Intervention Modeling of the 2016 Economic Recession Using Turkish Lira/Nigerian Naira Exchange Rates

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Abstract

This research work examined the exchange rate of a comparative value of the Nigeria Naira with respect to Turkish Lira to the economic recessions of 2016 from 1 January to 31 December 2016 utilizing Box and Tiao's intervention analysis approach (1975). The Eview 10 package was used to evaluate the data. Time plot of daily exchange rate of Turkish Lira/Nigeria Naira shows horizontal trend then a vertical abrupt increase on 23 June 2016which prompted an intervention modeling. The pre-intervention series are adjudged stationary using ADF unit root test at first difference. Post-intervention forecast were obtained. The pre-intervention dataset also indicated an upward movement showing that the series is not stationary. At a significance level of less than 5%, the pre-intervention series was shown to be stationary by the Augmented Dickey Fuller unit root test. Plotting the stationeries data's correlogram revealed that ARIMA(7,1,7) was suggestive. The accompanying observations and the intervention forecasts are in close agreement. The intervention impact is therefore noteworthy. The daily Turkish lira/\Nigerian Naira from 1st January to 31 December 2016, the pre-intervention series are adjudged stationary using ADF unit root test at first difference. Post-intervention forecast was obtained. This produced very close relationship between post-intervention forecast and the real data. This intervention model is hoped to be a basis for managing recession and help to proffer solution to exchange rates issue when it arises

Keywords: *Intervention, Modeling, Economic Recession, Turkish Lira/Nigerian Naira. Exchange Rate*

1.1 INTRODUCTION

The Nigerian economy has faced significant challenges over the past decade, marked by periods of recession that have had profound implications for its growth and development. Notably, the recessions of 2016 were pivotal, stemming from a confluence of factors including fluctuating oil prices, foreign exchange constraints, and global economic disruptions. Understanding the dynamics of these economic downturns is crucial for policymakers and stakeholders aiming to formulate effective intervention strategies (Central Bank of Nigeria, 2022).

This study focuses on the intervention modeling of the 2016 Nigerian economic recessions through the lens of the exchange rate fluctuations between the Turkish Lira (TRY) and the Nigerian Naira

(NGN)(Dimitrova,2018). The choice of the Turkish Lira as a comparative currency provides a unique perspective, given Turkey's own economic transformations and its integration into the European market. By analyzing the exchange rate movements and their correlation with macroeconomic indicators, this research aims to uncover insights into how currency fluctuations impact economic stability and recovery (Bokpin, 2020).

Through a comprehensive examination of historical data, this study seeks to model interventions that could mitigate the adverse effects of such recessions in the future. The findings will not only enhance our understanding of the Nigerian economy's resilience but also contribute to broader discussions on currency dynamics in emerging markets. Ultimately, this research aspires to offer actionable recommendations for policymakers to better navigate the complexities of economic downturns, ensuring sustainable growth and stability in Nigeria's economic landscape.

3.3 MATERIAL AND METHODS

The modeling of the intervention of the Turkish Lira//Nigerian Naira exchange rates because of the 2016 Nigerian economic recessions is examined in this paper. Daily statistics from January 1, 2016, to December 31, 2016, on the exchange rates for Nigeria, and Turkey. E-views 10 Statistical software utilized for conducting the investigation. The ARIMA Modeling Method was used.

3.4 Statistical Intervention Analysis

Assume that at time t=T, an intervention occurs in the time series Xt. The series' trend has changed because of this move. Box and Tiao [1] have suggested using an ARIMA model to simulate the pre-intervention series. Consider that this is an ARIMA (p, d, q). That is,

$$A(L)\psi^{\mathbf{d}}X_t = \boldsymbol{\beta}(\boldsymbol{L})\boldsymbol{\varepsilon_t} \quad (1)$$

Where A(L) is the autoregressive (AR) operator defined by

$$A(L) = 1 - \beta_1 L - \beta_1 L^2 \ldots\ldots\ldots.\beta_i L^i. \quad (2)$$

And B(L) is the moving average (MA) operator defined by

$$\beta(L) = 1 + \psi_1 L + \psi_2 L^2 + \cdots\ldots\ldots + \psi_i L^i. \quad (3)$$

Moreover, $\psi = 1 - L$ and $L^k X_t = X_{t-k}$

The sequence {Ɛt} is a white noise process. Based on model (1), forecasts are derived for the post-intervention period.

$$X_t = \frac{\beta(L)\varepsilon_t}{A(L)\psi^d} \quad (4)$$

Suppose these forecasts are F_t. The difference $Z_t = X_t - F_t$ can be modeled by

$$Z_t = \frac{C(1)*(1-C(2)(t-T+1))}{(1-C(2))} \quad (5)$$

The final intervention model is given by combining (4) and (5) to have

$$Y_t = \frac{\beta(L)\varepsilon_t}{A(L)\psi^d} + \frac{(L_1(C(1)*c(2)^{(t-T+1)}}{(1-c(2))} \quad (6)$$

WhereI$_t$ = 0, t < T and It = 1, t ≥ T.

