may be written as

$$\nabla^d \Phi(L) X_t = \Theta(L) \varepsilon_t \quad \dots\dots (3)$$

Whereby $X_t = \frac{\Theta(L)\varepsilon_t}{\Phi(L)\nabla^d}$ is the noise part of the intervention model where $\nabla = 1-L$.

On the basis of this model make post-intervention forecasts f.
Let $z = X_t - f$, $t \geq T$. Then
Z = c(1)*(1 – c(2) ^ (t-T+1))/(1 – c(2))……………………………(4)
where c(1) and c(2) are constants.

Combining (3) and (4), the intervention model is

$$X_t = \frac{\Theta(L)\varepsilon_t}{\Phi(L)\nabla^d} + c(1) * \frac{(1-c(2)^{t-T+1}}{1-c(2)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Computer Software

Eviews 10 was used for computations in the work.

RESULTS

In figure 1 is a time plot of the BRL/NGN exchange rates for the year 2020 beginning from 1 September 2020. There is an intervention at the close of the year as observable. This intervention is around November 2020 when the news of the economic recession in Nigeria was announced by the National Bureau of Statistics of Nigeria. This implies causality. Generally the trend is upward. Rather arbitrarily the intervention is taken for t=81, i.e. 20 November 2020.

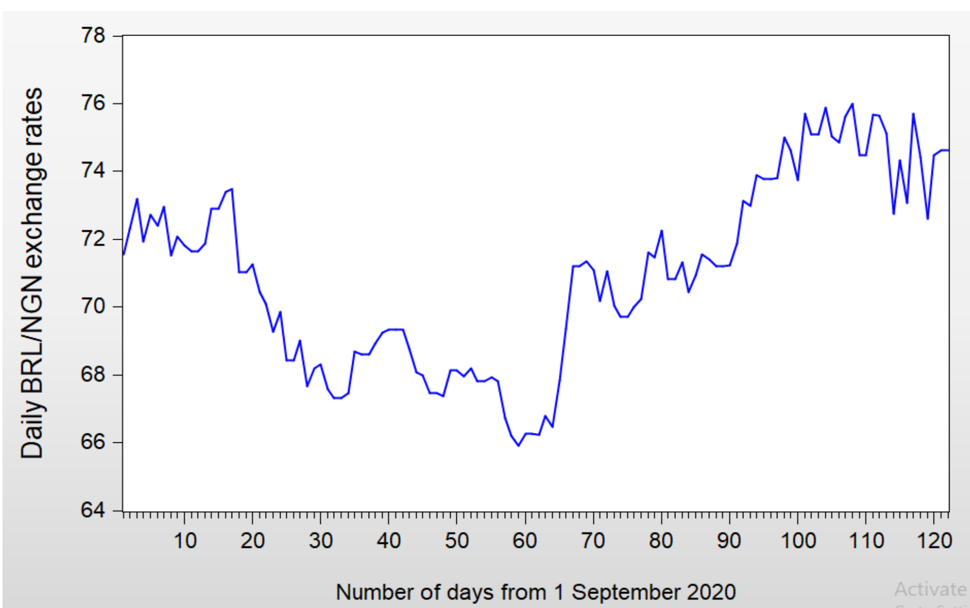

Figure 1: Time plot of the BRL/NGN exchange rates

Figure 2 is the time plot of the pre-intervention series. There is a generally negative trend.

