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Causal Relationship between Stock Prices and Foreign Direct Investment on Macroeconomic Variables: A Case of Nigeria

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Abstract

This study examined the potential causal relationship between variables of interest using Modified Wald test and Wald test granger causality test. The vector error correction (VEC) model was also employed to capture the dynamic interactions among the variables considered. The Modified test shows that there is unidirectional granger causality between stock price and exchange rate and with bidirectional causality between foreign investment and exchange rate. The causality between stock price and import & export rate was independent. There is unidirectional causality between foreign investment and growth rate, import rate and stock price. The Wald test shows there are unidirectional and independent cause among the variables. The Modified Wald test has comparable performance to Wald test. A Vector Error Correction (VEC) model was estimated with three cointegration relations. For stock price, the third error correction term indicates a short term adjustments towards the equilibrium path while in the case of foreign direct investment, the second and third error correction terms indicate a short term adjustment toward equilibrium path.

Keywords: Causality test, Cointegration, VEC Model.

I.0 Introduction

The stock market plays a major role as an economic institution which enhances the efficiency in capital formation and allocation. It assists both corporations and the government to raise long-term capital which enables them to finance new projects and expand other operations. In this manner, it was observed in [1] that the performance of the economy is boosted when capital is supplied to productive economic units.

The essence of foreign investment into an economy has generated interest among development experts on its desirability or otherwise. While some stress that though economic activities of a nation is a stimulator of growth and development, they believe that opening an economy to sudden inflow and outflow can destabilize sound economies and compel them to adopt fiscal policy measures capable of creating problems in the operations of their security market. Yet, others believe that foreign investment inflows has helped emerging economies to benefit from research and development from advanced economies which had assisted their industrialization efforts as well as boosting their stock market activities, just as the gains from the development in the stock market has also encouraged the inflow of foreign investment [2].

Foreign Direct Investment (FDI) is one of the most important tools which make nations especially the developing ones to achieve the investment levels beyond their levels of saving. In this era, it is almost impossible for every nation to close their boundaries for international trade The impacts of these factors are multidimensional and they have influences on common man whether they are social, economic, political or cultural.

Evolution of stock market has influence on the operation of banking institutions and hence, on economic promotion. This means that stock market is becoming more crucial, especially in a number of emerging markets and their role should not be ignored [3]. In [4] they argued that a well-established stock market not only can mobilize capital and diversify risks between market agents but also it is able to provide different types of financial services than banking sector to stimulate economic growth.

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The objective of this study is to evaluate the direction of causality relationship between stock market and selected macroeconomic variables in Nigeria using Toda-Yamamoto Causality test and to investigate the short term adjustment toward the equilibrium path using VEC model.

II. Review of the Related Studies

The study in [5] studied the important role played by the Karachi Stock market in the economic development of Pakistan, and he used the Granger's causality test and find out that no causal relationship existed between macro-economic indicators and stock exchange prices in Pakistan. He stated that the performance of macro-economic indicators cannot be used to predict stock prices; and again the stock prices in Pakistan do not reflect the macro-economic condition of the country.

Causal relationship was investigated in [6] between stock market and economic growth in Germany for the period of 1965 to 2007. He confirmed that there was unidirectional causality between stock market and economic growth with direction from stock market development to economic growth.

Long-run and short-run relationship between Karachi Stock Exchange (KSE) and some macroeconomic variables in Pakistan was studied in [7] using a monthly data from the period of January 2001 to December 2010. Johansen cointegration test, Vector Error Correction and Granger Causality test were used. Analysis of long-run relationship revealed that foreign exchange reserve, interest rate, import rate, money supply and wholesale production index show a positive and significant relationship with stock prices while exchange rate and export rate show a negative and insignificant impact on stock prices but industrial production index has a negative significant relationship with stock prices. However, the granger causality analysis revealed that money supply and wholesale production index have bi-directional causal relationship with stock prices; import rate, exchange rate and foreign exchange reserve have uni-directional relationship with stock while industrial production index, interest rate and export rate have independent relationship with stock prices.

A Cointegrated VAR model was used in [8] to study the Contemporaneous Long – run dynamics of the impact of foreign direct Investment (FDI) on Growth Domestics Products (GDP) with other four macroeconomic variables in the Nigeria. The VECM model were estimated with cointegration relation of exactly one .The study further investigate the causal relationship using the Granger Causality analysis of VECM which indicates a uni–directional causal relationship between GDP and FPI . The results of Granger Causality Analysis also show that some of the variables are Granger Causal of one another, at 5% level of significance.