4.0 RESULTS

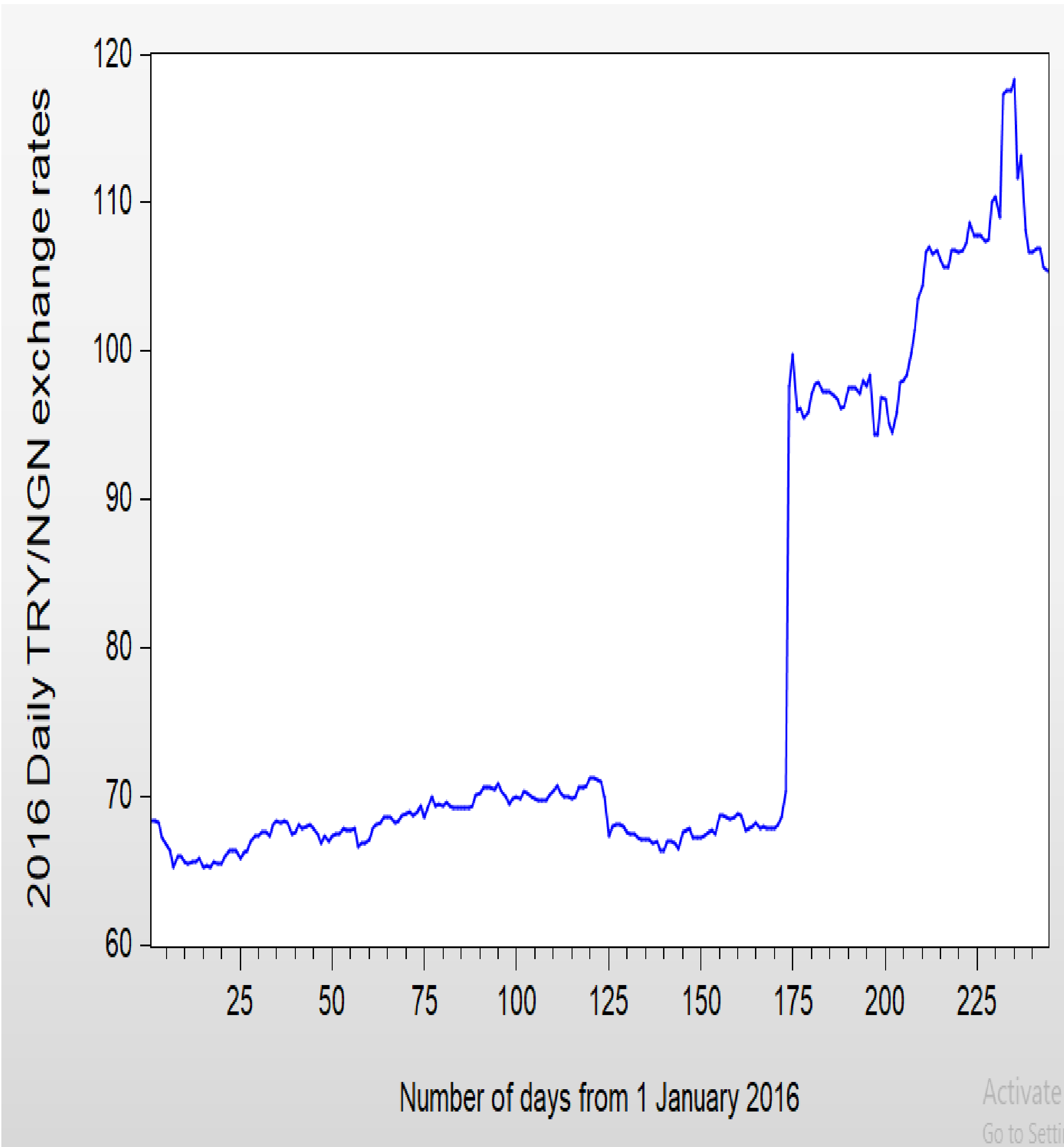


Figure 4.1: 2016 Daily TRY/NGN Exchange Rates

Source: Authors Drawing by Eviews 10

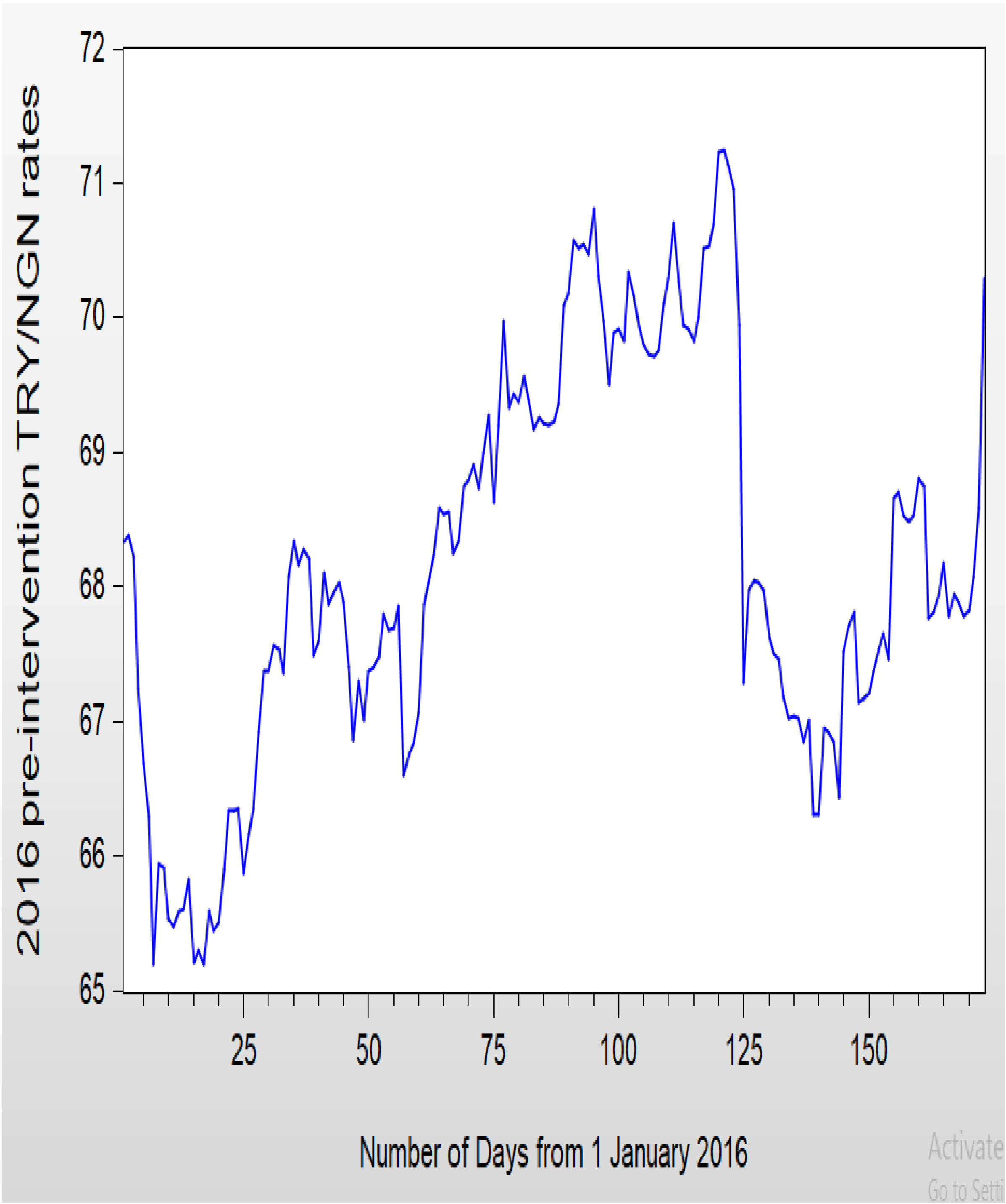


Figure 4.2:2016 Pre-Intervention TRY/NGN Exchange Rates
Source: Authors Drawing by Eviews 10

Table 4.1: ADF Unit Root Test at Level for Pre-Intervention 2016 TRY/NGN Exchange Rates

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.705062	0.4269
Test critical values:	1% level	-3.468521	
	5% level	-2.878212	
	10% level	-2.575737	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRYNGN)
Method: Least Squares
Date: 11/14/23 Time: 18:05
Sample (adjusted): 1/02/2016 6/20/2016
Included observations: 171 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TRYNGN(-1)	-0.037239	0.022833	-1.705062	0.0900
C	2.549102	1.556342	1.711993	0.0887

R-squared	0.015972	Mean dependent var	0.011216
Adjusted R-squared	0.010149	S.D. dependent var	0.434047
S.E. of regression	0.431839	Akaike info criterion	1.170099
Sum squared resid	31.51595	Schwarz criterion	1.206844
Log likelihood	-98.04347	Hannan-Quinn criter.	1.185008
F-statistic	2.742998	Durbin-Watson stat	1.738023
Prob(F-statistic)	0.099537		