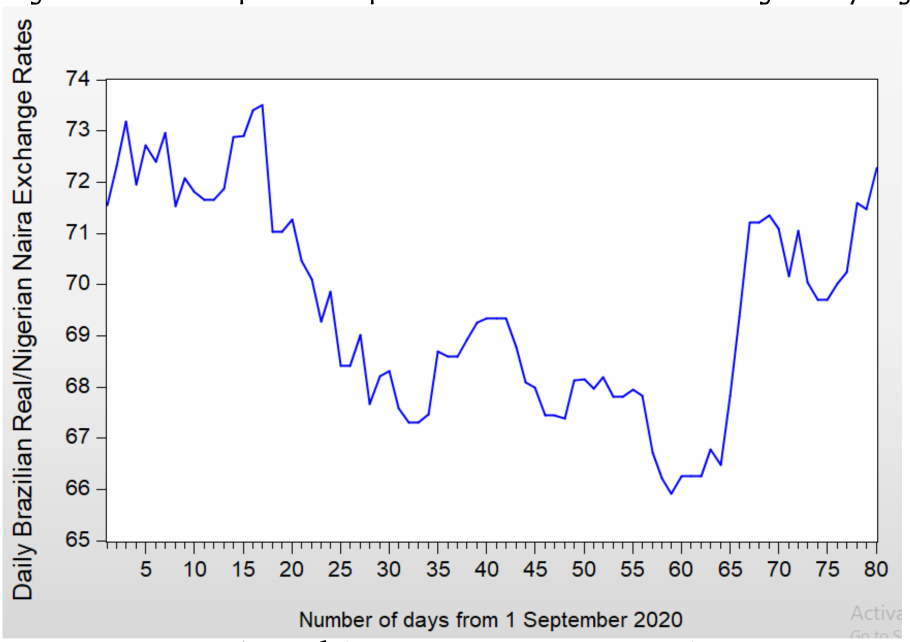

Figure 2: Time plot of the pre-intervention exchange rates

Table 1: Unit root test for the pre-intervention rates

Null Hypothesis: BRLN1 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.890197	0.9515
Test critical values:	1% level	-4.078420	
	5% level	-3.467703	
	10% level	-3.160627	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BRLN1)
Method: Least Squares
Date: 03/18/22 Time: 23:29
Sample (adjusted): 2 80
Included observations: 79 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRLN1(-1)	-0.039506	0.044379	-0.890197	0.3762
C	2.640303	3.165212	0.834163	0.4068
@TREND("1")	0.002894	0.003974	0.728198	0.4687

R-squared	0.031803	Mean dependent var	0.009053
Adjusted R-squared	0.006324	S.D. dependent var	0.711677
S.E. of regression	0.709423	Akaike info criterion	2.188506
Sum squared resid	38.24937	Schwarz criterion	2.278485
Log likelihood	-83.44597	Hannan-Quinn criter.	2.224554
F-statistic	1.248192	Durbin-Watson stat	2.009981
Prob(F-statistic)	0.292839		

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Clearly from the Table 1 results the pre-intervention series are not stationary, the p-value being 0.95 much greater than 0.05. There is therefore the need for differencing of the series. Figure 3 is the time plot of the differenced series.

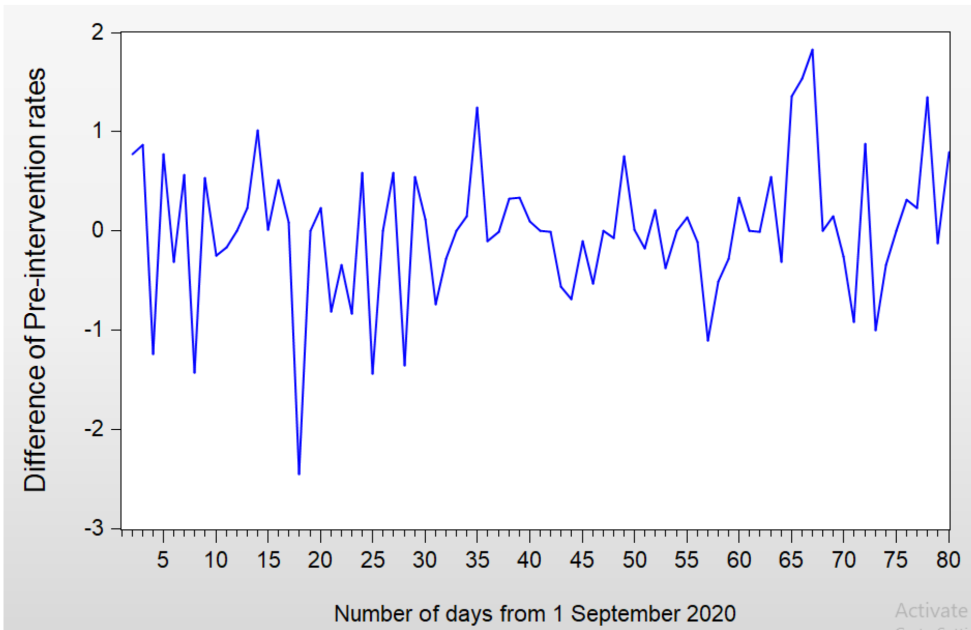

Figure 3: Time plot of the difference of the pre-intervention series

The result of Table 2 test shows that the difference series is stationary with a p-value of 0.0000 which is less than 0.05. The correlogram of the difference series in Figure 4 shows that all its spikes are within the non-significance range. This implies a white noise model for the difference series, which in turn implies a post-intervention forecast of 72.2711 for each post-intervention point. That is, f=72.2711.

