

Comparison of the Climates and Economies of Nigeria and Costa Rica

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Abstract — There is definitely a relationship between climate and economy. Even though it is called the giant of Africa, Nigeria is still a developing country in the West Coast of Africa and Costa Rica is in North America and is adjudged to have gone beyond the basics of a developing country but has not quite graduated into a developed country. This work is an attempt to compare the two nations in terms of climate and economy. Climate change impact and adaptation strategies in the two countries will be compared. In particular, as a proxy to the relative performance of their economies the exchange rates of their currencies, the naira and the colon, are studied and modelled. The approach to this modelling shall be that of intervention. This is as a result of the observation that on 4th August, 2017, there was a sharp decline in the amount of the colon per naira. The naira has not recovered till date. ARIMA intervention technique is used to model this currency relationship.

Keywords - Costa Rica, Nigeria, climate change, economy, naira/colon exchange rates, intervention.

I. INTRODUCTION

This research work is focused on a comparison of Costa Rica and Nigeria particularly in terms of climate change and economy. Climate change is a global phenomenon and has impacted every nook and cranny of the universe. It is mainly attributed to the green house effect engendered by emission of carbon dioxide into the atmosphere through industrial activities. It has been said that even though developed and industrialized nations contribute more to the green house effect the developing ones tend to suffer more the effect of the ensuing climate changes. Features associated with climate change include rise in atmospheric temperature, increase in sea level, flooding, drought, the drying up of water bodies, lower crop yields and so on. Each country has been affected in a peculiar way. Needless to say, global economy and that of each country have been impacted too. For instance Enete [1] has discussed some adverse effects of climate change on agricultural productivity in Enugu State of Nigeria. An empirical study by Adelegan and

Enyoghasim [2] has further confirmed that climate can adversely affect the economy.

The Republic of Costa Rica is a Latin American country blessed with a mountainous topography which gives it some protection from the vagaries of climate change. It is located within the latitude and longitude of 10° 00'N, 84° 00'W. It is situated in the north-western hemisphere in North America and has a water area of 40 square kilometers, land area of 51,060 square kilometers, a population of 4,872,543 and GDP US\$61.06 billion. Its climate is tropical in nature and the weather is pleasant throughout the year. Trade winds help to cool the weather and the hottest period is between March and May and the coolest between December and February [3]. It runs a democratic republic with a multi-party system [3].

Nigeria is a West African country located in the Gulf of Guinea of the Atlantic Ocean bordering with Benin to the west, Cameroun and Chad to the east and to the north. It has a water area of 13,000 square kilometers and land area of 910,768 square kilometers. It runs a Federal Presidential Republic type of Government. It is located in the tropics and has two main seasons: the rainy and the dry. Its population is 186,053,386, population density of 204.28/km² and GDP of US\$1,090.00 billion [3].

More discussion of comparative analysis of the two countries in terms of climate change impact, adaptation and expectations shall be given later in this work. This study shall narrow down to the relative performance of their economies with particular reference to their currencies' exchange rates. It is observed that since 4th August, 2017, the naira (NGN) has fallen sharply in value compared to the colon (CRC) and has not fully recovered. This calls for an intervention. It is the aim of this study to model this situation using Box-Tiao [4] ARIMA approach.

This technique has been widely applied and with a measure of success too. For instance Gilmour *et al.* [5] used intervention analysis to measure the health and social effects of a reduction in the supply of cocaine in Australia. Sorié [6] has shown that the introduction of the euro in 1 January

2002 has induced large and significant inflation perception errors in the euro area. Etuk and Eleki [7] have fitted an ARIMA intervention model to the Central African Franc (XAF)/ NGN exchange rates. Monthly household kerosene distribution in Nigeria is explained by an interrupted time series model by Etuk and Sibeate [8]. Etuk *et al.* [9] have proposed a model for the intervention in the distribution of prime motor spirit in Nigeria.

II. MATERIALS AND METHODS

A. Data

All the data used for this work are of secondary sources. Published information from various sources: periodicals and the website mentioned below. Daily NGN/CRC exchange rates from 29th May, 2017 to 24th November 2017 downloaded from the website www.exchangerates.org.uk/NGN-CRC-exchange-rate-history.html are analyzed in this work. The website was accessed for this purpose 25th November 2017. They are read as the quantities of the CRC per NGN and are listed in the appendix. The out-of-sample data were downloaded 14th December 2017.