Source: **Authors use of Eviews 10**

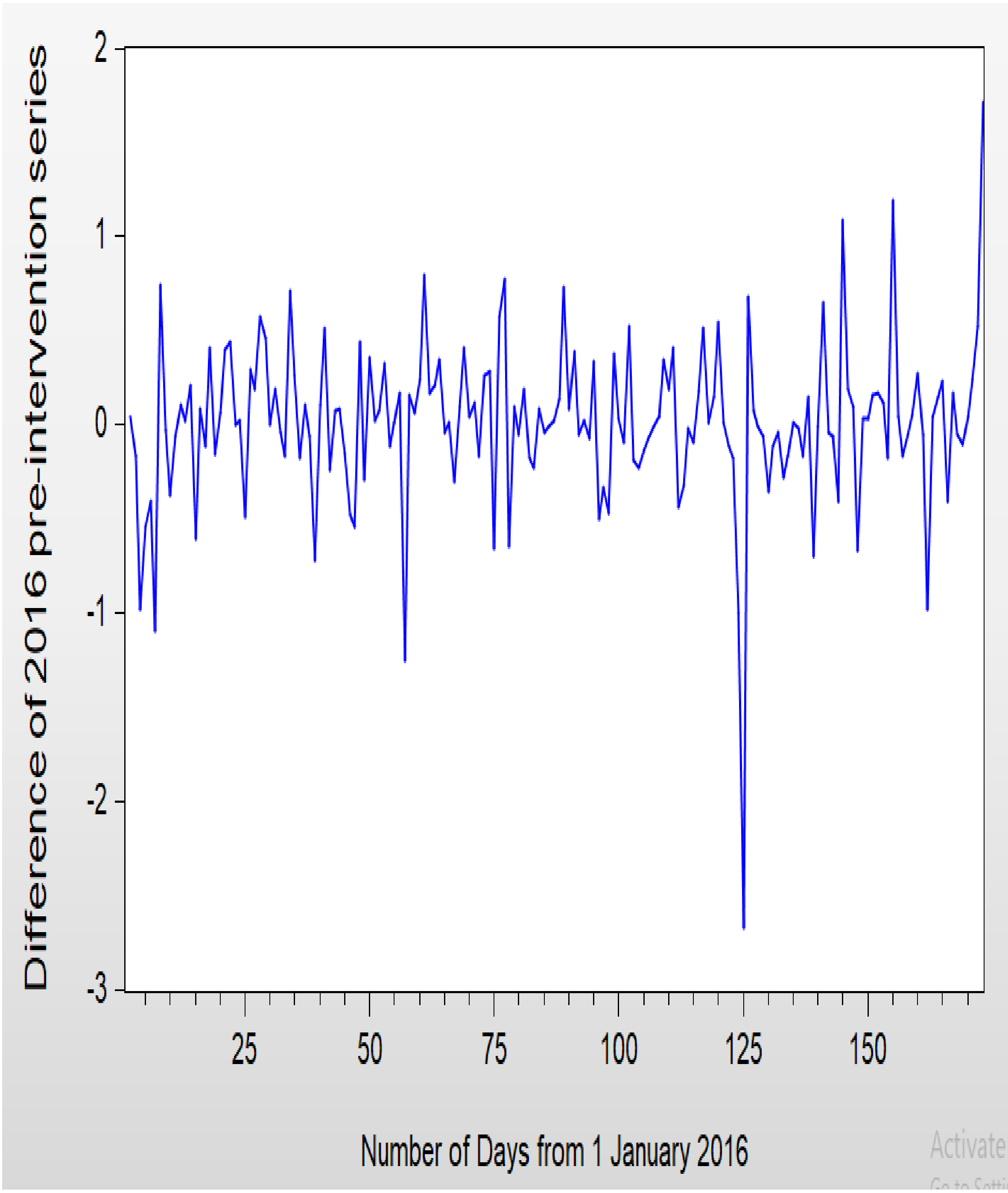


Figure 4.3: Difference of 2016 Pre-Intervention TRY/NGN Exchange Rates
Source: Authors Drawing from Eviews 10

Table 4.2: ADF Unit Root Test at First Difference of Pre-Intervention 2016 TRY/NGN Exchange Rates

