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A Granger Causality Test (GCT) Approach to Exchange Rate Volatility on Prices of Selected Construction Materials in North-Central Nigeria

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Abstract:

The importance of construction materials to Nigeria's construction industry sub-sector cannot be overemphasized considering its monumental contribution to its output. Unfortunately, there has been a continual upward surge in the prices of construction materials and its attendant effects on the volume of construction output owing to price vagaries which now threatens the infrastructural output of this sub-sector. This study thus, applies Granger Causality Test (GCT) to investigate the effect of Exchange Rate Volatility (ERV) on selected construction material prices for construction projects within the North-Central geopolitical zone of Nigeria. The data employed Exchange Rate Volatility (ERV) trend, and Average Price Trends (APT) of Cement, Block, Tile and Reinforcement for the period between 2011Q1 and 2020Q4. The results show p-values of 1.006e-05, 1.006e-05, 0.000668 and 1.006e-05 respectively for Cement, Blocks, Tile and Reinforcement. Thus, implying that there is presence of stochastic trend amongst the variables, as ERV do not granger-cause the selected construction material prices as well as having a long run unidirectional relationships with these materials prices. This study concludes that exchange rate votality has a negative consequence on each of the selected construction materials with a unidrectional impact and same not happening in reverse with its sensitivity not having a transformative effect on these materials prices except with the combination of several macroeconomic variables. The study recommends the need for the implementation of requisite fiscal policies including reduction in the usage of other currencies other than the Naira to transact within Nigeria, stoppage of the use of US Dollars as an intermediary for international currency exchanges and an increase in the production capacity of local construction materials.

Keywords: *Building Materials Prices, Construction Projects, Exchange Rate Volatility (ERV), Granger Causality Test (GCT), North – Central Nigeria*

1. Introduction

Construction projects are continuously carried out in a dynamic and changing environment induced by the increased uncertainties experienced in macroeconomic factors (Zavadskas et al., 2015), which is consequential to the construction materials

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prices and subsequently, the construction project output (Muhammed et al., 2022). Udosen & Akanni, (2010), describes building materials as comprising a wide range of materials used for construction activities with no engineering specialty being possible without their application. Studies of Ogunsemi (2010), Rajaprabha et al. (2016), Alabi (2017) and Idowu & Winston (2018), states that construction materials makes up between 50 - 60 percent of any construction project and therefore, requires adequate attention with regards to price increment and consequent impact on volume of construction project delivery. Derakhshanalavijeh & Teixeira, (2017), identifies exchange rate volatility as a major factor that influences the price fluctuation of building materials in developing nations. While Otieno, (2018), posits exchange rate to be the value or worth of money required in Naira to purchase a foreign currency or product mostly from another country, Obaedo & Oseghale (2020), affirms that the predominant foreign currency in use for most transactions in Nigeria is the US Dollar ($). Consequently, exchange rate have had a negative effect on the delivery of Nigeria's construction projects, as many projects are affected by the inconsistency of construction material prices in Nigeria (Muhammed & Adindu, 2021), induced by exchange rate volatility (ERV). Accordingly, the study of Oladipo & Oni (2012), suggests that construction materials price hike is due to unstable economic factors, and this has critically restrained the progress of the construction sector. Adegbembo & Adeniyi (2015), posits that there is need to stabilize economic indicator figures such as ERV, inflation and interest rate in order to control construction material prices. Similarly, Ogundipe & Ogundipe (2013) and Akanni et al. (2014), agrees that Naira exchange rate is integral to reducing construction material prices which has significantly affected the construction sector productivity in terms of project delivery.

As a result, many developing countries experience a similar reduction in construction outputs as a result of the volatile economic factors ensuing to fluctuation in the prices of construction materials (Derakhshanalavijeh & Teixeira, 2017). In New Zealand, Zhao et al. (2017), establishes ERV, producer price index (PPI), inflation, foreign direct investment (FDI), consumer price index (CPI) and liquidity index level (LIL) as affecting construction prices. Kim et al. (2011), identifies ERV, gross national income (GNI), CPI, liquidity ratio (LR), interest rate (IR), debt-leverage ratio as affecting the Korean construction industry. Kissi et al. (2017) and Enuameh (2019), agrees that the Ghanaian construction tender and material prices are affected by the economic factors of ERV, PPI, GDP, interest rate and composite CPI. Similarly, Hassen (2021), notes that ERV, inflation rate, interest rate and CPI are the economic factors affecting construction materials in Ethiopia. Despite the prevalence of several studies on the economic factors affecting construction material prices including the ERV, the problem remains that there is dearth of literature that establishes the long run effect of ERV on these construction materials prices, while the causal relationship between exchange rate and these materials prices largely remain in obscurity as well as the overall effect of the continued astronomical rise in exchange rate values against the foreign currencies especially in Nigeria. Consequently, if nothing is done about it,

there would arise an uncontrollable increase in the prices of the construction materials to a point that the cost of construction project would be so high to the extent that many project would either be abandoned or fail to take-off, which is consequential to the developmental stride of the nation (Muhammed et al., 2022), which reinforces the urgency for this study.