B. Intervention Modelling

Let $\{X_t\}$ be a time series which encounters an intervention at time $t=T$. Box and Tiao [4] propose that the pre-intervention series be modeled as an ARIMA(p,d,q). that means that for $t < T$

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

where ∇ is the differencing operator and $\{\varepsilon_t\}$ is a white noise process. Let L be the backshift operator defined by $L^k X_t = X_{t-k}$. Then $\nabla = 1 - L$ and (1) may be written as

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

Or

$$\Phi(L)(1 - L)^p = \Theta(L)\varepsilon_t \quad (3)$$

where $\Phi(L) = 1 - \alpha_1 L - \alpha_2 L^2 - \dots - \alpha_p L^p$ is the autoregressive (AR) operator and $\Theta(L) = 1 + \beta_1 L + \beta_2 L^2 + \dots + \beta_q L^q$ is the moving average (MA) operator. The constants α 's and β 's are chosen such that the zeros of Φ and Θ are outside of the unit circle for model stationarity and invertibility respectively.

From (3) the noise component of the intervention model is

$$X_t = \frac{\Theta(L)\varepsilon_t}{\Phi(L)(1-L)^p} \quad (4)$$

On the basis of the fitted model (1) forecasts are made for the post-intervention period of the series. Let this be F_t , $t > T-1$. For this post-intervention period, let $Z(t) = X_t - F_t$. Then according to [10]

$$Z(t) = \frac{c(1)^*(1-c(2)^{t-T+1})}{(1-c(2))} \quad (5)$$

Equation (5) is the transfer function of the intervention model. Therefore the overall intervention model is obtained by combining (4) and (5) to have

$$Y_t = \frac{\Theta(L)\varepsilon_t}{\Phi(L)(1-L)^p} + I_t \frac{c(1)^*(1-c(2)^{t-T+1})}{(1-c(2))} \quad (6)$$

where $I_t = 1$, $t > T - 1$, and zero elsewhere.

C. Computer Software

Eviews 10 was used for all computational work. It uses the least error sum of squares principle for model estimation.

III. RESULTS AND DISCUSSION

A. Comparison of the Climates

In Costa Rica, there has been loss of biodiversity [11]. As the change worsens the country is becoming warmer and drier and the sea level is rising higher and higher. In Cahuita which is on Costa Caribbean coast, infrastructure which used to be on dry land a few years ago is now immersed in the sea [12].

Adaptation and remediation activities are going on. From 80% deforestation in the late 1980s through aggressive planting of trees about a half of the country is forest again. Costa Rica is reputed for aiming at a zero level carbon emission by 2021 and it is the only country in Central America with such a goal [13].

On Nigeria, climate change has taken its toll too and even in a much wider scale. Odjugo [14] has empirically demonstrated that air temperature has been consistently on the increase and rainfall has been on the decrease in Nigeria between 1901 and 2015. Of late there have been cases of violent conflict in the country and the incidence is on the rise. For instance, in the 22nd April to 28th April 2018 week a Catholic Church was attacked by Fulani herdsmen and two

priests were killed alongside seventeen worshippers. The Boko Haram sects carrying out its ravaging activities and herdsmen are drifting southwards to avoid the increased desertification of the Northern parts of the country [15]. This is attributed to climate change which has increased atmospheric temperatures and reduced rainfall. There is also a noticeable reduction in crop yield. Lake Chad four decades ago or so had an area of more than 40,000 square kilometers but now has only 1,300 square kilometers area [16].

Adaptation and remediation are seriously hampered by scarcity of funds. However it has been recommended that afforestation efforts should be geared up. One way this can be done is in discouraging the use of wood for furniture and building in favour of iron and steel products. There is a plan to supply water to the disappearing Lake Chad and the Congo Basin.

B. NGN/CRC Exchange Rates Analysis

Exchange rate of the NGN and the CRC is being used here as a proxy for the comparative performance of the economies. Costa Rica is not a developing country and neither has it reached the status of a developed nation. On the other hand, Nigeria is still a developing country even though it is being referred to as the giant of Africa.

The time plot of of the exchange rates in Figure 1 shows a sharp decline at $t=68$ on 4th August 2017. This is the intervention point. It follows that the relative performance of the Nigerian economy has worsened. The pre-intervention rates have fairly horizontal trend (See Figure 2) and are adjudged stationary by the Augmented Dickey Fuller Test as summarized in Table 1. Its correlogram of Figure 3 shows evidence of 12-daily seasonality. An additive seasonal autoregressive model

$$(1 - L)X_t = 0.6130(1 - L)X_{t-1} + 0.3869(1 - L)X_{t-12} + \varepsilon_t \quad (7)$$

was fitted to it as summarized in Table 2. It has been shown to be adequate; the autocorrelation structure of its residuals shown in figure 4 is such that the residuals are mostly uncorrelated. Therefore the noise component of the intervention model is