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

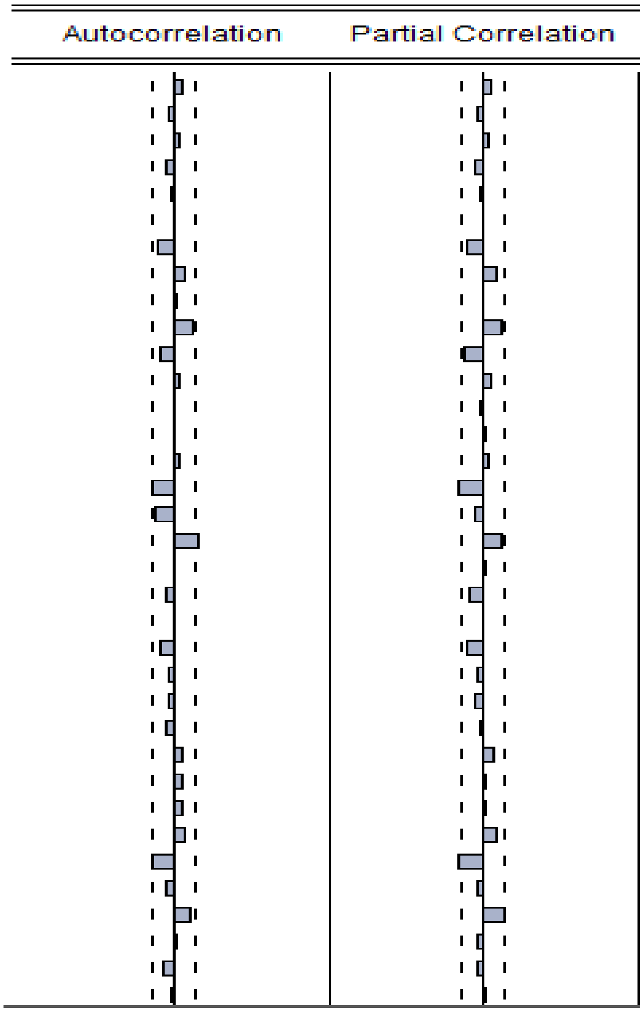
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.74386	0.0000
Test critical values:	1% level	-3.468749	
	5% level	-2.878311	
	10% level	-2.575791	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TRYNGN,2)
Method: Least Squares
Date: 11/14/23 Time: 18:09
Sample (adjusted): 1/03/2016 6/20/2016
Included observations: 170 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TRYNGN(-1))	-0.943566	0.080345	-11.74386	0.0000
C	0.011132	0.034099	0.326478	0.7445

R-squared	0.449365	Mean dependent var	0.009739
Adjusted R-squared	0.446107	S.D. dependent var	0.599127
S.E. of regression	0.445894	Akaike info criterion	1.234157
Sum squared resid	33.60085	Schwarz criterion	1.270901
Log likelihood	-103.5204	Hannan-Quinn criter.	1.249066
F-statistic	137.9183	Durbin-Watson stat	1.912509
Prob(F-statistic)	0.000000		

Source: Authors Use of Eviews 10



Lag	AC	PAC	Q-Stat	Prob
1	0.052	0.052	0.4657	0.495
2	-0.028	-0.030	0.6006	0.741
3	0.026	0.029	0.7210	0.868
4	-0.052	-0.056	1.2052	0.877
5	-0.020	-0.013	1.2781	0.937
6	0.003	0.001	1.2801	0.973
7	-0.102	-0.101	3.1800	0.868
8	0.076	0.087	4.2461	0.834
9	0.018	-0.000	4.3058	0.890
10	0.117	0.130	6.8358	0.741
11	-0.092	-0.127	8.4230	0.675
12	0.030	0.063	8.5949	0.737
13	-0.000	-0.022	8.5949	0.803
14	-0.007	0.009	8.6053	0.855
15	0.026	0.033	8.7361	0.891
16	-0.142	-0.164	12.594	0.702
17	-0.118	-0.064	15.275	0.576
18	0.168	0.129	20.761	0.292
19	0.003	0.017	20.762	0.350
20	-0.052	-0.082	21.286	0.380
21	-0.008	0.001	21.299	0.441
22	-0.098	-0.111	23.196	0.391
23	-0.039	-0.035	23.504	0.432
24	-0.041	-0.051	23.840	0.471
25	-0.058	-0.012	24.526	0.489
26	0.056	0.077	25.158	0.510
27	0.054	0.016	25.768	0.531
28	0.048	0.012	26.242	0.560
29	0.075	0.087	27.407	0.550
30	-0.143	-0.161	31.747	0.379
31	-0.053	-0.028	32.350	0.400
32	0.101	0.131	34.512	0.349
33	0.014	-0.029	34.552	0.394
34	-0.072	-0.038	35.678	0.389
35	-0.010	0.023	35.699	0.435

Figure 4.4: Correlogram of First Difference
Source: Authors Drawing from Eviews 10

Table 4.3: Estimation of the Arima (7, 1, 7) Model Fitted Pre-Intervention Data

Dependent Variable: D(TRY)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 01/11/24 Time: 06:52
Sample: 1/02/2016 6/21/2016
Included observations: 172
Failure to improve objective (non-zero gradients) after 32 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(7)	-0.618479	0.183953	-3.362157	0.0010
AR(10)	-0.102679	0.167583	-0.612705	0.5409
AR(16)	-0.120706	0.136601	-0.883640	0.3782
AR(18)	0.234633	0.131704	1.781522	0.0767
MA(7)	0.696829	0.847316	0.822396	0.4121
MA(10)	0.320453	0.619617	0.517179	0.6057
MA(16)	-0.018124	0.099566	-0.182027	0.8558
MA(18)	-0.140191	0.440077	-0.318560	0.7505
SIGMASQ	0.158433	0.026624	5.950641	0.0000

