



Research article

Dynamic links between the Nigerian equity market and those of selected regional and developed countries

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ABSTRACT

The dynamic and growing interdependent nature of equity markets across the world has elicited the interest of investors and researchers alike. This study examines the dynamic interactions between the Nigerian stock market and selected regional and global equity markets spanning eight years, from 2011 to 2018, using daily index data. The generalised impulse response function was used alongside the Toda and Yamamoto Granger causality test to investigate the short-run dynamic linkages, while the normalized Johansen vector error correction estimates served to assess the long-run linkages given the existence of cointegration. Findings from the study revealed that the UK and the Ghanaian stock markets exert significant long-run impact on the Nigerian stock market, while vagaries from the US tend to exert more influence on the Nigerian stock market in the short-run. The study recommends that more regional efforts are needed to enhance the integration of stock markets in West Africa. The findings have implications for national and regional policymakers as well as portfolio investors.

1. Introduction

In the return of Nigeria to a democratic regime in 1999, financial reforms like the consolidation and recapitalization of banks in 2005, and the recapitalization of the insurance companies in 2006 seem to have engendered more participation in her stock market from local investors at the onset and foreign investors thereafter. The Nigerian stock exchange was thenceforth rated as one of the best performing markets, though this rating dropped during the period of the global crisis.

Foreign participation grew from a paltry 14 percent in 2007 to 66 percent in 2012, to one of its highest level in the study period of 87 percent in October 2014, but dropped to 48 percent in December 2014. The activities of foreign investors imply that factors that could affect the market will go beyond local macroeconomic and firm/industry-based factors, to include international factors and diversification activities of foreign investors. In a bid to revise portfolio strategies, international investors invest and divest between markets and asset types leading to dynamic interactions between internationalized markets. Maher, Asif and Batool (2017) explains that “during a dynamic economic situation,

investors and portfolio managers must have the knowledge about international stock markets”.

Dynamic changes in stock prices are usually attributed to fundamentals in the local economy of a stock market, and international interactions are sometimes not considered as sources that trigger such changes. More so, most stock markets in Africa and West Africa are considered segmented both within themselves and with markets in other climes. Few empirical studies that have examined inter-market linkages stick to the view of market segmentation rather than integration. In the West African region, the Nigerian stock market is the largest both in terms of market capitalization and number of listed companies with significant foreign participation.

Given the size of the Nigerian stock market within West Africa, not much is known about the extent of the linkages between the Nigerian stock market and the others within West Africa. In addition, this current study is interested in investigating the extent of the linkages between the markets in the West African region on one hand, and those of the selected global markets on the other hand, both in the short and long-run. This investigation is important because linkages amongst markets have implications for both portfolio investors and market regulators. For

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instance, long-run co-movements or cointegration between two markets may suggest that the two markets have similar behaviour, and investors may want to diversify their portfolios by investing in a third market independent of the others. More so, the knowledge of the extent of inter-linkages amongst markets offers vital clues to market regulators which could help in crafting necessary policies. Sparse empirical literature exist that examine dynamic interaction between the Nigerian stock market vis-à-vis other markets in the international capital market space. [Wake-man-Linn and Wagh \(2011\)](#) hold a similar view, stating that few researches have been done at the regional level in Sub-Saharan Africa.

Against this backdrop, this study intends to evaluate the hypothesis that there are short-run and long-run interactions between the Nigerian stock market and other stock markets in the West African region as well as selected global stock markets. The study spans 2011 through 2018, thereby capturing more recent periods as well as the period not sufficiently covered by existing literature. Starting with 2011 (which is some years after the global financial crisis), this study does not delve into the analysis of the effects of the global financial crisis.

2. Empirical literature

Many studies have focused on the linkages stock prices have with local factors, including political factors like election announcements as contained in [Osamwonyi and Omorounwa \(2017\)](#), [Osual et al. \(2018\)](#); macroeconomic factors as in [Ali et al. \(2015\)](#), [Uwubamwen and Omorokunwa \(2015\)](#), [Lawal et al. \(2016\)](#), [Iheanacho \(2016\)](#), [Mroua and Trabelsi \(2019\)](#), and [Manasseh et al. \(2019\)](#). [Anaraki \(2010\)](#) examined the relationship between the US Fed policies, financial crisis and the European equity market.

Meanwhile, studies examining stock market linkages among developed countries, and between emerging/frontier and developed countries in other climes are in abundance. Empirical studies that have examined stock market inter-linkages in other climes include but are not limited to [Diebold and Yilmaz \(2009\)](#), [Dasgupta \(2014\)](#), [Maher et al. \(2017\)](#), [Lean and Smyth \(2014\)](#), [Ouattara \(2017\)](#), [Sahar and Shah \(2017\)](#), [Polanco-Martinez et al. \(2018\)](#), and [Ahmad et al. \(2018\)](#).

The advent of the global financial crisis seems to have spurred studies into inter-linkages between the Nigerian stock market and markets in the US where the crisis emanated from. Such studies include [Tella \(2009\)](#), and [Obadiaru \(2012\)](#). While [Tella \(2009\)](#) examined the impact of the global crises on the Nigerian capital market by empirically assessing the relationship between the Dow Jones Industrial Average (DJIA) and the Nigerian Stock Exchange All Shares Index (NSEASI), [Obadiaru \(2012\)](#) similarly examined the impact of the global crises on the Nigerian stock market but employed the Standard and Poor's 500 index to represent the US market instead.