$$X_t = \frac{\varepsilon_t}{(1-L)(1-0.6130L-0.3869L^{12})} \quad (8)$$

Forecasts were obtained for the post-intervention period on the basis of (7) and $Z(t)$ was modeled according to equation (5) and was summarized in Table 3 by

$$Z(t) = \frac{-0.2823*(1-(-0.1654)^{t-67})}{1.1654} \quad (9)$$

for $t > 67$. This is the transfer function of the model, by combining (8) and (9), as

$$Y_t = X_t + I_t Z(t) \quad (10)$$

where $I_t = 1, t > 67$ and zero elsewhere. Post-intervention forecasts and observations are shown to closely agree in Figure 5. In Table 4 it may be observed that there is a close agreement between out-of-sample observations and their corresponding forecasts.

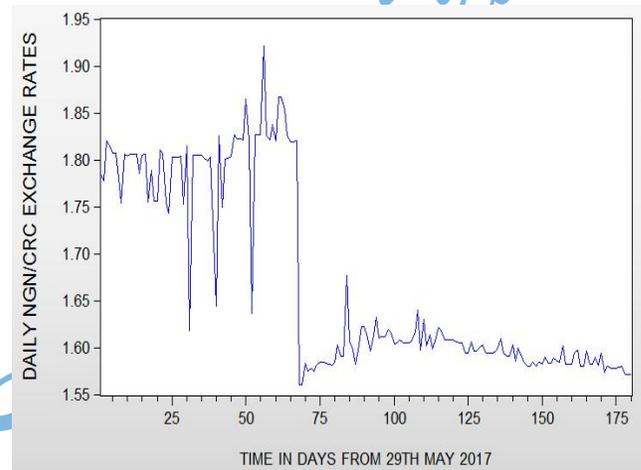


Figure 1: Time plot of daily NGN/CRC exchange rates.

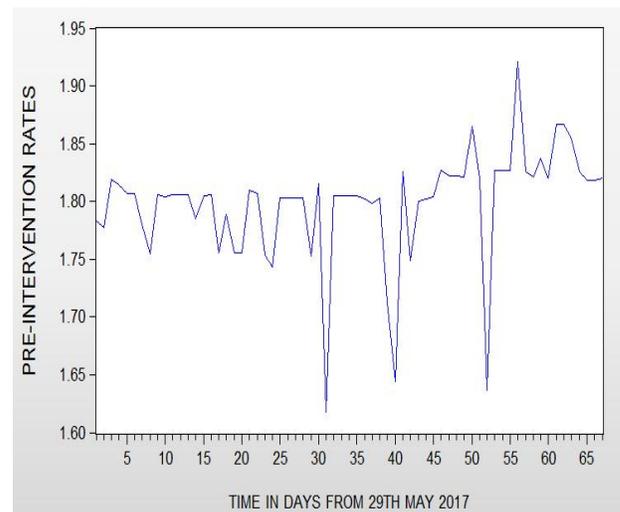


Figure 2: Time plot of the pre-intervention rates.

Table 1: Stationarity test for pre-intervention rates

Null Hypothesis: Pre-intervention NGN/CRC exchange rate series has a unit root

		t-statistic	Probability
Augmented Dickey-Fuller test statistic		-6.678428	0.0000
Test critical values	1% level	-3.533204	
	5% level	-2.906210	
	10% level	-2.590628	