R-squared	0.149184	Mean dependent var	0.011408
Adjusted R-squared	0.107427	S.D. dependent var	0.432783
S.E. of regression	0.408877	Akaike info criterion	1.138959
Sum squared resid	27.25040	Schwarz criterion	1.303654
Log likelihood	-88.95051	Hannan-Quinn criter.	1.205780
Durbin-Watson stat	1.755758		

Inverted AR Roots	.90-.36i	.90+.36i	.84	.73+.52i
	.73-.52i	.44-.79i	.44+.79i	.19-.97i
	.19+.97i	-.14+.88i	-.14-.88i	-.55-.81i
	-.55+.81i	-.67+.61i	-.67-.61i	-.84-.25i
	-.84+.25i	-.95		
Inverted MA Roots	.93-.38i	.93+.38i	.81	.66+.53i
	.66-.53i	.42+.77i	.42-.77i	.15+.96i
	.15-.96i	-.09+.82i	-.09-.82i	-.57+.61i
	-.57-.61i	-.59-.79i	-.59+.79i	-.85+.25i
	-.85-.25i	-.94		
	Estimated MA process is noninvertible			

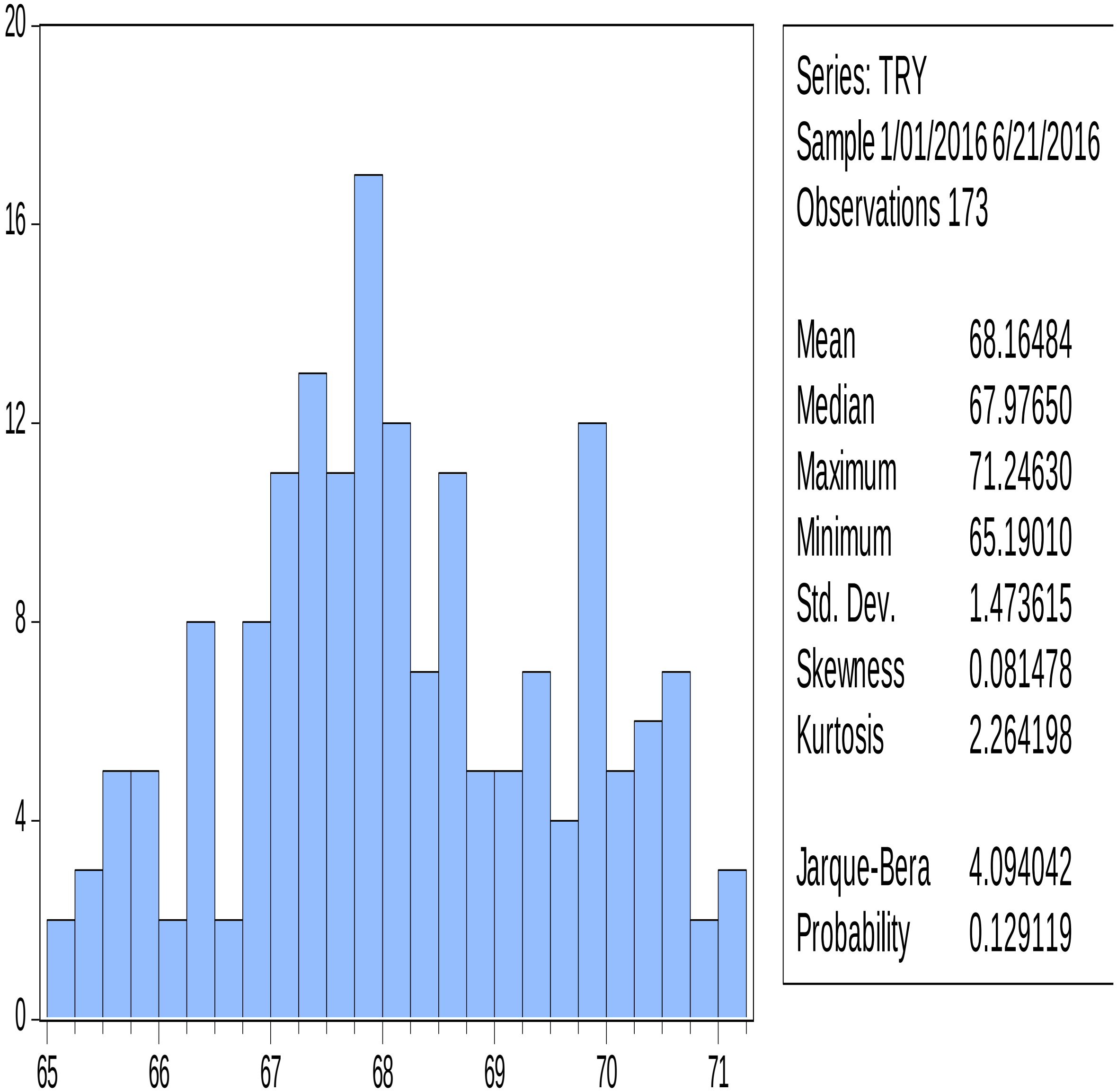


Figure 4.5: Histogram of the Residuals of the ARIMA (7, 1, 7) Model of Pre-Intervention Data