Several studies such as that of Ugochukwu et al. (2017), examines the correlation between exchange rate and construction materials prices with an application of correlation analysis. Olatunji et al. (2018), assesses the causal relationship between fluctuation in building materials and outturn cost of project with similar application of correlation analysis. Omede & Saidu (2021), uses Mean Index Score (MIS) and Correlation analysis to investigate materials price fluctuation influence on contractors building cost performance in Abuja. Similarly, Obaedo & Oseghale (2020), applied correlation and regression to analyse the impact of ERV on prices of selected constructed materials in Edo state. Despite these studies, the challenge remains that the continued rise in exchange rate in Nigeria has continued to impugn the prices of these construction materials with little to no effect of these studies. As a result, this study attempts a different perspective on the ERV concept by adopting 'Granger Causality Test (GCT)' approach to investigate the impact of ERV on selected construction material prices in North-Central Nigeria projects. Thus, the specific objectives of this study are to;

1. Investigate the presence of stochastic trend amongst the selected variables
2. Determine the long run relationship between ERV and the selected construction materials prices.
3. Assess the causal relationship between ERV and the selected construction materials prices.
4. Suggest possible solutions to ameliorate the challenges posed by ERV.

2. Theoretical Background

Exchange Rate and Building Materials Prices

Naira (₦) exchange rate is the value or worth of money required in Naira to purchase a foreign currency or product mostly from another country (Otieno, 2018). The predominant foreign currency in use for most transactions in Nigeria is the US Dollar ($) (Obaedo & Oseghale, 2020). When the value of money required to purchase a dollar falls or reduces, it is referred to as Naira gaining strength against the dollar. Conversely, if such increases, then it is referred to as Naira weakening (Otieno, 2017). The Naira currency lost more than half of its worth in exchange when the country experienced a free fall in the prices of petroleum products that culminated into the nation experiencing recession twice in the last half a decade. Several studies opined the numerous significance of exchange rate to the prices of building materials (Oladiran, 2015; Windapo et al., 2017; Muhammed & Adindu, 2021; Muhammed & Muhammed, 2021). It is also a strong indicator of economic performance which

connotes a reflection of the strengths and weaknesses of an economy (Anoka & Takon, 2014). The annual trend of exchange rate between 2011 and 2020 which is the period considered for this study portend an aggressively continuous rise in rate of exchange of Naira to US Dollar from the lowest recorded of ₦153.90 in 2011 to the highest of ₦358.80 recorded in 2020. Furthermore, exchange rate is an important determinant of a country's cross-border trading growth which either promotes or reduces international competitiveness (Otieno, 2017).

Cement

The demand for cement production and distribution are induced by the increment in construction activities which is a determinant of infrastructural development brought about by residential and commercial construction activities through private or corporate developers within a nation (Okpalaobi et al., 2022). There exist abundant input resources for local commercial production of cements in Nigeria (Anosike, 2021). African Iron and Steel Association (AISA, 2010), posits that the cement industry grow rapidly in Nigeria to a value of almost ₦134 billion in 2008 which was a significant increase in the ₦26 billion obtainable in 2004. Fast forward to 2011, the cement (50kg) average prices has progressively risen from ₦1,300 which is the least price between 2011 and 2020 to ₦2,925 which is the highest price of the cement within the North-Central Nigeria for the period considered.

Sandcrete Blocks

Nigeria's construction sector mostly use hollow sandcrete blocks to carry out its activities, thus, playing an important role in building projects (Aiyewalehinmi & Tanimola, 2013; Morenikeji et. al., 2015; Ajao & Ogunbayo, 2018; Anosike, 2021). Sandcrete blocks are building material manufactured industrially or manually through the combination of water, sand and cement in a specified ratio in accordance to its requirements and used in walling of houses, fences, and other infrastructures (Ambrose et al., 2019; Adese & Olajide, 2021; Abubakar & Omotoriogun, 2022). According to Oyetola & Abdullahi (2006), sandcrete blocks have been in use for more than five decades in West Africa and have been the most common building material. They further stated that the blocks are appropriate in both load bearing and non-load bearing foundations and walls. The average prices of the nine inches sandcrete hollow block was ₦84 in 2011 and ₦190 in 2020, which more than double the price at the commencement period of this study.

Floor Tiles

Tuile is a French word that tile was derived from, which is coined from the Latin word *tegula* which connotes a roof tile constituting fine clay (David, 2011). According to Saswat & Vikas (2016), tiles are materials mostly used in floors, shower walls, roof covering and several other objects including tables. A tile is rectangular or thin squared shaped materials such as concrete, cork, metal, ceramic stones or glass (Akinbobola et al., 2021). Clay is the major material required in tile production which

is largely prevalent in states such as Ogun, Kogi, Niger, Akwa Ibom, Kano, Ondo, Kwara, Gombe and several Eastern States of Nigeria (David, 2011; Adeala & Osore, 2016; Akaninyene & Jonathan, 2016; Irabor, 2019). The prices of tile in Nigeria have largely been on the rise and have affected post construction output (Adeala & Osore, 2019). The average price of ceramic wall tile of size 250 x 400 mm in 2011 was ₦439 and increased to ₦1250 in 2020 which is more than twice the amount paid for it at the beginning of the period considered.