Studies like [WAMA \(2011\)](#) and [Agyapong \(2014\)](#) focused on intra-regional market linkages. [Alagidede \(2008\)](#), amongst others, studied the relationship between stock markets in Africa viz-a-viz markets in other climes. [Obadiaru et al. \(2018\)](#) studied volatility spillovers amongst West African equity markets and with major global exchanges, while [Obadiaru et al. \(2019\)](#) investigated the correlation of stock market returns, examining yearly samples from 2008 to 2016.

[Alagidede \(2008\)](#) studied the integration of selected African markets within themselves and included the markets of South Africa, Egypt, Nigeria and Kenya, and further examined the integration with other markets outside the African continent including India, Brazil, Mexico, US, UK and Japan from 1997 to 2006. The author employed correlation, Johansen cointegration, and Granger causality with impulse response function (IRF) to analyze the data. The study showed weak interactions between African markets and further revealed that only South Africa and Egypt showed a significant relationship with the developed markets.

[Suwanpong \(2011\)](#) assessed return and volatility spillover across equity and currency markets from 1998 to 2010 between advanced economies of Japan, US, Germany France, and Australia and emerging economies of Indonesia, the Republic of Korea, Malaysia, Philippines,

Thailand, Singapore and Hong Kong using the Vector Autoregressive (VAR) analytical technique. Daily data were collected and aggregated to weekly data. Findings from the study revealed that about 30% and 50% of the forecast error variance in the currency markets and equity market respectively comes from spillovers. While the return spillover reached its highest level in the global crisis period, the volatility spillover spikes up in most periods of financial crises.

[WAMA \(2011\)](#) conducted a study on financial integration in West Africa. For the integration of capital markets, the relationship between the stock market of the Francophone countries - Bourse Régionale des Valeurs Mobilières (BRVM), the Nigerian Stock Exchange (NSE) and the Ghanaian Stock Exchange (GSE) were examined using quarterly index data from the first quarter of the year 2000 to the third quarter of 2010. The VAR method was used for the study and the results showed that there was no cointegration between the three stock markets. [Agyapong \(2014\)](#) used both linear and nonlinear cointegration methods to investigate the degree of stock market integration in the West African Monetary Zone (WAMZ). The linear cointegration test indicated that the Ghanaian and Nigerian markets were not integrated.

[Dasgupta \(2014\)](#) examined the integration and dynamic interactions between the Indian stock market and the other BRIC (Brazil, Russia, India, and China) countries using both Johansen and Julius, and Engel and Granger cointegration test, Granger causality, IRF and variance decomposition analysis (VDA). A long-run relationship is observed between the Indian and Brazilian markets, while there was no long-run relationship with the Russian and Chinese stock markets. Findings from the impulse response function show that the Indian market responds to shocks in the short-run. The variance decomposition analysis reveals interactions between the BRIC markets. Evidence of the dominance of the Indian stock market among the BRIC is also revealed.

[Singh and Singh \(2016\)](#) empirically investigated linkages between the US equity market and those of Brazil, Russia, India and China (BRIC) pre, during and after the crisis periods from 2004 to 2014 using the Johansen cointegration, Gregory-Hansen cointegration, Toda and Yamamoto causality test, VAR, the Vector Error Correction Model (VECM), IRF and the VDA. Findings from the study reveal the varying level of comovements between the US market and all the BRIC markets in the various sub-period analysis. The cointegration test found the presence of a long-run relationship in the pre-crisis and post-crisis periods, while the Gregory-Hansen test reveals the presence of a single structural break. Apart from the Brazilian market, the other markets contribute to maintaining a long-run stable relationship with the US market. In general, the study revealed that the US equity market has a major effect on the BRIC's while the Brazilian market seems to play a dominant role in the determination of the other BRIC countries.

[Lean and Smyth \(2014\)](#) examined the intensity of integration between stock markets in China and those in Thailand, Philippines, Vietnam, Indonesia, Malaysia, and Singapore from 2001 to 2012 using daily data. The VEC, VAR and Gregory and Hansen test for cointegration with structural breaks were employed. The results show that the markets in the study are co-integrated in the long-run and shocks to one market quickly reverberates to other markets in the region.

[Ouattara \(2017\)](#) examined the integration of emerging stock markets of the BRICS countries using quarterly data from 2000-2015. The Johansen cointegration, VAR Granger causality/wald test, correlation, IRF and the VDA were employed to examine the long-run and short-run dynamics between the markets. The study revealed that though there were no long-run relationships between the markets, there were unidirectional causalities between the market pairs, except between the Indian and Brazilian market. Furthermore, the Chinese stock market was found to be more independent than the other markets in the study.

[Sahar and Shah \(2017\)](#) studied returns and volatility spillovers between the stock markets of Turkey, Pakistan, Kuwait, Egypt, Jordan, Lebanon, Indonesia, Morocco and Tunisia as well as those of Japan UK and US from 1996 to 2016 using VAR in line with [Diebold and Yilmaz \(2009\)](#). The findings of the study revealed returns and volatility

spillovers of 36.5% and 22.4% respectively implying that higher returns spillovers were observed than volatility spillovers. Though a clear indication of spillover effect from the more developed markets was not established, the Japanese market was observed to be the highest transmitter of volatility followed by the US and Turkish market, while Tunisia, Turkey, and Indonesia were the main recipients.