Source: Authors Drawing of Eviews 10

Table 4.4: Estimation of the Intervention Transfer Function

Dependent Variable: Z				
Method: Least Squares (Gauss-Newton / Marquardt steps)				
Date: 11/14/23 Time: 12:06				
Sample 101 153 Included observation:71 Convergence achieved after 39 iterations				
Coefficient covariance computed using outer product of gradients				
Z1=C(1)*(1-C(2)^(T-100))/(1-(2))				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	25.15593	5.758596	4.368413	0.0000
C(2)	0.230850	0.177936	1.297373	0.0000
R-squared	0.013118	Mean dependent var		32.57246
Adjusted R-squared	-0.001184	S.D. dependent var		6.403680
S.E. of regression	6.407470	Akaike info criterion		6.580571
Sum squared resid	2832.841	Schwarz criterion		6.644308
Log likelihood	-231.6103	Hannan-Quinn criter.		6.605917
F-statistic	3.18E+25	Durbin-Watson stat		0.988463
Prob(F-statistic)	0.000000			

Source: Authors use of Eviews 10

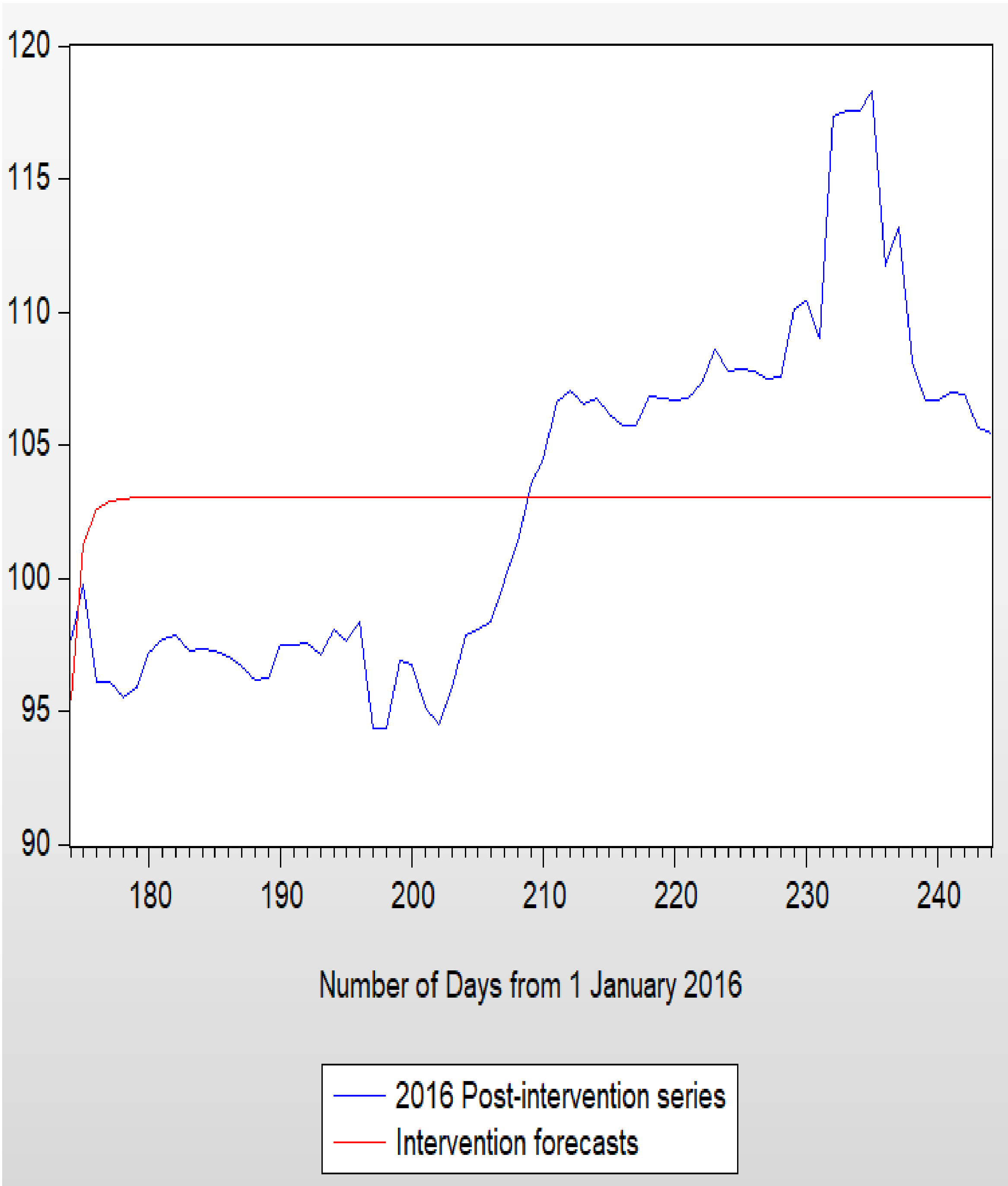


Figure 4.6: Comparison of the Intervention Forecasts and Post Intervention
Source: Authors Drawing from Eviews 10