Define z = brl/ngn – f, t › 80

Table 2: Unit root test for the difference of the pre-intervention data

Null Hypothesis: DBRLN1 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.961894	0.0000
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DBRLN1)
Method: Least Squares
Date: 03/18/22 Time: 23:36
Sample (adjusted): 3 80
Included observations: 78 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DBRLN1(-1)	-1.027958	0.114703	-8.961894	0.0000
C	-0.000763	0.080991	-0.009417	0.9925

R-squared	0.513804	Mean dependent var	0.000223
Adjusted R-squared	0.507407	S.D. dependent var	1.019153
S.E. of regression	0.715292	Akaike info criterion	2.193056
Sum squared resid	38.88488	Schwarz criterion	2.253484
Log likelihood	-83.52917	Hannan-Quinn criter.	2.217246
F-statistic	80.31555	Durbin-Watson stat	1.991065
Prob(F-statistic)	0.000000		

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Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.027	-0.027	0.0613	0.805
		2	0.143	0.142	1.7497	0.417
		3	0.094	0.103	2.4944	0.476
		4	-0.055	-0.071	2.7496	0.601
		5	-0.039	-0.074	2.8778	0.719
		6	-0.100	-0.098	3.7494	0.711
		7	-0.011	0.012	3.7593	0.807
		8	-0.177	-0.146	6.5952	0.581
		9	-0.179	-0.191	9.5201	0.391
		10	0.076	0.100	10.051	0.436
		11	0.054	0.157	10.323	0.502
		12	0.029	0.025	10.401	0.581
		13	0.149	0.071	12.564	0.482
		14	0.108	0.070	13.709	0.472
		15	0.070	0.042	14.199	0.510
		16	-0.093	-0.166	15.075	0.519
		17	0.018	-0.089	15.110	0.588
		18	0.010	0.063	15.122	0.654
		19	-0.073	0.070	15.690	0.678
		20	-0.024	-0.002	15.752	0.732
		21	-0.073	-0.062	16.333	0.751
		22	-0.076	-0.018	16.978	0.765
		23	-0.091	-0.050	17.919	0.762
		24	-0.029	-0.106	18.019	0.802
		25	0.067	-0.010	18.552	0.818
		26	0.050	0.113	18.858	0.842
		27	0.019	0.045	18.905	0.873
		28	0.091	0.025	19.955	0.866
		29	0.005	-0.020	19.958	0.894
		30	0.036	0.027	20.125	0.913
		31	-0.029	-0.072	20.237	0.931
		32	0.072	0.002	20.938	0.933

Figure 4: Correlogram of the difference of the pre-intervention data

This correlogram implies that the fit to the differences of the pre-intervention data is a white noise process. This means that the post-intervention forecasts on the basis of this are each equal to 72.2711, the value of the original series at the last pre-intervention date, that is, November 19, 2020.

Table 3: Transfer function determination for the intervention model

Dependent Variable: Z
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 03/18/22 Time: 23:48
Sample: 81 122
Included observations: 42
Convergence achieved after 32 iterations
Coefficient covariance computed using outer product of gradients
Z=C(1)*(1-C(2)^(T-80))/(1-C(2))

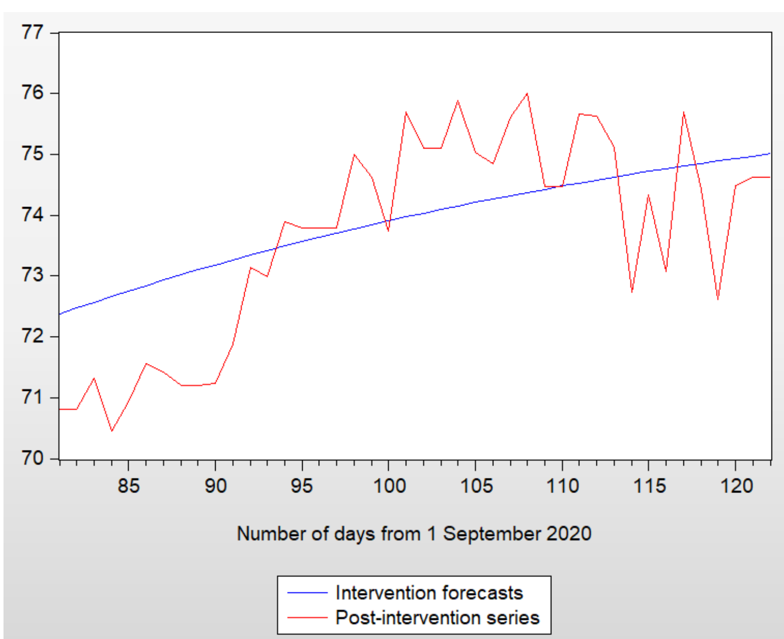
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.101146	0.041418	2.442083	0.0191
C(2)	0.976955	0.030239	32.30732	0.0000