Steel / Reinforcement

Steel is an alloy of carbon and iron where the alteration of carbon ranges between 0.04 and 1.7% (Ehizemhen et al., 2020). Steel entails several degree of phosphorus, sulphur, manganese as well as other elements as raw materials and applicable in their production process. Nigeria as a nation is not productive in iron production despite the abundance of several iron and steel industries situated in the country including the Ajaokuta and Itakpe Iron & Steel companies. This is attributable to largescale mismanagement, thus, significantly reducing the output level of the country's steel production (Muhammed & Muhammed, 2021). Between 2011 and 2020, the increment witnessed in the prices of reinforcement rods is mostly unbearable and has led to reduced productivity in the construction industry. The reinforcement bar (12mm), annual average price in 2011 was ₦1,082 and in 2020, the price was ₦2,704. Similarly, the average price in 2011 is the least price level for steel for the period considered for this study.

The Balance of Payment Theory Underpinning the Study

The theory underpinning this study is premised on 'the balance of payment theory' suggested by Jhingan (2011), who posited that under free exchange rates, a nation's exchange rate is dependent upon its Balance of Payments. It further stated that "a favourable balance of payments raises the exchange rate, while an unfavourable balance of payments reduces the exchange rate" (Jhingan, 2011). This connotes that the demand for the supply of foreign exchange determines exchange rate. It is worth the payment in value of goods and services purchased from another country plus loans and investment made overseas. There exists equilibrium in the payment of balance if there is equality in debits and credits. Consequently if credit is exceeded by debit, then it is undesirable and conversely, if credit exceed debit, it is desirable. Moreover, the undesirable balance of payments connotes supply of foreign exchange as more than its demand which induces fall in domestic currency external value in comparison with the foreign currency and as a consequence, triggers the fall in exchange rate. Conversely, when there is desirability in the balance of payment, then at a given exchange rate, there is more demand for foreign exchange currency than its supply. This induces a rise in the domestic currency's external value in comparison to the foreign currency which as a result induces the rise in exchange rate. This theory applies to the Nigerian setting in the area of demand for foreign currency on the basis of foreign construction materials importation as a result of the inadequacy of local

production capacity to meet the demand of the Nigerian populace. Nigerian's demand for foreign products necessitates the demand for foreign currencies. However, what makes it worse is Nigeria's continued and unabated use of the US Dollar as an intermediary for international trade transactions and her foreign exchange dealings including the Chinese that uses (Yen). Consequently, this has led to an undesirable balance of payments as a result of its continued demand for foreign currencies in order to import foreign products which increasingly decrease the value of Naira in relation to other foreign currencies. However, reduction in the demand for foreign currency exchange as a result of the reduction in the demand for foreign products (importation) will significantly boost the country's balance of payments position in relation to other nations of the world.

Conceptual Framework of the Study

This framework posits the relationship between the endogenous and exogenous variables of this study. It indicates that the relationship is between the macroeconomic factors of inflation rate, interest rate, foreign direct investment (FDI), consumer price index (CPI) and most importantly, the variable of concern ERV as identified in the studies of Kim et al. (2011), Zhao et al. (2017) and Derakhshanalavijeh & Teixeira (2017), and the prices of the selected construction materials including cement, sandcrete blocks, floor tiles and reinforcement. This is predicated on the fact that the impact of ERV on these selected materials is determined through the application of the requisite analytical tools including the unit roots tests and the granger causality test to assess the quarterly time series data of these variables which as a result have influenced the other. While the unit root test is applied to investigate the presence of stochastic trend in the variables, granger causality test is used to ascertain the long run relationship and the causal relationship that may have existed amongst the considered variables, which do not mean they predictably control each other and thus, influences the direction of this study.

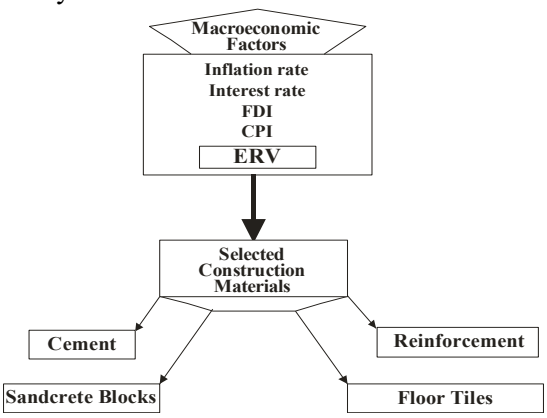

Figure 1. Conceptual Framework

Empirical Review of Related Studies on Exchange Rate Volatility Vs Construction Material Price fluctuation