Polanco-Martinez et al. (2018) investigated the integration between five European equity markets (Italy, Spain, Ireland, Greece, and Portugal) among themselves and with the Standard and Poor's (S&P) 350 index for Europe in the crisis period and the period preceding the crisis using the wavelet analytical technique and nonlinear Granger causality from 2004 to 2011. The results indicate higher levels of correlation in the crisis period than in the period before the crisis. Also, the Italian, Portuguese and Spanish markets showed higher levels of integration than the other markets and the S&P 350 index. Finally, the nonlinear causality test showed that there were more uni-directional and bi-directional causalities in the crisis period than in the preceding period.

Ahmad et al. (2018) examined interactions of the bond markets of the BRICS (Brazil, Russia, India, China, and South Africa) with three major global bond markets (US, EU and Japan) using VAR and variance decomposition from 1997 to 2016. Weekly data was employed for the study. Findings revealed that Russia and South Africa are net transmitters of volatility to other BRICS markets, while India and China showed a low level of connectivity with the others. Furthermore, the Chinese bond markets showed more connectivity with the US bond market while shocks from the US were observed to be influential on the BRICS. The result indicated that there was increased correlation between the DJIA and virtually all the markets in the study during the crisis period, but the relationship waned generally after the crisis especially with the developing markets.

Ozen and Tetik (2019) examined if there was a difference in the way developed and developing markets reacted to the DJIA market index during the 2008 global financial crisis. The study considered developed markets of UK, France and Germany and the developing markets of the BRICS-T (i.e. Brazil, Russia, India, China, South Africa and Turkey). The data of the study covered from 2007 to 2017 and was analysed using VECM. The findings of the study revealed that the developed markets reacted differently from the developing markets to the US market.

This study attempts to fill the gap in existing literature by empirically examining the interactions between the Nigerian stock market and two major regional markets as well as two major global equity markets considering more recent data set of market-wide indices from 2011–2018. The choice of the longitudinal scope of the study is informed by the need to capture more recent data than those in existing empirical literature in order to investigate more recent interactions between the markets in a post (global) crisis period. The centrality of the US and UK markets in the global financial market framework motivates the choice of these as representatives of the global market. At the regional level, the Ghanaian and the BRVM stock markets rank second and third largest markets respectively in West Africa after the Nigerian stock market (based on market capitalization), which is the motivation for selecting them. Though none of the markets are formally integrated (i.e. *de jure* integration), but the fact that they are all internationalized exposes them to interactions and co-movements which is typical of *de facto* or informal integration.

The uniqueness of this study lies in investigating the short and long-run linkages between Nigeria and the selected regional and global stock markets which have been largely ignored by most existing studies. Furthermore, the study considers the existence of structural breaks in the long-run relationship between the markets which could significantly bias the result of the long-run test.

3. Data

Daily index data from 2011 to 2018 were used for the study. The Nigerian stock exchange All Shares index (NSEASI), the Ghanaian Stock

Exchange Composite Index (GSECOM), the BRVM composite index (BRVMCOM), which is an index for the West African Economic and Monetary Union (WAEMU) stock market, the Standard and Poor's 500 index (SP500) for the US stock market and the Financial Times 100 index (FTSE) for the UK stock market are the market indices of interest. The Ghanaian and WAEMU markets were selected as they are the biggest in the West African region next to Nigeria and are involved in the drive to foster regional capital market cooperation and integration. The US and UK markets were included in the study because they are regarded as major global financial centres with potentials to influence other markets across the world. The data for the West African market indices were sourced from African Markets website while those of the US and UK were sourced from Yahoo Finance and Financial Times websites respectively.

4. Estimation methodology

The aim here is to investigate the dynamic linkages between the Nigerian stock market and selected regional and global stock markets, both in the short and long-run. The stationarity properties of the series are first assessed to understand their nature and to know which technique to be applied. In the case of a mixture of stationary and non-stationary variables, specifically I (0) and I (1) but not I (2), a commonly used estimation technique is the autoregressive distributed lag (ARDL) bounds test due to Pesaran et al. (2001). If they are all I (1) and cointegrated, a common empirical practice is to use the vector error correction (VEC) model, but if they are I (1) but not cointegrated, the series may be first-differenced and the VAR model used.

The unit root test is presented in Table 2 and shows that the series are all I (1). The Lee-Strazichich unit root test which accommodates up to two structural breaks was utilized to test for the stationarity of the variables. Consequently, the cointegration test is conducted in order to investigate whether or not the series have a common long-run relationship. The Gregory and Hansen test is employed in order to consider the possibility of a structural break which may affect the conclusion of the cointegration test. We specify three specifications: the first accounts for a structural break in the intercept (level shift model), this is specified as:

$$y_t = \mu_1 + \mu_2 \varphi_{it} + \theta' x_t + u_t \quad (1)$$

The second accommodates a time trend in the data, this model is given as:

$$y_t = \mu_1 + \mu_2 \varphi_{it} + \gamma_t + \theta' x_t + u_t \quad (2)$$

while the third is more general, here, all the coefficients – intercept and slope coefficients – are allowed to shift. This third model is specified as:

$$y_t = \mu_1 + \mu_2 \varphi_{it} + \theta'_1 x_t + \theta'_2 x_t \varphi_{it} + u_t \quad (3)$$

where $\tau \in (0, 1)$ denotes the timing of the break date.

The null hypothesis of no cointegration is tested against the alternative hypotheses in Models 1–3. The ADF^* , Z_t^* and Z_a^* statistics of the Gregory-Hansen test are used to determine the existence of cointegration in the presence of specific form(s) of a break.