The response of aggregate industrial output to relative change in prices and exchange rate in Nigeria was investigated in [9] using Cointegrated VAR methodology. The results of which provide evidence of long-run equilibrium relationship among the variables. A vector error correction (VEC) model was employed and the dynamic correlations of the variables have been captured by the analyses of impulse response and variance decomposition. The response of industrial output to a standard deviation shock from change in prices is negative but quite minimal more specifically at initial periods while the response of Industrial output (GDP) to exchange rate innovations is positive more specifically at second year but reduces subsequent to another positive level which continuous even after the tenth year's period.

The effect of macroeconomic variables on stock prices in Ghana was examined in [10]. They used cointegration test and Vector Error Correction Model (VECM) to examine both the long-run and short-run dynamic between stock market index and macroeconomic variables and confirmed that there is cointegration between the variables under study which indicated long-run relationship.

Relationship between stock market volatility and macroeconomic variables volatility in Nigeria was investigated in [11]. They found a bi-causal relationship between market volatility and real GDP. However, they did not find evidences on the causal relationship between stock market volatility and the volatility in interest rate and inflation rate.

The linkage between FDI and current account was examined in [12] using Johansen Juselius cointegration technique and Granger causality test on quarterly data of Pakistan from 1976 to 2005 and found long run relationship with the unidirectional causality respectively. The relationship between FDI and exports in Turkey from 1982 to 2009 was investigated in [13]. The analysis shows that exports growth is comparatively greater than the GDP growth and FDI is one of the important factors that can increase Turkish exports. No short run causality is seen between FDI and current account. It also suggests exports based investment flows are valuable if profit outflows are less.

III. Materials and Methods

Quarterly time series data for Real GDP, Foreign Direct Investment (FDI), Exchange rates USD/NGN (ER), Export rate (EXP), Import rate (IMP) and stock price index of the Nigerian Stock Exchange (NSE) were used in this research work. The Data were obtained from Statistics Department of the Central Bank of Nigeria (CBN).

Testing for Granger Noncausality

Testing for granger non-causality in the context of VAR models involves testing whether some parameters of the model are jointly zero. Such test has involved a standard F-test in a regression context [14]. However, the research conducted in [15] has shown that when the variables are cointegrated, F-test procedure is not valid, as the test statistic does not have a standard distribution.

The result obtained in [15] has given rise to the development of some alternative tests for integrated and cointegrated systems. This includes Wald version of the test proposed in [15] and Modified Wald test Proposed in [16].

Wald Test for Granger Noncausality

For an n x 1 vector time series $\{X_t : 1, 2, \ldots, t\}$, the VAR(k) is

$$X_t \sum_{i=1}^{k} \Pi_i X_{t-i} + \varepsilon_t \tag{1}$$

Where Π is an nxn matrix of parameters, $\varepsilon_t \sim IN(0, \Sigma)$, and equation (1) is initialized at $t = -k+1, \ldots, 0$, the initial values can be any random vector including constants. Let $X_t = (X_{1t}^T, X_{2t}^T, X_{3t}^T)$ where X_{st} is an n_s x 1 vector for $s = 1, 2, 3$ with $n = n_1 + n_2 + n_3$. Also, with Π_i conformably partitioned, let $\Pi_{i,13}$ be $n_1 \times n_3$ top-right partition of Π_i. Suppose we wish to determine whether or not X_{3t} Granger cause X_{1t}. Then, in this model, the null hypothesis of granger non causality (GNC) is $H_0 : p_{13} = 0$ where $p_{13} = \left[\Pi_{13}^1, \Pi_{13}^2, \ldots\ldots\Pi_{13}^k\right]$.

This null hypothesis can also be written as $H_0 : R\theta = 0$, the Wald statistic is given as;

$$W = T\hat{\theta}^T R^T \left\{R\hat{V}\left[\hat{\theta}\right]R^T\right\}^{-1} R\hat{\theta} \tag{2}$$

Where $\hat{\theta}$ is the LS estimator of $\theta = vec\left[\Pi_1, \Pi_2, \ldots\ldots\ldots\Pi_k\right]$, $\hat{V}\left[\hat{\theta}\right]$ is a consistent estimator of asymptotic variance covariance matrix of $\sqrt{T}\left(\hat{\theta} - \theta\right)$, T is the number of observations, R is a selector matrix such that $R\theta = vec\left[P_{13}\right]$. Wald statistic in [15] is asymptotically a $\chi^2(n_1 n_2 k)$ variate under H_0 when each series is either stationary or nonstationary with sufficient cointegration.