Haruna, et al. (2018), assessed construction material price fluctuation in Adamawa state with emphasis on causative factors, effects and inflationary trends of construction material prices with secondary data between 2014 and 2016. In the study, structured questionnaire was retrieved from 210 respondents on the causative factors. Percentages and mean rating were applied to analyse the responses on the causative factors while the effects and trends were presented through table, graphs and charts. Study's results showed that inflation was highest in the month of December, 2015 (15.7%) with aluminium roofing sheets having the highest annual inflation rate of (19.4%), while 9 inches block had a minimum inflation rate of (7.5%) in the same year. The study concluded by ranking low GDP as the highest in the effect of construction materials price fluctuation with a mean rating of 3.81, followed by unemployment rate and project abandonment. Similarly, Muhammed & Adindu (2021) study that assessed the effect of the trend in exchange rate volatility on material price management of selected construction materials in north central Nigeria projects. The study was based on quarterly data obtained for a 10-year period (2010 to 2020), which included ERV data for the study period and selected building materials namely cement, blocks, tiles and reinforcement as variable factors. Using Ordinary Least Square (OLS) approach, the study's results revealed p-values of <2.2e-16, <2.2e-16, <2e-16 and <2.2e-16 for cement, block, tile and reinforcement respectively. The study concluded that ERV is an excellent measure for forecasting the prices of the selected construction materials. Furthermore, Ofurum & Ihuah (2021), explored the trend in building materials costs on Owerri Urban property development with cross sectional survey design and questionnaire employed for data collection. Simple random sampling was employed to retrieved data from 360 respondents with a response rate of 90%. The employed analytical tools include frequency, percentage, tables and charts. Results from empirical data obtained indicated that the factors that trigger building material price fluctuation mostly, include: overall inflation rate, import duties increment, high rate of taxes, raw materials unavailability, cost of transportation and petroleum pump prices, inaccessibility of production processing materials. The study concluded that increase in construction material prices reflect a similar rise in property development cost with a direct positive correlation.

Muhammed & Muhammed (2021), assessed the correlation between petroleum pump price volatility and selected building materials prices of construction projects in Nigeria between 2011 and 2020. The study adopted Pearson Moment Correlation Coefficient (PMCC) in data analysis involving estimated annual pump prices of petroleum product and the selected building materials (cement, block, ceramic tile and reinforcements) prices for the period under review. Results indicated the existence of a strongly positive relationship between the petroleum pump price volatility and the prices of selected materials with a correlation coefficient of 0.872, 0.920, 0.820 and 0.864 respectively. The study concluded that 1 Naira increase in the pump prices of

petroleum products will ensue to a similar rise in the prices of construction materials and posits further that there is need to deploy requisite fiscal policies devoid of political intrigues in tacking the effect of the petroleum pump prices on construction materials price fluctuation in Nigeria. Also, Obaedo & Oseghale (2020), investigated ERV impact on Edo State construction material prices using a data on ERV, cement, granite, sharp sand, cement fibre, reinforcement bar and emulsion paints for a period of 5 years. The analytical methods applied include percentages, correlation and regression analysis. Findings from the study revealed a strong positive relationship between ERV and prices of the selected construction materials. The study concluded that there is need for the stability of Naira exchange rate policy implementation to checkmate the increments in the construction material prices.

3. Methodology

Research Design
The study employed both descriptive and explanatory methods of quantitative research. It is descriptive in the sense that it explores the nature of trend demonstrated by ERV for the period under review; and explanatory as it attempts to explain the causal relationship that exist between exchange rate volatility and the selected construction materials prices.

Sources of Data
This study is based on the volatility experienced in exchange rate and attendant fluctuation in the market prices of selected construction materials, viz: cements (50kg), tiles (25 x 40 mm), hollow sandcrete blocks (9 inches) and reinforcement bars (12mm). The study also employed secondary data comprising of the trend between the first quarter of 2011 and the last quarter of 2020 retrieved from the CBN Annual Statistical Bulletins (CBN, 2021), World Bank's World Construction Indicators (WBWCI, 2021) and Author's Field Survey (2022).

Sample Size and Method of Analysis
The quantitative data comprised of the data from Q1 (2011) to Q4 (2020), of CBN (2021) and WBWCI (2021) which make up a sample size of 40, while Granger Causality Test (GCT) approach is employed for the data analysis.

Estimation Approach
The first step entails the pre-estimation evaluation. These are the initial data estimation using descriptive statistics in order to define and summarize the data in a significant manner, and to specify if the data are normally distributed via their variety of averages and Jargue-Bera values (Gujarati & Dawn, 2009; Oseni & Adekunle, 2017; Amaefule & Maku, 2019). The next step is the determination of the variable stability using Augmented Dickey-Fuller (ADF), and Phillips Perron unit root tests. These tests are

required in order to stop non-stationary regressor from invalidating several standard empirical outcomes (Amaefule & Maku, 2019).

The testing of unit roots in the time series is to investigate the presence of stochastic trend (Oseni & Adekunle, 2017). Subsequently, Luketpol (2011), posited that "correlation does not imply causality". This, however imply that a long run relationship may exist among the considered variables, which do not mean they predictably control each other. A particular type of relationship was pointed out by Granger (1988), which is known as Granger Causality Test (GCT). This approach is specifically used to evaluate the propensity of a variable in succeeding the other. If Y can be forecasted by X, it is deducible that Y is granger caused by X which correspondingly posits that Y can be granger caused by X assuming the historical trend of X increases the level of precision in predicting Y current value (Boheman & Maxén, 2015). However, that X is exhumed to grange-cause Y does not connote X to lead to Y which differentiates GCT from the usual causality test (Engle & Granger 1991). Consequently, this indicates that historically when X ensues, Y proceeds.
The granger causality test hypotheses are indicated below as;
H_0: if all $\beta i = 0$ = there exists no granger causality
H_1: $\beta i \neq 0$ = there exists granger causality exists