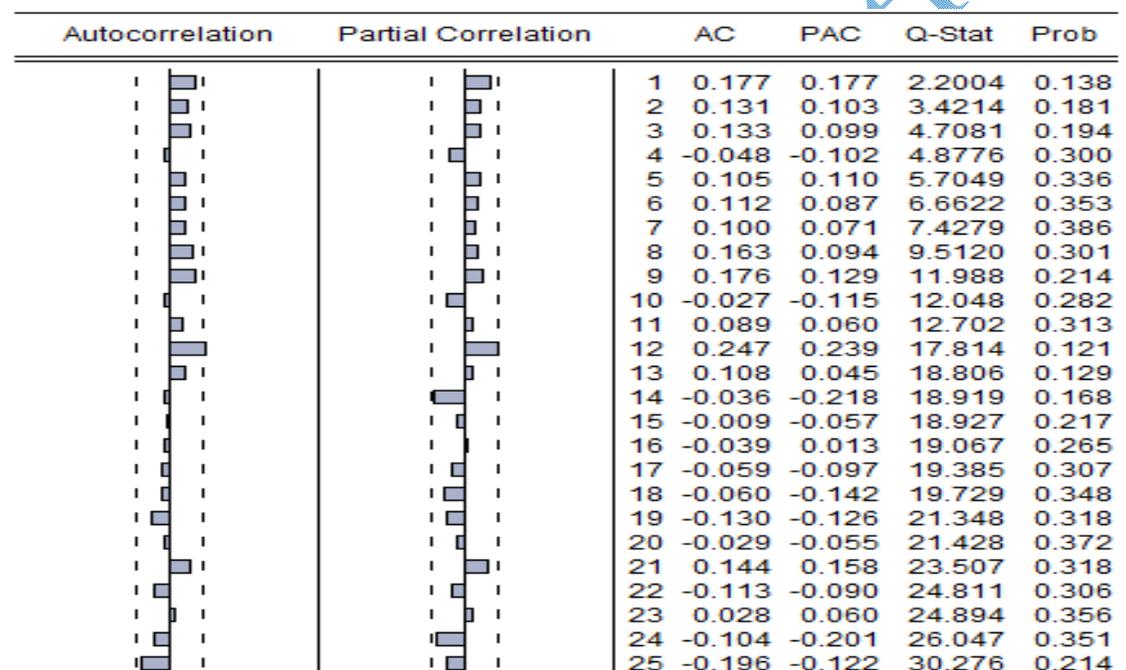


Figure 3: Correlogram of the pre-intervention series.

Table 2: Estimation of the pre-intervention AR(12) model

Variable	Coefficient	Standard Error	t-Statistic	Probability
AR(1)	0.613008	0.000297	2066.983	0.0000
AR(12)	0.386918	0.001677	230.7165	0.0000
SIGMASQ	0.002595	0.000298	8.715318	0.0000