For the short-run dynamic linkages, the ARDL cointegration bounds test estimates for the short-run may be used if the series are a combination of I (0) and I (1)¹ while the impulse response and variance decomposition derived from the VEC estimates may be used if the series are all I (1). As shown by the results of the cointegration test presented in the next sub-section, although all the series are I (1), they are nonetheless cointegrated. In this regard, a VEC model of K dimensions is employed. K in

¹ Pesaran et al. (2001) actually note that the ARDL cointegration bounds test may be applied if the series are I(0), I(1) or both. However, it is still a common empirical practice to use VEC models for series that are all I(1).

our case is 5, which stands for the 5 selected markets being analysed in this study, is stated as:

$$\Delta y_t = v + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (4)$$

where y_t is a $K \times 1$ vector of the natural logarithm of equity market index prices, v is a $K \times 1$ vector of parameters, $\Pi = \sum_{j=1}^p A_j - I_K$, $\Gamma_i = -\sum_{j=1}^p A_j$, A_j is a $K \times K$ matrix of parameters, I_K is unit matrix of size K and ε_t is a $K \times 1$ vector of independently and identically distributed errors.

The impulse response is sensitive to the orderings of variables. The impulse response technique shows the response of an endogenous variable to a one standard deviation shock to the error of a given variable in the system. Pesaran and Shin (1998) proposed the use of the generalized impulse response functions (GIRFs) to circumvent the difficulty of ordering of variables in structural impulse response functions. The Toda and Yamamoto (1995) Granger causality test may also be used to assess short-run linkages².

The Toda-Yamamoto approach concerns itself with the estimation of an augmented VAR of a $(k + d_{max})$ th order with d_{max} being the maximal order of integration and k the optimal lag length in the original VAR system. The Toda and Yamamoto test, using a modified Wald test statistic, tests zero restrictions on the coefficients of the original VAR (k) model and possesses an asymptotic (chi-square) distribution with k degrees of freedom (Adriana, 2014). The test essentially involves two main stages. The first is to determine the optimal lag length (k) and the maximum order of integration (d_{max}) of the variables. The second stage employs the Wald procedure to test the VAR (k) and Toda and Yamamoto suggested that researchers could estimate a $(k + d_{max})$. Thereafter, the Wald test is applied to the first k coefficients matrices with the use of the chi-square statistics (Adriana, 2014)³. The choice of Toda and Yamamoto (1995) follows, as noted by the authors, from the fact that the standard statistics of the Wald tests do not follow their usual asymptotic distribution under the null of zero restrictions.

5. Preliminary analyses

5.1. Descriptive statistics

First, a preliminary analysis is conducted to understand the properties of the variables. The descriptive statistics for the variables, in their non-transformed forms are provided in Table 1 while Table 2 presents the stationarity properties of the variables.

The Nigerian stock exchange recorded the highest mean value in contrast with that of the stock market of the Francophone dominated countries (that is the West African Economic Monetary Union - WAEMU) that has the lowest in the group. The same holds for the other statistics. Next, in order to determine the appropriate estimation technique to be adopted and to avoid spurious regressions, the stationary properties of the variables are investigated. However, to unify the values for the variables across the different markets, the variables are log-transformed as shown in subsequent analyses.

² Singh and Singh (2016) noted that the exact nature of Toda-Yamamoto's Granger causality test as it relates to its short- or long-run instrument is under debate. They however noted that it is reasonable to consider this test in the light of the short-run when considering the lagged impact of variables and the values of the daily indices when investigating dynamic linkages between markets.

³ The steps for conducting the Toda and Yamamoto Granger causality/non-causality test may be obtained from <http://davegiles.blogspot.com/2011/04/testing-for-granger-causality.html>.

5.2. Unit root test

Some studies have proposed the test for unit root in the presence of structural breaks; whether the date of the structural break is known (exogenously determined – Perron, 1989) or unknown (endogenously determined – Zivot and Andrews, 1992 and Lee and Srazicich, 2003). While the Zivot and Andrews's unit root test can only accommodate one structural break, Lee and Srazicich (2003) proposed a unit root test with provision for up to two breaks. The decision criterion is that the t statistics should be greater than the critical value (for instance at 5%). The unit root test clearly shows that all the series are non-stationary at level but integrated of order one as seen in Table 2.

The scope of this current study is 2011–2018 and thus clearly outside the period of the global financial crises of 2008–2009. However, rather than conclude that there is no occurrence of a break in the stock market indices for each of the markets, the endogenously determined break date in the context of unit root test comes to the fore, as presented in Table 2. In Figure 1, the line for each series suggests that there is no sudden break in any of the series but rather a gradual break. Generally from the individual graph of the indices, it can be observed that at the beginning of the study period most of market index values were low and seem to be recovering from the vagaries of the global crises. All the indices increased towards the middle of the study period (i.e 2013-2015), generally peaked in the last three years (i.e 2016-2018), and started experiencing a decline at the end of the study period.

5.3. Cointegration test

Sequel to the unit root test, in what follows, a cointegration test is performed; this is important in order to investigate whether or not the series have long-run relationships despite being individually non-stationary. If cointegration exists, then the fear of a spurious regression is allayed and the vector error correction (VEC) model is employed, if not, the series are first-differenced and the vector autoregression (VAR) model is used. In the spirit of unit root with breakpoints, Gregory and Hansen (1996) proposed a cointegration test in the presence of a single structural break that is endogenously determined. The first model specifies a break only in the level, the second deals with a break in the trend while the third is a shift in the regime⁴.