Modified Wald Test for Granger Noncausality (Toda-Yamamoto Causality)

A method was proposed in [16] that gives an asymptotic χ^2 null distribution for GNC statistic in the VAR model, irrespective of the system's integration or cointegration properties. The covariance matrix singularity of the LS estimator in a nonstationary system that can be removed by fitting a VAR process whose order exceeds the true order by highest degree of integration in the system. For instance, when the data generating process (DGP) is a VAR(k) with I(1) variables, we estimate a VAR(k+1) model (irrespective of whether cointegration exists or not) and test for granger noncausality (GNC) using the first k coefficients. Modified Wald test for GNC is given as:

$$X_t = \sum_{i=1}^{k} \Pi_i X_{t-i} + \sum_{i=1}^{d} \Pi_{k+i} X_{t-k-i} \varepsilon_t \tag{3}$$

Where d is the highest order of integration for any element of X_t. In this augmented VAR(k), the null hypothesis of GNC between X_{3t} and X_{1t} is $H_0 : P_{13} = 0$ where $p_{13} = \left[\Pi_{13}^1, \Pi_{13}^2, \ldots\ldots\Pi_{13}^k\right]$. The Wald statistic is also given as in equation (2)

$$W = T\hat{\theta}^T R^T \left\{R\hat{V}\left[\hat{\theta}\right]R^T\right\}^{-1} R\hat{\theta}$$

Where $\hat{\theta}$ is the LS estimator of $\theta = VEC\left[\Pi_1, \Pi_2, \ldots\ldots, \Pi_{k+d}\right]$ and R is a selector matrix such that $R\theta = VEC\left[P_{13}\right]$ under our assumptions, Wald statistic is asymptotically as a $\chi^2(n_1 n_2 k)$ variate under the null hypothesis irrespective of nonstationarity properties of X_t.

Vector Error Correction Model (VECM)

Vector Autoregressive (VAR) is a multivariate time series model that has been used primarily to capture the relationship and independencies between important time series variables [17].

The General basic model of VAR (*p*) has the following form

$$y_t = \mu + \psi D_t + A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t \tag{4}$$

where y_t is the set of *K* time series variables $y_t = (y_{1t},...,y_{Kt})'$, A_i's are (*K* × *K*) coefficient matrices, μ is vector of deterministic terms, D_t is a vector of nonstochastic variables such as economic intervention and seasonal dummies and $u_t = (u_{1t},...,u_{Kt})'$ is an unobservable error term. Although the model (4) is general enough to accommodate variables with stochastic trends, it is not the most suitable type of model if interest centers on the cointegration relations.

The VECM form

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + ... + \Gamma_{p-1} \Delta y_{t-p+1} + \mu + \psi D_t + u_t \qquad (5)$$

$$\Pi = \sum_{i=1}^{p} A_i - I \quad \text{and} \quad \Gamma_i = -(A_{i+1} + ... + A_p)$$

In the VECM model, attention focuses on the (*n*× *r*) matrix of cointegrating vectors β, which quantify the "long-run" relationships between variables in the system, and the (*n*× *r*) matrix of error-correction adjustment coefficients α, which load deviations from the equilibrium (*i.e.* Πy_{t-1}) to Δy_t for correction. The Γ_i coefficients in (5) estimate the short-run effects of shocks on Δy_t, and therefore allow the short-run and long-run responses to differ.
The term Πy_{t-1} is the only one that includes I(1) variables. Hence, Πy_{t-1} must also be I(0). Thus, it contains the cointegrating relations. The Γ_{jS} ($j = 1, . . . , p - 1$) are often referred to as the short-run or short-term parameters, and Πy_{t-1} is sometimes called the long-run or long-term part.

IV. Results and Discussion

Modified Wald test proposed in [16] and Wald test in [15] test were used to determine whether one time series is good to forecast the other.

