INTERVENTION MODELING OF DAILY NORWEGIAN KRONER/NIGERIAN NAIRA EXCHANGE RATE.

VICTOR-EDEMA UYODHU AMEKAUMA, GEORGE SOKARI DANIEL

Abstract - This study specifically developed an appropriate intervention model for the daily Norwegian Kroner (NOK) /Nigerian Naira (NGN) exchange rate. The data with 180 observations (October 24th, 2017 – April 21st 2018) was sourced from Nigerian Bureau of Statistics (NBS). The point of intervention is spotted at T=81 and was characterized by step function. 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 plot further shows that the pre-intervention rates are non-stationary but became stationary after first difference was taken. The ACF and the PACF of the differenced exchange rate data showed a white noise pattern. Forecast was made. The difference between the forecast and the post-intervention series was modeled after the intervention transfer function and was seen to be statistically significant \( P < 0.002 < 0.05, 0.01 \), this is an indication of model adequacy. There was a close agreement between the intervention model and the post intervention data. The model so fitted may be used to help strengthen the Nigerian Naira.

Index Terms: Intervention model, Naira, Kroner, stationary, exchange rate, model adequacy, pre intervention, post intervention.

1 INTRODUCTION

Data collected chronologically over time are often affected by different external occurrences commonly referred to as interventions. Exchange rates data are not exceptions. They are affected by major political and/or economic policy initiatives and at other times, policy changes. Once interventions are identified, in some cases their effects are evaluated and in others, they are embodied into the time series model to help enrich the parameter estimates of the model.

Intervention or intervention analysis is a term frequently used to describe an extension of the Auto Regressive Integrated Moving Average (ARIMA) model [1],[2],[3]. Its main purpose is to measure the effect of change either in policy, event etc, on the possible outcome of a variable. Doing intervention requires careful observation to see a significant interruption in the stable pattern of behaviour of a time series of interest caused by intervention and that it is essential to implicitly model its impact [4]. Intervention modeling generalizes the univariate Box-Jenkins methods by allowing the time path of the response variable to be influenced by the time path of the explanatory or intervention variables [3]. Furthermore, intervention analysis in statistics is an evolving regression used to check the impact of an event on the time series of interest [5]. If an intervention is known, it is necessary to find out if there is evidence that such changes in the time series really occurred as expected. And if it is true that the expected change in time series actually occurred, what can be said of the nature, pattern and magnitude of its occurrence.

Several interventions have been modeled concerning daily exchange rates of Nigeria naira and some other currencies. In [6] Etuk et al modeled and analyzed the intervention of daily Yuan-naira exchange rates using the ARIMA. Another study was done by Etuk [7]. He modeled the intervention analysis of daily GBP-USD which was occasioned by BREXIT. In another two separate studies, [8] Etuk et al modeled the intervention of Yen-Naira exchange rates and [9] modeled the exchange rate of the Cedi-USD. These studies were geared toward studying the intervention behavior pattern of various exchange rates.

The Nigeria’s naira is popularly placed against the US Dollar, GB Pounds, CH Yuan and a few others. Not very much is regionally known about the economic and currency relationship between the Norwegian Kroner and the Nigerian Naira.

The pre-intervention time plot from the data obtained for this study shows an initial negative trend and later a positive trend. The explosive issue or jump of the time plot of the exchange rate which does not return to the status quo however continued in the new level indicates an intervention problem. It becomes a problem because the jump in the exchange rate does not favour the Naira. Although, quite a number of daily exchange intervention studies have been done recently by some scholars, attention has not been given to modeling the daily exchange rate intervention between the Nigerian naira and the Norwegian Kroner. Hence, the main purpose of the study is to provide an appropriate time series intervention model of daily Norwegian Kroner/Nigerian Naira exchange rate.

2 MATERIALS AND METHODS

2.1 Data
The data is the daily exchange rate of the Norwegian Kroner to the Nigerian naira. The data starts from October 24th, 2017 to April 21st, 2018, covering a total period of one hundred and eighty (180) days and was obtained from the Nigerian Bureau of Statistics (NBS).

2.2. Methodology

The data analysis here employs the Box-Jenkins method given its using statistical tool.

3. INTERVENTION MODEL

An intervention model is represented by two separate components. There is the set of interventions on the series and a fundamental disturbance term [10]. Box and Tiao [1] stated the general form of intervention model as:

\[ Y_t = V(B)I_t + N_t \]  \hspace{1cm} (1)

where \( I_t \) is an intervention or dummy variable that is defined as:

\[ I_t = \begin{cases} 1, & t = T \\ 0, & t \neq T \end{cases} \]  \hspace{1cm} (2)

The intervention of a policy programme beginning at time \( t=T \) is 1 is called a pulse function if it remains for just a period and a step function if it remains as 1 for the entire presence of the intervention exercise. To illustrate this we write;

\[ Y_t = C + W_t I_{1t} + \frac{\theta(L)}{\phi(L)} \varepsilon_t \]  \hspace{1cm} (3)

where

\[ I_{1t} = S_{1t}^{(c)} = \begin{cases} 1, & T \geq t \\ 0, & \text{otherwise} \end{cases} \]  \hspace{1cm} (4)

C is a constant and \( Y_t \) is the level of change with respect to gains or losses made in the value of reduction. The intervention variable \( I_{1t} \) corresponding to the policy programme here is a step function.