The Z_t and Z_a statistics in the case of the first model suggest that there were breaks on the 24th of December in the first model while similarly indicating a break on 14th of November in the second and third model. The ADF statistic indicates breaks on 26th December, 17th November and 24th December. Generally, the break date of November corresponds with the period/month of massive foreign portfolio outflow (as high as N 116.5 billion in November amounting to a drop in the participation of foreign investors from 80.92 percent to 48.24 percent) in the Nigerian stock market leading to a sharp decline in the ratio of participation of foreign investors to local investors in the market. That amount of outflow remained the highest and second only to the outflow in May 2018. The Gregory-Hansen cointegration tests are summarized in Table 3. On the whole, at 5 percent, the Z_t and Z_a statistics conclude that there is cointegration⁵ since the test statistic (absolute values) are greater than the critical values at the 5 percent level. The existence of cointegration suggests that despite being individually non-stationary variables, the selected stock markets have a relationship in the long-run.

⁴ Readers may consult Gregory and Hansen (1996) for more details.

⁵ Both the Trace and Maxeigen Statistics of Johansen cointegration test also conclude that there is cointegration.

Table 1. Descriptive statistics.

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
NSEASI	2086	31070.34	6618.084	19732.34	43039.45
BRVMCOM	2086	223.33	53.72525	134.37	320.3
GSECOM	2086	1917.425	630.2902	940.04	2439.2
SP500	2086	1945.093	481.5489	1099.23	2271.72
FTSE	2086	6547.716	646.9678	4944.44	7142.83

Source: Authors' computations

Table 2. Lee and Strazicich Unit Root test with breaks.

Variable	1 st Break Date (Break Date at 1 st Diff)	2 nd Break Date (Break Date at 1 st Diff)	T Stat. at Level	T Stat. at 1 st diff.	Order of Integration
LNSEASI	03/06/2013	03/03/2017	-1.85	-33.49	I (1)
LBRVMCOM	29/10/2012	14/10/2013	-3.61	-46.38	I (1)
LGSECOM	02/07/2015	20/02/2018	-1.40	-51.68	I (1)
LSP500	14/11/2014	11/02/2016	-4.62	-47.58	I (1)
LFTSE100	22/12/2014	24/12/2015	-4.89	-44.72	I (1)

Note: Critical values at 1%, 5% and 10% are -5.44, -4.92 and -4.53 respectively.

The General-to-Specific (GTOS) lag length selection criterion is used to select the lag order.

Varying the trend specifications (in respect of the trend and break) does not change the basic conclusions.