Table 1: Modified Wald test

Variables	Hypothesis	P-value	Result	
GDP	SPI →GDP	0.8133	≠	Independent
	SPI←GDP	0.0534		
	FDI→GDP	0.0439	↑	Uni-directional
	FDI←GDP	0.6389		
EXP	SPI→EXP	0.9154	≠	Independent
	SPI←EXP	0.1619		
	FDI→EXP	0.0055	↕	Bidirectional
	FDI←EXP	0.0398		
ER	SPI→ER	0.0076	↑	Uni-directional
	SPI←ER	0.4017		
	FDI→ER	0.5124	≠	Independent
	FDI←ER	0.7118		
IMP	SPI→IMP	0.7808	≠	Independent
	SPI←IMP	0.4041		
	FDI→IMP	0.0305	↑	Uni-directional
	FDI←IMP	0.59682		
FDI	SPI→FDI	0.1523	↓	Uni-directional
	SPI←FDI	0.0010		

The detailed analysis of Modified Wald test in Table 1 shows that there is unidirectional cause between SPI and ER while GDP, IMP and EXP are independent to SPI. Foreign direct investment granger causes GDP, IMP and SPI, which indicates a unidirectional cause. There is bidirectional causality between FDI and EXP while there is causality between FDI and ER.

Table 2: Wald test

Variables	Hypothesis	P-value	Result	
GDP	SPI →GDP	0.34800	≠	Independent
	SPI←GDP	0.1896		
	FDI→GDP	0.5788	≠	Independent
	FDI←GDP	0.9569		
EXP	SPI→EXP	0.2482	≠	Independent
	SPI←EXP	0.8019		
	FDI→EXP	0.0209	↑	Uni-directional
	FDI←EXP	0.2613		
ER	SPI→ER	0.7416	↓	Uni-directional
	SPI←ER	0.0338		
	FDI→ER	0.4200	≠	Independent
	FDI←ER	0.3433		
IMP	SPI→IMP	0.6012	≠	Independent
	SPI←IMP	0.2152		
	FDI→IMP	0.0076	↑	Uni-directional
	FDI←IMP	0.0604		
FDI	SPI→FDI	0.6012	↓	Uni-directional
	SPI←FDI	0.0022		

The detailed analysis of Wald test in Table 2 shows that SPI is independent to GDP. FDI cause SPI but SPI does not cause FDI, also ER cause SPI but, SPI does not cause ER while IMP and EXP are independent to SPI. Also unidirectional relationships exist from FDI to EXP, IMP, while GDP and ER are independent to FDI.

Table 3: Comparison of Modified Wald and Wald test for Granger Non-causality

Variables	Modified WALD Test			WALD Test		
	Hypothesis	P-value	Results	Hypothesis	P-value	Results
GDP	SPI→GDP	0.8133	≠	SPI→GDP	0.34800	≠
	SPI←GDP	0.0534		SPI←GDP	0.1896	
	FDI→GDP	0.0439	↑	FDI→GDP	0.5788	≠
	FDI←GDP	0.6389		FDI←GDP	0.9569	
EXP	SPI→EXP	0.9154	≠	SPI→EXP	0.2482	≠
	SPI←EXP	0.1619		SPI←EXP	0.8019	
	FDI→EXP	0.0055	↨	FDI→EXP	0.0209	↑
	FDI←EXP	0.0398		FDI←EXP	0.2613	
ER	SPI→ER	0.0076	↑	SPI→ER	0.0338	↑
	SPI←ER	0.4017		SPI←ER	0.7416	
	FDI→ER	0.5124	≠	FDI→ER	0.4200	≠
	FDI←ER	0.7118		FDI←ER	0.3433	
IMP	SPI→IMP	0.7808	≠	SPI→IMP	0.6012	≠
	SPI←IMP	0.4041		SPI←IMP	0.2152	
	FDI→IMP	0.0305	↑	FDI→IMP	0.0076	↑
	FDI←IMP	0.59682		FDI←IMP	0.0604	
FDI	SPI→FDI	0.1523	↓	SPI→FDI	0.6012	↓
	SPI←FDI	0.0010		SPI←FDI	0.0022	

The Modified Wald test exhibits consistent performance over the Wald test as revealed in Tables 1 and 2 respectively.

Unit Root Test

A sufficient condition for cointegration and establishing a long-run relationship is a test for unit root.

