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Co-Integration Analysis of Exchange Rate and Inflation Effects on Economic Progress of Nigeria

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ABSTRACT

Exchange rate fluctuations and inflation have posed the biggest challenge to Nigeria's economy. We examined the relationships between the US dollar and the Nigerian Naira exchange rate, as well as the effects on the economic growth of Nigeria (GDP). The Dickey Fuller enhanced test was used to assess the series' stability, and the Johansen co-integration test was applied to evaluate if the variables were co-integrated. ADF results show that the entire variables are stationary at the first difference rather than at the level. Trace statistics show that in a system with a 5% important level, there are at least two co-integrations according to the Johansen co-integration test. According to the longterm co-independence, INFR and EXR have a negative relationship with GDP, while in the short term the system has corrected its previous delays to a disbalanced position, with 58.9% quarterly growth, respectively Furthermore, the vector error correction model indicated GDP for a small-scale period was positively influenced by EXR, while INFR for a medium-scale period was significantly affected by INFR.

Keywords: Exchange Rate, Inflation, Economic growth (GDP), Stationarity, Economic growth cointegration, Vector Error Correction Model.

INTRODUCTION

In recent years, the research community has shown great interest in exploring the impact of exchange rates and rising prices on economic development. In particular, the challenges posed by exchange rate fluctuations and persistently high inflation rates have significant implications for developing nations, including Nigeria.

Nigeria, as a case study, grapples with a fragile exchange rate and persistent high inflation. The continuous drop in the value of the naira relative to other foreign currencies significantly affects her economy. Calderon *et al*. in (2020) conducted a study and revealed that factors such as the closure of borders, insecurity in the North-East, and challenges in key agricultural regions (such as the North-Central) contribute to Nigeria's poor GDP performance. For instance, the Boko Haram invasion in the North-East, rampant banditry activities in the North-Central and Western regions, and ongoing conflicts between Fulani herders and farmers all strongly impact agricultural activities in Nigeria. Consequently, the continuous increase in the price of domestic food items remains a critical area of concern for governments at all levels, particularly considering the 3.62 percent decrease in the first quarter of 2020 (National Bureau of Statistics, 2020).

In Nigeria, the economy had a major downturn in 2016 and 2020 due to two consecutive quarters of decline. The recession had a negative impact on government revenue and forex exchange rate. Consequently, the prices of consumable food items have skyrocketed in the past few months (National Bureau of Statistics, 2020). In addition, the government

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has been compelled to take loans from advanced as well as developing nations. The National Bureau of Statistics (2020) reported that Nigeria's GDP declined to 6.10 percent in 2020 from -5.0 percent in 2019 and -2.1 percent in 2018. The decline in GDP was mostly due to reduced economic activity both domestically and internationally because of general shutdown measures implemented to control the Covid-19 epidemic (Olunkwa *et al.*, 2021).

As a measure against inflation, Nigeria took a decisive step by devaluating her currency. The CBN strives to preserve a sustainable inflation level. The exchange and inflation rates adopted by countries often influence their investment decisions, as well as economic growth. For example, a moderate level of exchange and inflation rates could cause local firms and international trade to increase the level of investment in the country (Razin & Collins, 1997).

Prior studies have confirmed that exchange rates are associated with rise of economy in various countries. Razzaque et al. (2017) found that the conversion rate has a negative impact on economic development in both the short and long term for Bangladesh. For Ethiopia, different observations were made by Demile (2015) and (Yabu and Kessy, 2015; Mamo, 2012). While the study by Demile (2015) reported a positive relationship, that of Yabu and Kessy, 2015; Mamo, 2012 was negative. Also, the study conducted in the long- and short-run by Tadele (2014) indicated a positive and negative relationships for Ethiopia and Uganda, respectively.

On this subject, there appears no clear evidence in literature that examined the interplay among rising prices, conversion rate, and economic development in both the short and long run in Nigeria. This research intends to understand how the variables in question has impacted the Nigerian economy by using time series data from 2000Q1 to 2022Q2.