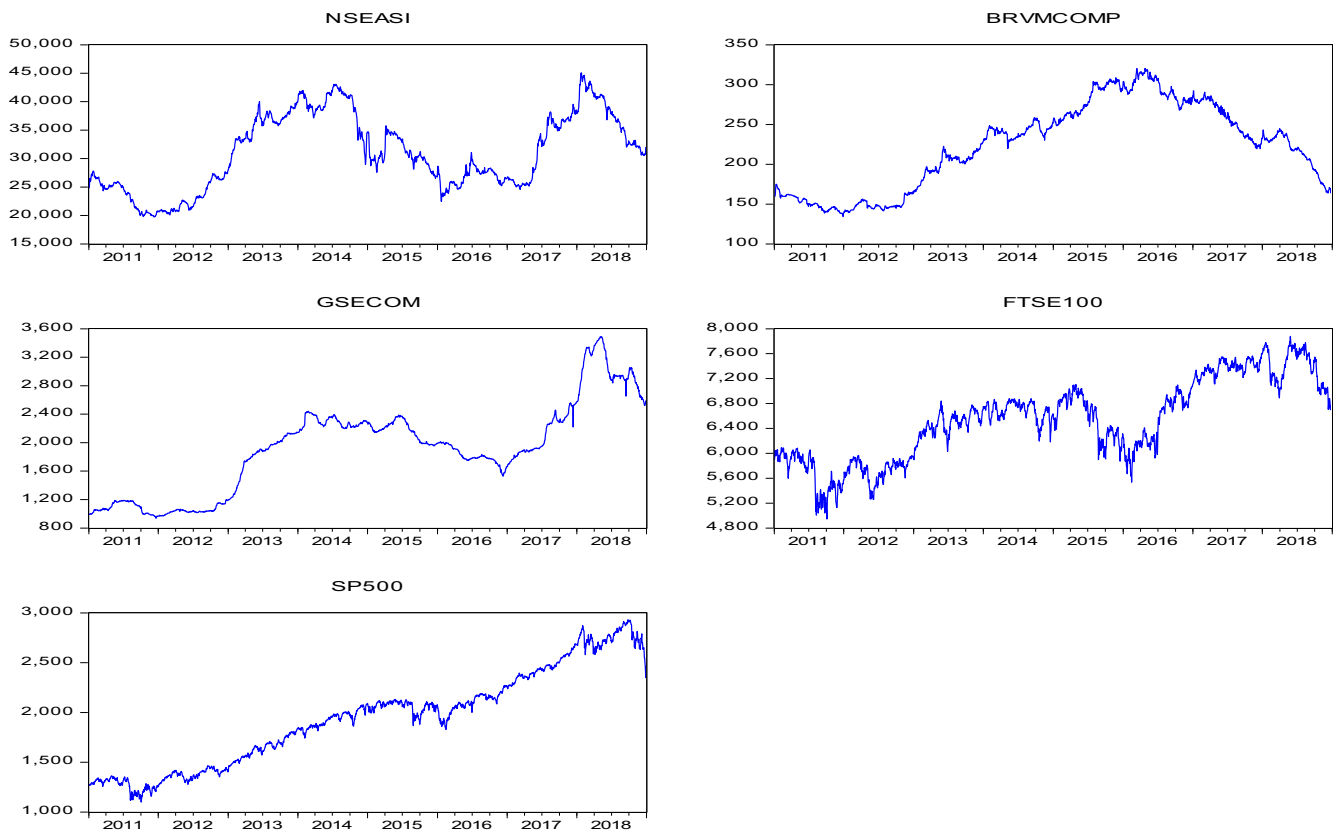


Figure 1. Trend of the indices of the selected stock markets.

Source: Authors.

6. Presentation of results

6.1. Long-run VEC linkages

To analyse the long-run linkages, given that the series are all I (1) and cointegrated, a VEC model is appropriate. The rank of the cointegrating

relationship is first investigated in order to impose the appropriate cointegration rank on the VEC model. The Trace statistic⁷ shows that there is one cointegrating equation (trace statistic of 95.41 greater than 5 percent critical value of 69.81). Given a cointegrating rank of 1, the normalized long-run VEC estimates are presented in Table 4. But at low lag orders, the model is still affected by serial correlation; this is not surprising since daily data are dealt with (observations as much as 2086). This serial correlation is completely purged by using sufficient lags (from

⁷ The Max eigen statistic gives the same conclusion.

Table 3. Gregory-Hansen cointegration test with structural break.

	Test Statistic	Breakpoint (Date)
Model 1: break (level)		
ADF	-5.203388	(26/12/2014)
Zt	-4.989807	(24/12/2014)
Za	-49.28401	(24/12/2014)
Model 2: break (level and trend)		
ADF	-5.189309	(17/11/2014)
Zt	-5.080157	(14/11/2014)
Za	-51.33842	(14/11/2014)
Model 3: break (regime)		
ADF	-5.507631	(24/12/2014)
Zt	-5.468028	(14/11/2014)
Za	-59.29250	(14/11/2014)

Note: The maximum lag used for the Gregory-Hansen cointegration test is 1 as suggested by the BIC information criterion for VAR lag-length selection. The AIC criterion suggested a VAR lag length of 3, however, the results are similar and the conclusions are the same⁶.

Source: Computed by the Authors

Table 4. Normalized long –run VEC estimates and the Error Correction Terms.

	LNSEASI	LBRVMCOM	LGSECOM	LSP500	LFTSE100	C
	1	-0.103153	1.216702	-0.224008	-1.902648	-20.14798
	-	(0.12140) [(0.13528)	(0.26671)	(0.55559)	-
	-	0.84968]	[-8.99384]	[0.83990]	[3.42454]	-
	D (LNSEASI)	D (LBRVMCOM)	D (LGSECOM)	D (LSP500)	D (LFTSE100)	
Error Correction Term	0.000894	9.43E-05	0.006616	0.000139	-0.002570	
	(0.00127)	(0.00104)	(0.00097)	(0.00126)	(0.00122)	
	[0.70535]	[0.09032]	[6.79199]	[0.11018]	[-2.10298]	

Note: The coefficients of each variable comes first, numbers in parentheses are standard errors and the numbers in squared brackets are the z statistics.

** and *** denote significance at 5% and 1% respectively.

Source: Computed by the Authors

6 upwards). The results of the Residual Portmanteau Test for autocorrelation and the Lagrange Multiplier test of serial correlation are in the supplementary appendix which is available as a supplementary material⁸. Consequently, the VEC model is fitted using lag 6. The model is also dynamically stable at this lag order (the VEC stability result is also in the supplementary appendix). It is expedient to note that the signs of the Johansen's normalized VEC estimates have been reversed before they are entered into Table 4. We normalize on the log of the Nigerian stock exchange all share index (LNSEASI).

Considering the normalized long-run estimates, LGSECOM (Ghanaian) and LFTSE100 (UK) significantly impact the Nigerian stock market (LNSEASI). However, only the Ghanaian stock market positively and significantly impact the Nigerian stock exchange market. The finding is however different from those of WAMA (2011) and Agyapong (2014) who found that there was no significant long-run relationship between the Nigerian and the Ghanaian stock markets. The difference in the findings can be attributed to difference in the longitudinal scope of the studies, the increasing efforts towards capital market integration in West Africa, and the cooperation between the stock markets of the two countries. A 1 percent increase in the Ghanaian stock market leads to an average increase of about 1.22 percent in the Nigerian stock exchange market. Contrarily, a 1 percent increase in the UK's stock markets index leads to about a 1.90 percent decrease in Nigerian stock market. Both the

⁸ We rely more on the Portmanteau autocorrelation result as it is able to reveal autocorrelations at higher lag orders as compared to the LM test (See Brueggemann et al., 2004).

LBRVMCOM and LSP500 do not significantly impact the Nigerian stock market.

The lower segment of Table 4 contains the speed of adjustment back to equilibrium in the event of a short-run deviation from equilibrium. Only the coefficient on the UK stock market is negatively significant. This implies that this market acts as the restoring agent in the situation of a short-run disequilibrium, albeit as a slow restoring agent. It is a slow restoring agent given that its speed of adjustment back to equilibrium in the next day is just 0.26 percent. The Nigerian, Ghanaian, WAEMU and US stock markets, whose error correction terms are positively signed are above equilibrium.