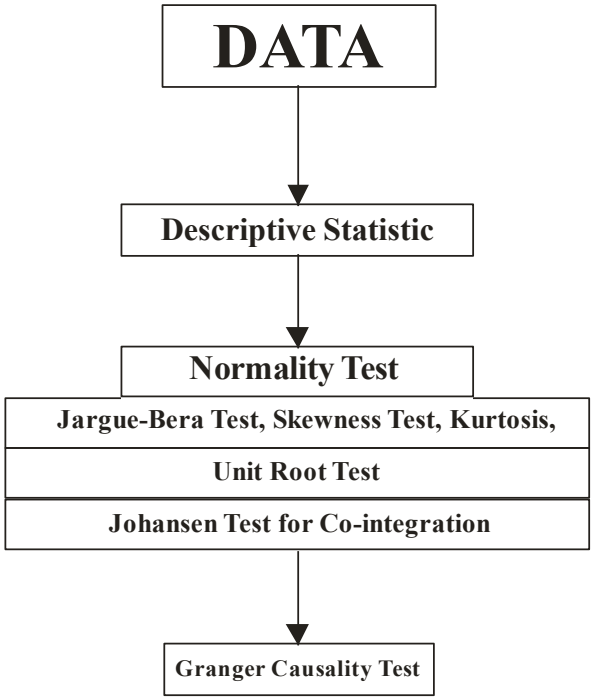

Figure 2. Graphical illustration of the Estimation Sequence
Source: Authors, (2023)

4. Empirical Findings/Result

Descriptive Statistics

Table 1. Descriptive Statistics of the Data

Variable factor	Observation	Range	Minimum	Maximum	Sum	Mean	Median	Std. Deviation
ERV	40	227.49	153.51	381.00	9461.15	236.5288	196.99	77.49544
Cement	40	1746.50	1178.52	2925.02	72626.13	1815.6533	1512.36	594.96215
Block	40	113.46	76.55	190.01	4717.80	117.9450	98.24	38.65484
Tile	40	1195.11	54.89	1250.00	30598.52	764.9630	646.31	275.44002
Reinforcement	40	1614.54	1089.47	2704.01	67142.71	1678.5678	1398.09	550.10951

Source: Authors Computation, (2023).

Table 1 indicates that within the minimum and the maximum values lies the mean and median of all the variables involved from the 40 observations made on the data between Q1 (2011) to Q4(2020). This shows that ERV, cement, block, tile and reinforcement for the period considered for this study has a mean of 9461.15, 72626.13, 4717.80, 30598.52 and 67142.71 while the standard deviations are depicted as 77.49544, 594.96215, 38.65484, 275.44002 and 550.10951 respectively indicating that the mean highest value for the variable lies on the cement prices for the period under review which however differs from the highest mean score of the studies of Adeniran (2016) and Iwegbu et al. (2019). It suggests a normal distribution for the variables as they are statistically significant at 5% level of significance.

Normality Test

Table 2. Multivariate Normality Test

Jarque-Bera Test		
Chi-Squared	**df**	**p-value**
353.69	10	<2.2e-16
Skewness Test		
63.126	5	2.742e-12
Kurtosis		
290.56	5	<2.2e-16

Source**:** Authors Computation (R-Programming), (2023).

The adopted multivariate normality test for the model connotes the rejection of the null hypothesis which is signifies that the error term in the model indicates normal distribution with the collective Jarque-Bera, Skewness and Kurtosis probability statistics p-values of <2.2e-16, 2.742e-12 and <2.2e-16 respectively less than the significant level of 5% which indicates their individual statistical significance. The result suggests all equations to be normally distributed in the model as similar to the position of the studies of Iwegbu et al. (2019), Amaefule (2019) and Oboni (2019).

Unit Root test

Unit root test are conducted to stop non-stationary regressor from invalidating several standard empirical outcomes (Amaefule & Maku, 2019), which may lead to misleading deductions. That is why the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root test are deployed for this purpose. The testing of unit roots in the time series is to investigate the presence of stochastic trend (Oseni & Adekunle, 2017), in line with first objective of this study.

Table 3. Results of Augmented Dickey-Fuller Test & Phillips Perron at level and first difference