Literature Review

A review of the literature indicates that the exchange rate and inflation rate are macro-economic indicators that could either positively or negatively influence the country's economy. Various studies have used different methods to analyse how micro-economic factors affect the economy. Okoro and Charles (2019) applied cointegration, unit root, Granger causality testing, and error correction estimations to examine the dynamic impact of commodity currencies on the financial market. The outcome of their investigation indicates that the Japanese and Chinese yen, as well as the French franc, have a detrimental long-term impact on the actual gross domestic product of Nigeria. The analysis of the US dollar and British Pound Sterling revealed a favourable long-term effect on the GDP.

In 2019, Akinbode *et al.* conducted a study on the impact of currency rates on economic development in Nigeria using Autoregressive Distributed Lag (ARDL) analysis. The study revealed that factors such as imports, trade openness lag, Foreign Direct Investment (FDI), currency conversion rate, interest rate, and inflation had a substantial influence on the economic growth of the nation in the long-term. Idris and Suleiman (2019) study how inflation affected economic development in Nigeria between 1980 and 2017. They applied the vector error correction approach on certain parameters, including gross domestic product, inflation rate, interest rate, and exchange rate in the nation. Their findings indicate a sustained co-rrelation between the variables and the inflation rate, with the interest rate exerting a substantial and adverse impact on long-term economic development of Nigeria.

Onwubuariri *et al.* (2021) assessed the effect of inflation on economic development of

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Nigeria through the auto-regressive distribution gap (ARDL) and the error correction (EC) models. Their findings indicate that rising prices of goods has a detrimental impact on economic growth by diminishing competitiveness and decreasing the buying power of money. Ewubare and Ushie (2022) analysed the relation between the unstable currency conversion rates and economic growth in Nigeria. They used bounds co-integration testing and the ARDL model to show a long-term connection between GDP increase and certain indicators, which were found to have a negative impact on economic growth. Yusuf *et al.* (2022) also observed that the relationship between inflation and currency conversion rates has negatively affected, in short-term, the economy but a favourable outcome in the long-term.

The impact of rising prices as well as the currency conversion rate on economic development has led to divergent conclusions in the field of economics, with no consensus reached on the co-relation between conversion rates, price hikes, and economic growth. Developing nations like Nigeria are underrated in the rankings due to the abundance of material and the instability of conversion rates.

MATERIALS AND METHODS

The Nigeria Central Bank (CBN) database provides adequate quarterly data covering 2000Q1 through 2022Q2. Exchange rates from naira to US dollar (EXR), inflation rate (INF), and economic growth (RGDP) are variables of interest used in this study. The ADF test, also known as the Augmented Dickey Full, was utilised to assess data stationarity, while the Johanson test for co-integration and the VEC models were applied to analyse the short-term and long-term influence between the GDP, INF, and EXR.

Augmented Dickey Fuller (ADF) Test

The ADF approach is used to test the stationery of time series data in this research work, which is the most widely used for this kind of analysis. The ADF test estimates the following regression:

$$\Delta Y_t = \alpha + \beta y_{t-1} + \sum_{j=1}^{p} \emptyset_j \Delta Y_{t-j} + e_t \qquad 1$$

Where, and are the coefficients, t is the stochastic time and e_t is a white noise error term.

The standard Dickey-Fuller model has been augmented by Δy_{t-j} and then the ADF model was obtained above.

Decision Rule: Reject H_0if the test statistics are less than the critical value, or if the asymptotical p – value is less than the significant value, otherwise accept the null hypothesis.

Co-integration Test

Multiple efforts have been undertaken to establish the co-integrating order of a Vector Error Correction (VEC) algorithm. Several of them are evaluated and contrasted as reported in (Hubrich *et al*., 2001). The Johansen (1995) likelihood ratio (LR) technique and its variants are often recommended due to their robustness compared with alternative techniques that might have limitations in certain scenarios. Although the data variable may not be normally distributed, the likelihood ratio testing could show better characteristics compared to other methods.

If $r = n$ and a model is unrestricted, using Banerjee *et al* (1993) method, the maximized log likelihood is given by

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$$L(n) = K - (\frac{T}{2}) \sum_{i=1}^{n} \log (1 - \lambda_i) \quad (2)$$

Where $K = -(\frac{T}{2})(n(1 + log2\pi) + log|S_{\infty}|$

For any given value of r, where r < n, only the first Eigen value should be positive. If a model is restricted, the log likelihood is given by

$$L(r) = k - (\frac{T}{2}) \sum_{i=1}^{r} \log (1 - \lambda_i) \quad (3)$$

A likelihood ratio test of the hypothesis that there are r co-integration vectors against the alternative hypothesis that there are n co-integration vectors is given by:

$$\eta_r = 2\big(L(n) - L(r)\big) = -T(\sum_{i=r+1}^{n} \log (1 - \lambda_i) \quad 4$$

The above equation is known as the trace statistics.