Table 4: Unit Root Test

Variables	Augmented Dickey-Fuller test statistic		Phillips-Perron Test Statistic	
	Null Hypothesis: Variable is Non stationary		Null Hypothesis: Variable is Non stationary	
	Level	First Difference	Level	First Difference
SPI	-1.9163	-6.0959	-1.9423	-6.1030
EXP	2.7077	-8.2904	-1.4763	-8.1900
GDP	2.2847	-3.9313	1.1607	-14.8333
FDI	-2.3648	-12.7410	-2.2446	-17.4229
IMP	4.6152	-6.3915	-1.4812	-8.4657
ER	-0.2149	-8.9272	2.76621	-8.9292
Test Critical values				
5%	-2.8887		-2.8889	
10%	-2.5813		-2.5815	

Table 4 indicate that all the variables are non-stationary at level but become stationary at the first differencing.

Cointegration Analysis

Table 5: Cointegration test

Hypothesized No of CE(s)	Trace Statistics	0.05Critical Value	Prob.	Max-eigen Statistics	0.05 Critical Value	Prob.
None	257.327	95.754	0.000	99.177	40.078	0.000
At most 1	158.150	69.819	0.000	75.282	33.877	0.000
At most 2	82.868	47.856	0.000	61.820	27.584	0.000
At most 3	21.048	29.797	0.355	13.207	21.132	0.433
At most 4	7.842	15.495	0.483	7.812	14.265	0.398
At most 5	0.029	3.841	0.864	0.029	3.841	0.864

The results for both Trace statistic and Maximal Eigen statistic reported in Tables 5 indicated that there are three co-integrating vectors.

Short-Run Relationship

Given the evidence that there are three cointegrating vectors, now the short-run relationship can also be analyzed.

Table 6: Vector Error Correction Estimates

Error Correction	D(SPI)	D(ER)	D(GDP)	D(EXP)	D(FDI)	D(IMP)
CointEq1	-0.022916 [-1.02499]	0.029450 [0.65329]	-0.090644 [-8.92809]	0.260537 [5.44211]	0.005596 [0.03088]	0.040810 [0.90259]
CointEq2	-0.093076 [-2.68118]	0.045063 [0.64379]	-0.185643 [-11.7762]	0.276451 [3.71900]	0.894477 [3.17937]	0.052393 [0.74628]
CointEq3	-0.599128 [-1.57902]	-0.790545 [-1.03331]	-3.263848 [-18.9425]	0.734036 [0.90345]	-1.519286 [-0.49392]	1.227039 [1.59907]

The coefficients of CointEq1, CointEq2 and CointEq3 in Table 6 above show the speed of adjustment toward disequilibrium in the period of study. All the error correction terms are significant with negative signs. This implies that the adjustment in SPI is due to the first error correction, second error correction and third error correction terms. According to the first error correction term, the SPI is adjusted by 2.29% per every quarter of the year to the long-run equilibrium. In the second error correction term, the SPI is adjusted by 9.31% per quarter of the year to the long-run equilibrium. According to the result of the third error correction term, it shows speedy adjustment of 3.930% per quarter to the long-run equilibrium which is quiet rapid.

Also the first error correction term shows that foreign direct investment is adjusted by 1.51% to the long-run equilibrium. In the second error term, FDI is adjusted by 89.45% to the long-run. In the third error correction term, FDI is by 151.92 to the long-run equilibrium.

V. Conclusion

This research paper used causality test to investigate the causal relationship and estimate the short-run relationship using VEC model for stock prices and foreign direct investment on some macroeconomic variables in Nigeria. The Modified Wald test shows that there is unidirectional cause between SPI and ER while GDP, IMP and EXP are independent to SPI. Foreign direct investment granger causes GDP, IMP and SPI, which indicates a unidirectional cause. There is bidirectional causality between FDI and EXP while there is causality between FDI and ER. The Wald test shows that SPI is independent to GDP. FDI cause SPI but SPI does not cause FDI, also ER cause SPI but, SPI does not cause ER while IMP and EXP are independent to SPI. The unidirectional relationships exist from FDI to EXP and IMP, while GDP and ER are independent to FDI. All variables were found to have a unit root at their levels. Further analysis indicates evidence of three (3) long-run equilibrium (cointegration) relationships between the variables. Vector Error Correction Model described the three error correction terms. The estimate revealed that in stock price, the first error correction term showed the short-run dynamic adjustment rate of 2.29% while the second and the third error correction terms showed 9.31% and 59.91% of the short-run dynamic adjustment rates respectively. Government should improve the investment climate for existing domestic and foreign investors.

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