R-squared	0.472911	Mean dependent var	1.369645
Adjusted R-squared	0.459734	S.D. dependent var	1.715963
S.E. of regression	1.261281	Akaike info criterion	3.348580
Sum squared resid	63.63316	Schwarz criterion	3.431326
Log likelihood	-68.32018	Hannan-Quinn criter.	3.378910
Durbin-Watson stat	0.660682		

The intervention model is given by

$$X_t = \frac{\varepsilon_t}{1-L} + \frac{0.101146(1-.976955^{t-80})}{0.023045} \qquad (6)$$

by model (5).



The Pearson chi-square goodness-of-fit statistic is equal to 0.7835 < $\chi^2_{0.01}$ = 63.7 meaning that the p-value < 0.01. This is a testimony to the goodness-of-fit of the intervention model to the post-intervention data.

CONCLUSION

Adequacy of the intervention model (6) to the post-intervention data in not in doubt. This avails as model to use for planning purpose to seek redress of the situation, especially to the relatively suffering party. Coincidentally this year witnessed the advent of the covid-19 pandemic in this country at the preent time. The study might be said to have been conducted during the time of influence of the pandemic in Nigeria. Adminstrators shall find the result of this study very useful.

REFERENCES

Aljazeera (2020). Nigeria slips into recession blamed on COVID-19 and oil prices. (Nov. 2020) https.www.aljazeera.com › news.

Box, G. E. P. and Jenkins, G. M. (1976). Time Series Analysis Forecasting and Control. Revised Edition, Holden-Day, San Francisco.

Box, G. E. P. and Tiao, G. C. (1975). Intervention analysis with applications to economic and environmental problems. Journal of the American Statistical Association, 70(349), 70-79.

Etuk, E. H., Onyeka, G. N. and Leesie, L. (2021). An Autoregressive Integrated Moving Average Intervention Model of 2016 Brazilian Real and Nigerian Naira Exchange Rates. Journal of Basic and Applied Research International International, 27(9), 1-7.

Gilmour, S., Degenhardt, L., Hall, W. *et al.* (2006). Using intervention time series analyses to assess the effects of imperfectly identifiable natural events: a general method and example. *BMC Med Res Methodol 6, 16(2006).* https://doi.org/10.1186/1471-2288-6-16.

Jarrett, J. E. and Kyper, E. (2011). ARIMA Modelling with intervention to Forecast and Analyze Chinese Stock Prices. International Journal of Engineering Business Management. https://doi.org/10.5772/50938.

Mrinmony, R., Ramasubramanian, V., Amrender, K. and Anil, R. (2014). Application of Time Series Intervention Modelling and Forecasting Cotton Yield. Statistics and Applications, 12(1&2), 61 – 70.

Nkwocha, O. (2019). Intervention analysis and classification: key to health outcomes opyimization. Int J Health Care Qual Assur. 2019 March 11; 347-359. Doi: 10.1108/IJCQA-03-2018-0066. PMID:31017055.

Okereke, O., Ire, K. and Omekara, C. (2016). The impact of NEEDS on inflation Rate in Nigeria: An intervention analysis. International Journal of African and Asian Studies. Volume 22(26).

Oreko, B. U., Nwobi-Okoye, C. C., Okiy, S. and Igboanugo, A. C. (2017). Modeling the impact of intervention measures on total accident cases in Nigeria uing Box-Jenkins methodology: A case study of federal road safety commission. Cogent Engineering, 4, issue 1. https://10.1080/23311916.2017.1345043.

Rosales-Lopez, A., Raposo, L. M., Nobre, F., Almeida, R. T. (2018). The use of intervention analysis of the mortality rates from breast cancer in assessing the Brazilian screening programme. Research on Biomedical Engineering, 34(7). DOI: 10.1590/2446-4740.180053.

Yaacob, W. F. W., Husin, W. Z. W., Abd. Aziz, N. and Nordin, N. I. (2011). N intervention model of Road Accidents: The Case of OPS Sikap Intervention. Journal of Applied Sciences. 11(7): 1105 – 1112. DOI: 10.3923/jas.2011.1105.1112.