Next, the short-run linkages are considered using the estimates of the Toda and Yamamoto Granger causality test, and the Generalized Impulse Response Functions (GIRFs) test. Going by the interest of the current study on the integration of the Nigerian stock market with the selected stock markets, the analyses that follow pay more attention to the Nigerian stock market.

6.2. Short-run linkages

The estimates of the Toda and Yamamoto Granger causality test⁹ is first presented as contained in Table 5. The results suggest that all the past values of the stock markets other than UK's contain useful information about the Nigerian stock market and their performances may be used to predict the behaviour or performance of the Nigerian stock market.

⁹ Maximum lag of 6 is used in line with the VEC estimates.

Table 5. Toda and Yamamoto Granger Non-Causality/Block Exogeneity Wald Test results.

Null Hypothesis	Chi-Square (Probability)	Decision	Direction of Causality
LNSEASI does not Granger cause LBRVMCOM	13.19(0.040)**	Reject null hypothesis	LNSEASI ↔ LBRVMCOM (Bi-directional causality)
LBRVMCOM does not Granger cause LNSEASI	13.06(0.042)**	Reject null hypothesis	
LNSEASI does not Granger cause LGSECOM	4.01 (0.675)	Cannot reject null hypothesis	LGSECOM → LNSEASI (Uni-directional causality)
LGSECOM does not Granger cause LNSEASI	13.78(0.032)**	Reject null hypothesis	
LNSEASI does not Granger cause LSP500	11.22(0.082)*	Reject null hypothesis	LSP500 ↔ LNSEASI (Bi-directional causality)
LSP500 does not Granger cause LNSEASI	16.27(0.012)**	Reject null hypothesis	
LNSEASI does not Granger cause LFTSE100	5.55(0.476)	Cannot reject null hypothesis	LNSEASI LFTSE100 (Independence)
LFTSE100 does not Granger cause LNSEASI	7.53(0.275)	Cannot reject null hypothesis	

Note: The null hypothesis is that there is no Granger causality

The probabilities of the Chi-Square are given in parentheses

* and ** denote significance at 10% and 5% level respectively

Source: Computed by the Authors.

The finding that the US' stock market can help in predicting the behaviour of the other markets (Nigeria and UK) than any other market is similar to the finding of Singh and Singh (2016). In their case, investigating the integration between the US and the BRIC (Brazil, Russia, India and China) stock markets, they found that the US stock market, before the global financial crisis, can help in predicting the behaviour of the Russian and Indian stock markets. During the crisis, they found that the US stock market predicts the behaviour of all the BRIC stock markets – a result that still holds for all other markets apart from that of Brazil, after the crisis. The results of this current study also show that the UK stock market helps in predicting the behaviour of the Ghanaian and the US

stock markets. Other findings are that all the markets except UK's contain information about the Nigerian Stock Market.¹⁰ With respect to the direction of causality, bi-directional causalities run between Nigerian and WAEMU, and the Nigerian and US markets.

Turning to the generalized impulse response functions, a 21 day period (corresponding to approximately 1 month, given that data for 5 days a week is employed here) is used to represent the short-run. Figure 2 shows that the Nigerian stock exchange market responds the most to a one standard error shock to the US and UK's stock markets and responds the least to the Francophone markets which is in the same region (West Africa) with Nigeria. On the whole, it is easy to deduce that most markets respond to both the US and UK stock markets in similar fashion. Within West Africa, the Nigerian stock market appears to be the most influential as a standard deviation shock to the Nigerian stock market affects more stock markets (on the average) than those of Ghana and the Francophone countries. The response of the US and UK stock markets to those of the West African countries, Nigeria inclusive, in the whole is negligible, and

⁶ The estimates are available upon request.

¹⁰ Note that although the causality and impulse response results are taken to be short-run, the former can be viewed in terms of a 6-day period while the later in terms of a 21-day period.