ADF AT LEVEL					
Variables	**T-Statistics**	**Lag Order**	**P-Value**	**Alterlocal Hypothesis**	**Remark**
ERV	-2.2849	2	0.4617	Stationary	Not Stationary
Cement	-2.2844	2	0.4619	Stationary	Not Stationary
Block	-2.2850	2	0.4616	Stationary	Not Stationary
Tiles	-2.0291	2	0.4914	Stationary	Not Stationary
Reinforcement	-2.2849	2	0.4616	Stationary	Not Stationary
PHILLIPS PERRON TEST AT LEVEL					
ERV	-30.12	3	0.3134	Stationary	Not Stationary
Cement	-30.140	3	0.3140	Stationary	Not Stationary
Block	-30.042	3	0.3312	Stationary	Not Stationary
Tiles	-46.019	3	0.3727	Stationary	Not Stationary
Reinforcement	-30.980	3	0.3881	Stationary	Not Stationary
ADF AT FIRST DIFFERENCE					
Variables	**T-Statistics**	**Lag Order**	**P-Value**	**Alterlocal Hypothesis**	**Remark**
ERV	-3.5865	2	0.04703	Stationary	Stationary
Cement	-3.5996	2	0.04602	Stationary	Stationary
Block	-3.5857	2	0.04709	Stationary	Stationary
Tiles	-4.0502	2	0.01812	Stationary	Stationary
Reinforcement	-3.5854	2	0.04711	Stationary	Stationary
PHILLIPS PERRON TEST AT FIRST DIFFERENCE					
ERV	-31.440	3	0.01	Stationary	Stationary
Cement	-31.071	3	0.01	Stationary	Stationary
Block	-31.437	3	0.01	Stationary	Stationary
Tiles	-47.628	3	0.01	Stationary	Stationary
Reinforcement	-31.434	3	0.01	Stationary	Stationary

Source: Researchers Computation (R-Programming), (2023).

On estimating the stochastic trend presence in the model, the result shows that there is a lack of stationarity of all variables at level, with a total value of their corresponding t-statistics less than the 0.05 critical values in both tests. This shows that the variables have effect on the nature of the other in the time series, and ascertaining that the result are not the same which is in converse with a deterministic model. Consequently, the model become stationary after testing the variables at their first differences in both the ADF and PP test as all variables are integrated of the same order of 1 (Iwegbu et al., 2019). The results are largely consistent with the findings of Adeniyi & Adeyemo (2014), Rolle & Uffie (2015) and Adeniran (2016) whose variables at their first difference became stationary.

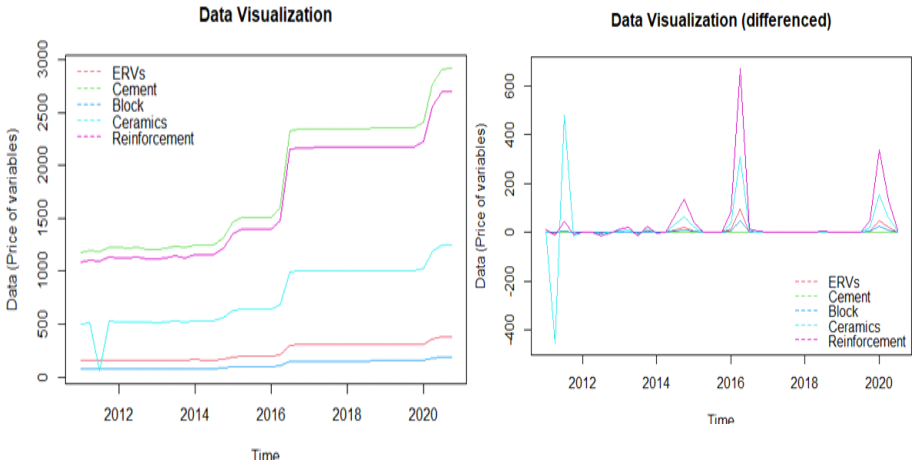

Figure 2**.** ADF Chart at level and first level (VAR in difference)

Source: Authors Computation (R-Programming), (2023).

The ADF chart indicates the variables maintenance of a constantly upward trend with a consistent rise in their value between the first quarters of the first year under review throughout the period till the last quarter of the last year under consideration which in this case is between 2011 Q1 and 2020 Q4 as visible from the data visualization chart. However, the visualization chart for the difference indicates slight different argument from the studies of Olatunji et al. (2018) and Enuameh (2019), as all the variables maintained constant and upward positive trends without negative impact of exchange rate on any of the variables as the pattern throughout under the reviewed period.

Johansen Test for Co-integration

This test is applied to ascertain the existence of a long run relationship between the variables considered in the model (Olanrewaju et al., 2012). According to Selva (2019), the cointegration of two or more time series data connotes the existence of a long run statistical relationship among the variables in line with the second objective of this study.

Table 4. The Johansen Cointegration analysis

VALUES OF TEST STATISTICS AND CRITICAL TEST					
	Test	**10pct**	**5pct**	**1pct**	
r <= 4	0.15	6.50	8.18	11.65	
r <= 3	9.86	15.66	17.95	23.52	
r <= 2	27.30	28.71	31.52	37.22	
r <= 1	46.73	45.23	48.28	55.43	
r = 0	72.00	66.49	70.60	78.87	
EIGEN NORMALISED COINTEGRATION RELATIONS					
ERV	1.000000000	1.000000000	1.000000000	1.000000e+00	1.000000e+00
Cement	0.20841780	0.2056590613	0.036579688	-1.950896e-02	2.380038e-01
Block	-2.26269956	0.0984279616	7.190007492	2.635706e+02	1.212376e+02
Tiles	-0.00170223	-0.0009931287	0.001297502	4.070976e-04	-3.251904e-04
Reinforcement	-0.20648718	0.0751322215	-0.686281351	-1.864070e+01	-8.915972e+00
EIGEN WEIGHTS LOADING MATRIX					
ERV	-39.07648	31.14213	-10.341738	1.2054421	-1.3947355
Cement	-299.14584	244.34329	-75.620971	9.4035518	-10.6837548
Block	-19.32974	15.70237	-4.902729	0.5921169	-0.6963618

Tiles	98.82181	328.05318	-449.670120	-1.8916763	-5.4921012
Reinforcement	-274.97971	223.39939	-69.758759	8.4613450	-9.9094210

Eigenvalues (lambda) for the five variables: "0.485741886, 0.400250946, 0.368052165, 0.225553304 & 0.003827619".