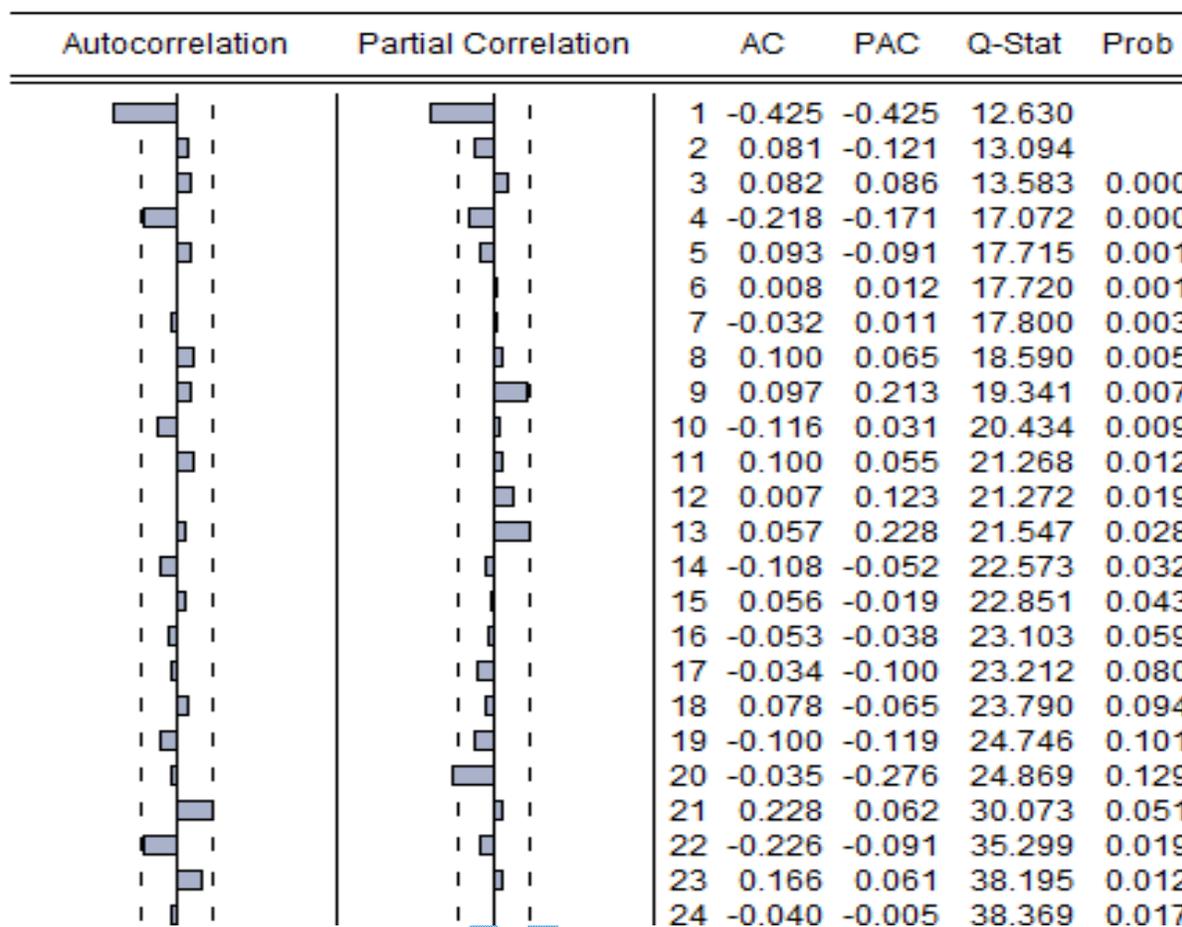


Figure 4: Correlogram of the pre-intervention AR(12) residuals.

Table 3: Estimation of the intervention transfer function

Dependent Variable Z
 Method: Least Squares (Gauss-Newton / Marquardt steps)

	Coefficient	Standard Error	t-Statistic	Probability
C(1)	-0.282331	0.016424	-17.19052	0.0000
C(2)	-0.165390	0.067975	-2.433101	0.0000

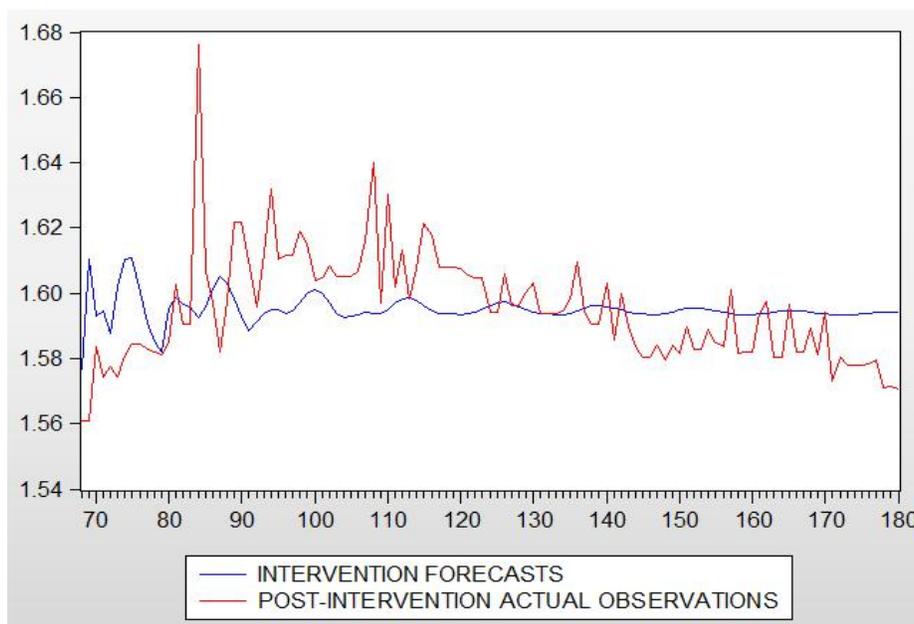


Figure 5: Comparison of the post-intervention observations and forecasts.

Table 4: Out-of-sample observations and forecasts

DATE	ACTUAL OBSERVATION	INTERVENTION FORECAST
November 25, 2017	1.5708	1.5938
November 26, 2017	1.5681	1.5936
November 27, 2017	1.5706	1.5934
November 28, 2017	1.5707	1.5932
November 29, 2017	1.5717	1.5931
November 30, 2017	1.5802	1.5931
December 1, 2017	1.5728	1.5931
December 2, 2017	1.5728	1.5933
December 3, 2017	1.5742	1.5934
December 4, 2017	1.5728	1.5936
December 5, 2017	1.5736	1.5936
December 6, 2017	1.5756	1.5936
December 7, 2017	1.5715	1.5936
December 8, 2017	1.5768	1.5935
December 9, 2017	1.5768	1.5933
December 10, 2017	1.5769	1.5931
December 11, 2017	1.5749	1.5930
December 12, 2017	1.5716	1.5929
December 13, 2017	1.5697	1.5928

IV. CONCLUSION

Costa Rica has immense advantage over Nigeria. Topographically it is sheltered by a mountainous environment from disasters like hurricanes and cyclones and is reputed as the least affected country by climate change within the Central American zone. It has a higher per capita income than Nigeria and is in a better position to combat the effect of climate change. Nigeria is also making serious efforts to contain the damaging effects of climate change though bedeviled by an economic recession and bad governance which are believed to be the reason for the intervention in the currency exchange rates. The intervention model (10) may be useful in the management of its economy and particularly with regards to the relative value of the naira.

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