Decision rule: Accept H_0: (there is no significant co integration relationship) if t – is greater than the critical value or if the asymptotical value p - is less than the level of significance. Otherwise, accept H_0.

Vector Error Correction Model

The Vector Auto-regressive Model (VAR) is an econometric model that represents the dynamic connections between stationary variables. The initial step in this approach is to assess the stationarity of the variables. If the variables are not stationary at the first level, then compute the first differences of the series and repeat this process until it achieves stationarity. If the variables are not stationary at the level, adjustments must be made to the VAR model to provide a reliable assessment of the connection between the variables. The VEC is a specific form of the VAR model designed for variables that exhibit stationarity when differenced once. If the series are co-integrated, they progress together over an extended period. Hence, it is suitable to use VEC for determining short-term and long-term effects among the variables. The VEC model can be described as below:

$$\Delta y_t = \pi y_{t-1} + r_1 \Delta y_{t-1} + \ldots + r_{p-1} \Delta y_{t-p+1} + c + e_t \quad \ldots\ldots 5$$

RESULT AND DISCUSSION

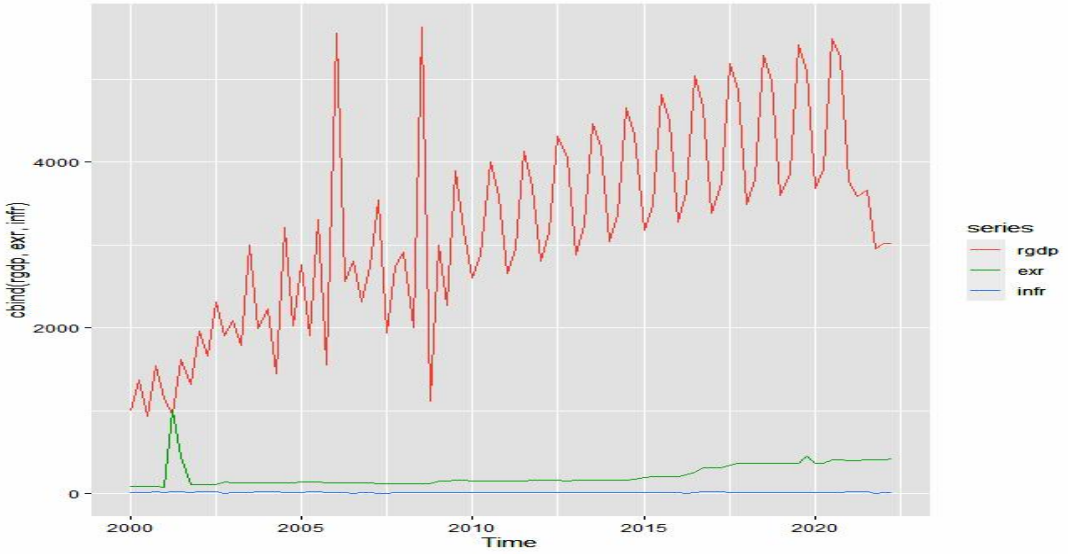

Figure 1: Line graph for the actual time series data on RGDP, INFR and EXCR.

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Figure 1 displays the three-month trends of RGDP, INFR and EXCR. The line graph shows that the time series data is not stationary.