Source: Authors Computation (R-Programming), (2023).

The system for the test of cointegration amongst some or all the variables in this model is indicated by the rejection of the null hypothesis. This is because the individual time series has an integation order that is higher than the time series linear combinations. The linear combination as shown in the divide first for both the t-test and critical value test, second for the Eigen normalised cointegration relations and third for the weights load matrix for the five time series variables is therefore stated as "s = 1.00000000*ERVs + 0.20841780*Cement - 2.26269956*Block - 0.00170223*Tiles - 0.20648718*Reinforcement". The rejection of all the null hypotheses posited at 0.05 critical value shows the presence of long run relationship amongst the five equations in the model while the maximum Eigen test posited in the second part of the divide shows 5 cointegration equations at 0.05 critical levels. Thus, the consequences of this result indicates the presence of a long run relationship amongst the variables of ERV, cement, block, tile and reinforcement prices which is similar to the findings in the study of Agbede (2013), Rolle & Uffie (2015) and Adeniran (2016). The specificity of this study is predicated on the certainty that the cost of construction materials prices increase with the increase in the macroeconomic indicators such as the ERV, inflation rate and interest rate both in the long and short run. However, according to Olatunji et al. (2018), the uncertainties in the economic indices of most developing nations induce construction material prices cost randomness to be excessively disordered making such linear models to be influenced by the uncertainties inherent in the macroeconomic factors.

Causality Analysis for ERV Against all the Variables Considered

The GCT indicates the direction of statistical relationship between the variables (Engle & Granger, 1991). The degree of freedom, the null hypotheses, their rejection or acceptance is based on the 0.05 level of significance which provides an indication as to the presence or absence of causal relationship amongst the model variables (Amaefule & Maku, 2019), in line with the third objective of this study.

Table 5. The causality table for ERV and the variables

H_0: ERV do not Granger-cause Cement Price increment				
F-Test	**df 1**	**df 2**	**Lag Order**	**Pr (>F)**
2.273	33	35	2	0.3581
H_0: No instantaneous causality between ERS and Cement Price increment				
Chi-Square	**df 1**	**Significance level**	**F**	**p-value**
19.499	1	5%	1.0594	1.006e-05

H_0: ERV do not Granger-cause Block Price increment				
F-Test	**df 1**	**df 2**	**Lag Order**	**Pr (>F)**
0.062166	33	35	2	0.9449

H_0: No instantaneous causality between ERS and Block Price increment				
Chi-Square	**df 1**	**Significance Level**	**F**	**p-value**
19.5	1	5%	0.0568	1.006e-05

H_0: ERV do not Granger-cause Tiles Price increment				
F-Test	**df 1**	**df 2**	**Lag Order**	**Pr (>F)**
23.411	1	72	2	0.9202
H_0: No instantaneous causality between ERS and Tiles Price increment				
Chi-Square	**df 1**	**Significance Level**	**F**	**p-value**
11.576	1	5%	0.0834	0.000668

H_0: ERV do not Granger-cause Reinforcement Price increment				
F-Test	**df 1**	**df 2**	**Lag Order**	**Pr (>F)**
0.047562	1	72	2	0.9435
H_0: No instantaneous causality between ERS and Reinforcement Price increment				
Chi-Square	**df 1**	**Significance Level**	**F**	**p-value**
19.5	1	5%	0.0582	1.006e-05

Source: Author's Computation (R-Programming), (2023).

Depicted in table 4.5 above is the causal relationship between ERV and the variables considered for this study. The first correlation is between ERV and Cement in both same and reverse forms. With a lag order of 2 and p-value of 1.006e-05 which is significantly less than the 0.05 significant level indicating the rejection of the null hypothesis. The result indicates that ERV do not in the longrun granger-cause changes in the prices of cement which indicates a unidirectional relationship between exchange rate and the prices of cement. The second causality test is for the correlation between ERV and Block prices in both same and reverse manner. Similalry with a lag order of 2 and p-value of 1.006e-05 indicates the rejection of the null hypothesis on the basis of it being less than the employed 0.05 level of significant. This likewise indicates a unidirectional relationship between the forecaster and the forecasted variable. The third causality test depicts ERV against Tile price trend which indicates the null hypothesis rejection with a p-value of 0.000668 which is signifcantly less than the 0.05 significant level. This equally suggests a unidirectional relationship between the predictor and the predicted variable. Lastly, the causality test picked the correlation between ERV and Reinforcement which also depicts a rejection of the null hypothesis with a p-value of 1.006e-5 likewise indicating a unidirectional relationship between the picked variables. In consonance, the studies of Baloi & Price (2003), Olatunji (2010), Muhammed & Adindu (2021) and Siboleka (2022), outlines that these macroeconomic factors of inflation rate, interest rate, construction sector economic health, balance of trade, FDI, CPI and ERV as pre-contract estimates whose rise can transform into rise in the prices of these construction materials which subsequently transform into outturn cost of the construction project as posited in this study explaining the direction of the causal relationship between the prices of these materials and ERV.