Discussion of Results

Figure 4.1 depicts the time plot of the 2016 Daily Turkish Lira/Nigeriannaira exchange rates, which begins on January 1 and ends on June 23 with a largely horizontal trend. Following then, there was an abrupt vertical surge known as Intervention Point T, T = 175, which happened right away. After that, there was a comparatively flat trend from June 24 to December 31 without any come back. The time plot of the 2016 Pre-Intervention Turkish Lira/Nigerian naira exchange rates prior to intervention is displayed in Figure 4.2. It appears that the time plot is moving in an upward trend. Figure 4.3 shows the difference of 2016 pre-intervention rates

Table 4.1 shows the ADF unit root test at level for pre-intervention 2016 Turkish Lira/Nigerian naira exchange rates. The Unit Root test results for the Pre-Intervention Series utilizing the Augmented Dickey Fuller test (ADF) are shown in Table 4.1. With a statistic value of -1.705062 ,lower than the crucial values of 1%, 5%, and 10% of -3.468521,-2.878212, and -2.575737, respectively. The pre-intervention series is determined to be non-stationary with probability values of 0.4269. However, the series was first modified to be stationary by differencing, as seen in Figure 4.3. Its stationary qualities were validated in Table 4.2 with an ADF statistic value of -10.53 and a probability value of 0.0000.Figure 4.3 shows the difference of 2016 Pre-Intervention Turkish Lira/Nigerian Naira Exchange Rates. Table 4.2 shows the ADF unit root test at first difference of pre-intervention 2016 Turkish Lira/Nigerian Naira Exchange Rates. Also, the correlogram structure of the Pre-Intervention series is displayed by plotting the autocorrelation function and partial autocorrelation function against the lag duration in any analysis that seeks to construct or establish a model, as in this work (Figure 4.4).Usually, these graphs are used as a reference when choosing the model to fit. It also shows that the relevance isn't increasing. For the fluctuations in the pre-intervention dataset, this supports the white noise model hypothesis. Good exponential decay and a damped sine wave pattern are displayed by both functions.

Figure 4.4 shows correlogram of first difference of 2016 Pre-Intervention Series with no serious significant spike. Table 4.4 demonstrates the estimation of the intervention of the transfer function. Here, we show that the post intervention model transfer function model fulfills the formula:

$Z_t = \frac{C(1) * (1-c(2)^{T-t}}{(1-c(2)}$, where C(1) = 25.1569, C(2) = 0.2309 and t = 175 . Therefore, we have:

$Z_t = \frac{25.1569 * (1-0.2309)^{T-173}}{(1-0.2309)}$

Figure 4.5 illustrates the comparison of the Intervention forecast and the post intervention. This shows that there is a close agreement between the Pre-Intervention Data and the Post-Intervention forecast.Therefore, Giving the ARIMA(7,1,7) model with $\Delta Xt = -0.618479x_{t-7} - 0.102679x_{t-10} 0.120706x_{t-16} - 0.696829\varepsilon_{t-7} - 0.320453\varepsilon_{t-10}$its predictions, post-intervention observation, and adequacy plot.

Conclusion

The analysis of the Turkish Lira/Nigerian Naira exchange rates from January to December 2016 reveals critical insights into the dynamics surrounding the intervention point. Prior to the intervention, the exchange rates exhibited a non-stationary upward trend, which shifted dramatically post-intervention to a relatively flat trend. The ARIMA (7, 1, 7) model effectively captured the relationship between the exchange rates and the intervention, demonstrating a close alignment between pre- and post-intervention forecasts. These findings underscore the significance of intervention analysis in understanding and predicting currency fluctuations in response to economic events.

Recommendations

1. Future research should explore the incorporation of additional macroeconomic indicators, such as inflation rates and political stability, into the predictive models to improve accuracy in forecasting exchange rate movements.
2. Financial authorities should establish a framework for the continuous monitoring of intervention points and their effects on exchange rates to ensure timely responses to economic changes and mitigate adverse impacts.
3. Engage relevant stakeholders, including policymakers and economists, in discussions about the implications of exchange rate fluctuations, ensuring that informed strategies are developed to support economic stability and growth.

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