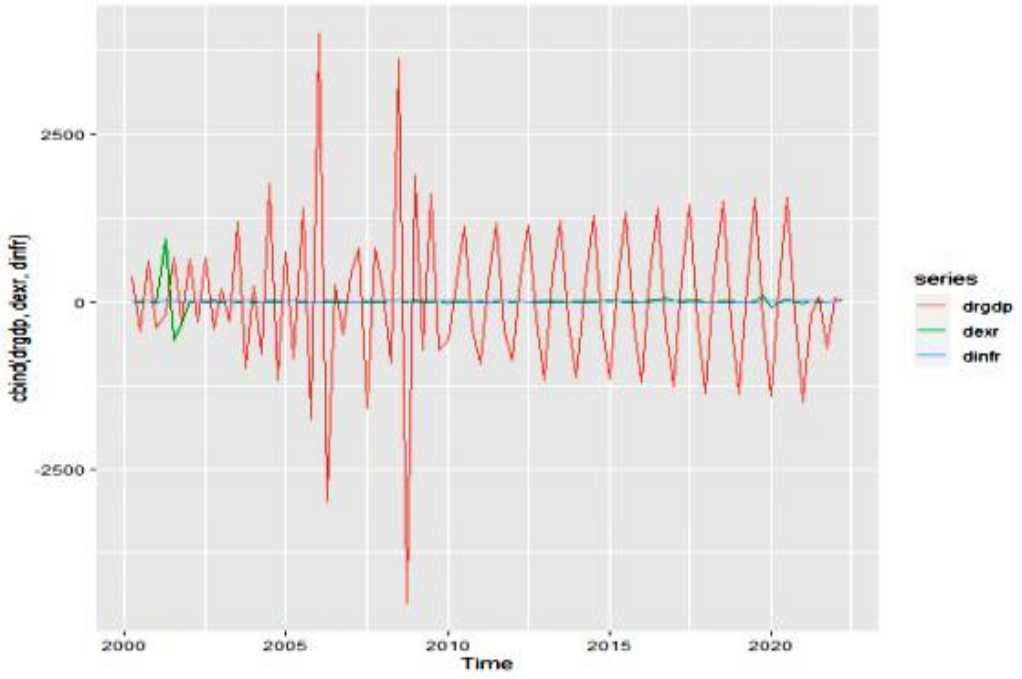

Figure 2: The line graph for the first difference of data on RGDP, EXCR and INFR

Figure 2 illustrates the nature of the trend for RGDP, EXCR and INFR indicates that the trends were improved and seen to be stationary after taking the first difference of the variables compared to Figure 1. Both graphs show a long-term movement in the same direction over the period considered and are related.

Unit Root Test

Table 1: Augmented Dickey Fuller Unit root test.

	At level		**AT FIRST DIFFERECING**		**Order of integration**
Variables	ADF	p-value	ADF	p-value	
RGDP	0.87058	0.9519	5..5674	0.01 ***	1(1)
EXR	2.8434	0.2293	-5.2431	0.01 ***	I(1)
INF	-2.9908	0.1687	-6.1603	0.01 **	I(1)

Note: *** indicates that the variables are significant at 5% significant level, at automatic maximum lags of 4

The H_O is that a series is not stationary against the alternative hypothesis H_1 that a series is stationary.

The stationarity test results obtained from the augmented Dickey-Fuller (ADF) test are shown in Table 1. Ultimately, the entire variables became stable at the first difference, indicating that they are integrated of order one (I(1)). With an RGDP value of 0.9519 > 0.05 at the level, the null hypothesis that it is not stationary at the level is accepted. However, after taking the first differences, the p-value of 0.01 < 0.05 significant threshold, leading to the rejection of the null hypothesis. Therefore, RGDP is stationary at the first differences. For EXR, when the p-value is 0.2293 > 0.05 at

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level, the null hypothesis (stationary at level) is accepted. After taking the first difference, with a p-value of 0.01 < 0.05, the null hypothesis is rejected, and it is concluded that EXR is stationary at the first difference. If the initial p-value for INF is 0.1687, which is above the significance threshold of 0.05, and after taking the first difference the p-value becomes 0.01 < 0.05, then the null hypothesis should be rejected. It may be concluded that INF is stationary at the first differences. This suggests that all the variables are stationary at I(I). Next, determine the optimal lag order for the VAR model.

Lag Order Selection

The Akaike and Hannan-Quin (HQ) information criteria, and the Final Prediction Error (FPE) were applied to choose an appropriate lag duration. Table 2 displays results for several selection criteria, with Lag four being chosen as the suitable lag duration considering it was the most frequently picked by the criterion.

Table 2: Lag order selection

Lag selection criteria	AIC	HQ	SC	FPE
No. of lags	4	4	3	4

Next, we will check for the presence of a long-term link (co-integration) across the variables.