4. DATA ANALYSIS AND DISCUSSION

The time plot of the series in figure 1 indicates an intervention point exactly at \( T=81 \). After the intervention point, the exchange rate between the Norwegian Kroner (NOK) and the Nigerian Naira (NGN) was more than forty-five Naira (₦45.00) per Kroner. The intervention is characterized by a step function as a careful observation of the period after time \( T=81 \), revealed that the exchange rate remained at more than forty-five Naira (₦45.00) per Kroner.

Figure 2 shows the pre-intervention data of the exchange rate of Norwegian Kroner (NOK) and the Nigerian Naira (NGN). The pre-intervention period is from \( T = 1 \) to \( T = 81 \). The time plot above shows an initial negative trend and a later positive trend. This is an indication of a pattern-three intervention analysis of time series. The trends follows a gradual decrease in the mean level which later rapidly increased and levelled off at the new increased or higher mean level. This is clearly not favourable to the Nigerian Naira.

Table 1 shows the null hypothesis that both the Norwegian Kroner (NOK) and the Nigerian Naira (NGN) have unit root. The Augmented Dickey-Fuller test statistics before adjustment indicated (-2.186597) which is not less than the t-value (-3.51536) for 1% (0.01) critical level. Again the value (-2.186597) is greater than the t-value (-2.898623) at 5% (0.05) critical level. Again, the value (-2.186597) is also not less than the t-value of (-2.586605) at 10% (0.1) critical level. The P-value which is 0.2128 is far greater than the 0.05 critical level of significance. This therefore shows that the Augmented Dickey-Fuller test statistics for the exchange rates is not significant.

Figure 3 shows the time plot of the differenced pre-intervention exchange rate moving erratically and showing no definite trend.

Table 2 shows the Augmented Dickey-Fuller test statistics for the differenced pre-intervention exchange rate is (-10.51532) which is less than the t-value (-3.516676) at 1% (0.01) critical level. Again the value (-10.51532) is less than the t-value (-2.899115) at 5% (0.05) critical level. At the same time, the value (-10.51532) is also less than the t-value of (-2.586866) at 10% (0.1) critical level. The P-value which is 0.0001 is also less than the 0.05 critical level of significance. This therefore shows that the Augmented Dickey-Fuller test statistics for the differenced exchange rates is significant.

Furthermore, the augmented Dickey-Fuller test after adjustment difference of the pre-intervention exchange rate shows a p-value of 0.0000 which is less than 0.05, and a C-value of 0.9220. This shows that the differenced pre-intervention series are stationary.

Figure 4 shows the Autocorrelation function (ACF) and Partial Autocorrelation Function (PACF) of the differenced exchange rates (DNOKN). The correlogram of the differenced exchange rate is the autocorrelation structure of white noise. The observations of both the autocorrelation function (ACF) and partial autocorrelation function (PACF) of the differenced exchange rates show no spikes at any of the lags under consideration. This means that they all fall within the mean range of the ACF and PACF.
On the basis of the white noise model of the differenced pre-intervention data, forecasts (F_t) are obtained for the post intervention period. This is given as

\[ Z_t = X_t - F_t \quad [5] \]

where, \( X_t \) is the original series at time \( t \).

\( F_t \) is the forecast at time \( t \).

\[ Z_t = C(1) \ast \frac{(1-C(2))^{(t-80)}}{1-C(2)} \quad [6] \]

Equation [6] is the transfer function and it is further written as;

\[ Z_t = 0.2388 \ast \frac{(1-(0.8064)^{t-80})}{1-(0.8064)} \quad [7] \]

The transfer function shows clearly, a close agreement between the intervention model and the post-intervention observations. Fig. 5 shows the graph of post intervention and intervention forecasts.
Figure 3: Differenced exchange rates, DNOKN

Table 2 Stationarity test for DNOKN

<table>
<thead>
<tr>
<th>Augmented Dickey-Fuller Test statistic</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-2.648178</td>
<td>0.005</td>
</tr>
<tr>
<td>5% level</td>
<td>-2.592115</td>
<td>0.010</td>
</tr>
<tr>
<td>10% level</td>
<td>-2.560686</td>
<td>0.015</td>
</tr>
</tbody>
</table>


Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DNOKN)
Method: Least Squares
Date: 04/26/18  Time: 14:18
Sample (adjusted): 389
Included observations: 78 after adjustments

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNOKN(1)</td>
<td>-1.181847</td>
<td>0.112393</td>
<td>-10.513224</td>
<td>0.0001</td>
</tr>
<tr>
<td>C</td>
<td>0.002916</td>
<td>0.029699</td>
<td>0.096199</td>
<td>0.9220</td>
</tr>
</tbody>
</table>

Table 3 Estimation of the intervention transfer function

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(1)</td>
<td>0.238767</td>
<td>0.061458</td>
<td>3.895797</td>
</tr>
<tr>
<td>C(2)</td>
<td>0.806378</td>
<td>0.051621</td>
<td>15.62099</td>
</tr>
</tbody>
</table>

R-squared 0.157647
Mean dependent var 1.156053
Adjusted R-squared 0.159154
S.D. dependent var 0.406328
S.E. of regression 0.372693
Akaike info criterion 0.883138
Sum squared resid 13.50492
Schwarz criterion 0.935242
Log likelihood -42.15991
Hannan-Quinn criterion 0.904225
Durbin-Watson stat 0.343481
Figure 5: Post-intervention data and Intervention forecasts

5. CONCLUSION

This work modeled intervention in the daily exchange of the Norwegian Kroner to Nigerian Naira. All formal tests and graphical presentations prove the adequacy of the intervention model based on the sample data.

COMPETING INTERESTS

No competing interests exist among authors.

REFERENCES