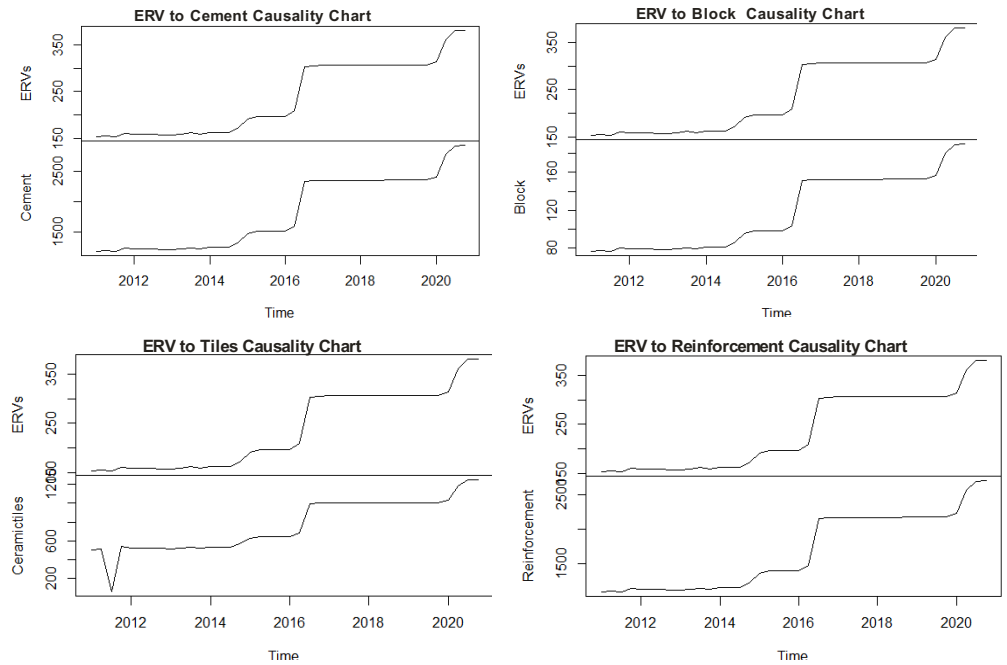

Figure 3. Granger Causality Chart for the variables considered
Source: Researcher's Computation (R-Programming), (2023).

Overall, the variables considered for this study indicates a unidirectional relationship between ERV and themselves when correlated. As proposed by the model, there exist instantaneous impacts of ERV on the prices of cement, block, tile and reinforcement which are felt throughout the country. This similarly triggers a long run relationship between ERV and the considered variables. However, the instantaneous impact of ERV can be felt on the construction material prices. Furthermore, the impact of the ERV as a single macroeconomic variable is not felt as much as the combined impact of the other macroeconomic variables such as inflation and interest rate on the prices of these building materials. While Siboleka (2022), sees a contrasting feature of ERV correlation against some of these variables in Namibia, Ugochukwu (2016), Ugochukwu et al. (2017), Olatunji et al. (2018), Obaedo & Oseghale (2020) and Saidu & Omede (2021) largely agrees with the position of this study but does not emphasize the causation effects as insinuated by this study. Moreover, this study has shown that ERV has impacted the construction materials price fluctuation within the North-Central region of Nigeria. The uniqueness of this study is predicated on the fact that the study uncovered that, despite the statistical evidence showing the presence of causation between ERV and these construction materials, there remain low elasticities of the pass-through effect of ERV on the prices of these selected construction materials if it is considered alone which is part of what was missing from the previous studies. This makes the study to settle that the sensitivity of the prices of these construction materials to ERV is largely low despite the causation effects and it takes the

combination of other macroeconomic factors to finally have the transformative effects it can have on these construction materials prices

5. Conclusions

This study empirically ascertained the impact of ERV on the selected construction material prices using the Granger Causality Test (GCT) approach. The study showed the presence of stochastic trend amongst the variables and indicates that ERV has a long run negative effects on the prices of selected construction materials (cement, block, tile and reinforcement). It similarly concludes that ERV granger-causes a unidirectional effect between the variables studied which indicate that ERV affects each of the prices of the selected construction materials with the same not happening in reverse. This study aligns positively with the study of Haruna et al. (2018) and Muhammed & Adindu, (2021). However, the impact of the exchange rate may not be as felt as much as the combined impact of macroeconomic variables on the selected construction materials which caused a reduced transformative effective that ERV can have on the construction material prices.

On the basis of the findings, this study recommends the need for the Nigerian government to formulate requisite fiscal policies to tackle ERV and other macroeconomic variables inconsistencies through the minimal usage and reduced transaction with any other foreign currency apart from the Naira within the Nigerian border, buying of foreign products directly from the supplier with the Naira instead of using another currency as an intermediary which would improve the balance of payment position of the nation, and increase in the local production of critical construction material especially cement, block, tile and reinforcement to assist in boosting the nation's balance of payment, and induces a positive value of the Naira currency relative to other currencies of the world

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