Johansen Cointegration Test

The Johansen test for co-integration was applied to establish the co-integration rank of the variables, since one of the prerequisites for using VECM is that the variables need to be co-integrated. Table 3 presents the trace outcomes of the test.

Table 3: Johansen test result (trace statistics)

H_O	Test statistic	Critical values		
		10%	5%	1%
r <=2	37.30	7.52	9.24	12.97
r <=1	105.04	17.85	19.96	24.60
r = 0	186.02	32.00	34.91	41.07

Table 3 indicates that all test statistics in the cointegration rank test exceed the threshold for significance at significant levels of 10 %, 5 %, and 1 %. Hence reject the null hypothesis which said there is no co-integration between the variables and conclude that there are at least two co-integration equations between the variables at all the three level of significant.

Long-Run Co-Integration Equation

The long run cointegration equation for RGDP is presented as given in Equation 6:

$$RGDP = 22.580 + 0.164EXCR - 0.1958INFR \quad \ldots\ldots\ldots\ldots 6$$
$$(0.0123) \qquad (0.0432)$$

The long-run cointegration equation indicates that EXR has a positive significant relationship with RGDP at a significant level; this indicates that increases in EXCR by 1.64%, will induce an increase in RGDP of 1 unit. These results agree well with the existing studies by (Idris and Suleman, 2019) and (Yusuf *et al.,* 2022). On the contrary, the results reported by (Razzaque *et al.,* 2017) and (Akinbode *et al.,* 2019) showed a negative long-term relationship with RGDP. Since INFR has a negative long-term relationship with RGDP at a significant 5% level, it indicates that the increase of 11.96% in INF will induce a decrease in RGDP by 1 unit. Furthermore, Similar results were also

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achieved by (Yabu and Kessy, 2012) in contrast to the findings of (Yusuf *et al.,* 2022) and (Idris and Suleman, 2019) that reported a significant positive long-term relationship between inflation and economic growth.

Error Correction Model

The short run co-integration equation was presented as given below:

$$\Delta RGDP = 0.019 + 0.28\Delta RGDP_{t-1} - 0.21\Delta INFR_{t-1} + 0.76\Delta EXCR_{t-2} - 0.57ECT_{t-1} \quad \text{.....(7)}$$
$$(0.0231) \qquad (0.0145) \qquad (0.0324) \qquad (0.0013)$$

Our ECM model shows that the system was significantly corrected at its previous lag to disequilibrium position in the long run at a rate of 57% at a 5% significant level. The results show that there is a significant short-term relationship between RGDP and its first lag at 5% significant level, EXCR has a significant positive short-term relationship with RGDP at lag 1.A similar outcome was reported by (Tadele, 2014) for Ethiopia. In contrast, the study carried out by Razzaque *et al*, (2010) showed that INFR has a negative significant relationship with RGDP at lag 2 at 5% significant level. This observation was supported by the findings of previous authors such as (Idris and Suleman, 2019), (Yusuf *et al*, 2022) and (Idris and Suleman, 2019).

CONCLUSION AND RECOMMENDATION

This research analysed the long-term and short-term correlation among the currency rate, rising inflation, and growth in the economy of Nigeria. It used quarter-to-quarter information on economic growth (RGDP), inflation rate (INFR), and exchange rate (EXCR) obtained from the CBN database from 2000 to 2022. The vector error correction model study showed that economic growth (RGDP), inflation rate (INFR), and exchange rate (EXCR) were stationary after being differenced once, and there are at least two co-integrations among them. The system repaired its previous period imbalance at a set rate of adjustment in the long run for economic growth, inflation, and exchange rate. The estimated findings indicate that 57% of the imbalance in economic growth was addressed on a quarterly basis. The inflation rate significantly hinders short-term economic development, whereas exchange rate notably boosts economic growth. The findings showed that the model reaches its equilibrium position in the long term when faced with shock and disequilibrium.

As a result of the above findings, the following are recommended.

a) Financial policy should aim to achieve and sustain stability of prices.

b) The government should implement an economic reform to align with the inflation rates to promote economic development.

c) Financial policy should involve government intervention in the market current conversion rates reserves for local refining to stabilise prices of market products and restrict the conversion rates within the limit that could economically boost domestic growth.

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