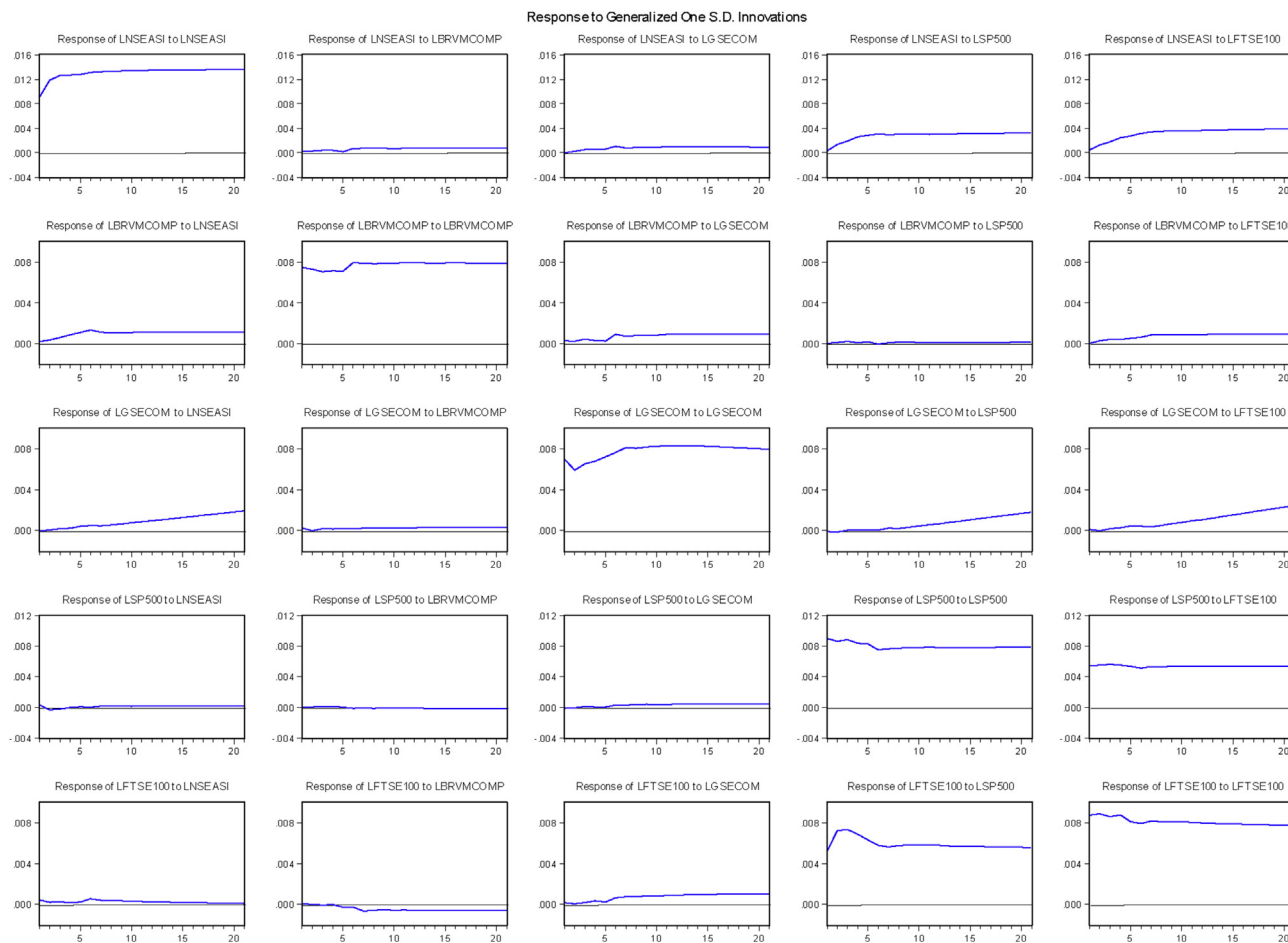


Figure 2. Generalized impulse response functions.

rather transitory, but the reverse does not necessarily ensue. The Nigerian stock market (more than the other West African markets) is also more exposed to vagaries of the UK and US stock markets. The response of the Francophone market tends to be the least in the West African region and dies out rather faster than those of Nigeria and Ghana. This, in line with the Granger causality results, suggests that the Francophone market tends to be the least integrated, hence the least affected.

7. Policy recommendations and conclusion

The primary aim of this study was to examine possible dynamic linkages that exist between the Nigerian equity market viz-a-viz other markets in the West African region and the global stock market in the light of increasing financial globalization and regional stock market cooperation. However, the dynamic linkages amongst the markets in the study were also generally investigated. The VEC technique was used for the analysis alongside the IRF, Gregory Hansen cointegration technique, and Toda and Yamamoto Granger causality test. The study revealed that the Nigerian stock market is affected the most by shocks from the US in the short-run. Regulatory authorities should take relevant steps to insulate the stock market against vagaries of international stock markets which could result in negative capital flows with potentials of distorting local markets significantly. Meanwhile, there is the need for investment managers to consider these interactions between internationalised markets as important factors affecting market dynamics.

The Ghanaian market was interestingly found to have a long-run relationship with that of Nigeria (a positive improvement) which will be of interest to regional regulatory bodies interested in the convergence of key macroeconomic indicators which include stock market indices, as a criterion for advancing the quest for formal regional integration. The

US remains the most influential market in the study, especially in the short-run. This has implications for diversification. The WAEMU market (BRVM) seem to be the most isolated market in the study and hence also in the West African region. Thus diversification opportunities may exist more in the BRVM as an alternate investment haven than the other markets in the study. This is however subject to the risk and return preference of the investor and also the prior composition of the investment basket of the investor in addition to other peculiar preferences.

Furthermore, more efforts need to be taken to eliminate the language barrier which could be a major reason for low interaction between the BRVM and other markets as revealed by the study. Regional efforts are also needed to enhance the integration of the Nigerian and Francophone stock market in the West African region. In general, the study accents to the dynamic and interdependent nature of internationalized stock markets as not being restricted to developed markets alone but also emerging and frontier markets. It also throws light on growing regional inter-market linkages in the West African region amidst efforts towards formal regional market integration.

Declarations

Author contribution statement

Obadiaru David Eseosa: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Omankhanlen Alex Ehimare: Performed the experiments.

Obasaju Barnabas Olusegun: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Eyiolorunsho David Tunji: Contributed reagents, materials, analysis tools or data.

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The authors declare no conflict of interest.

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References

- Adriana, D., 2014. Revisiting the relationship between unemployment rates and shadow economy: a Toda-Yamamoto approach for the case of Romania. *Proc. Econ. Fin.* 10, 227–236.
- Agyapong, D., 2014. Stock market integration in West African Monetary Zone: a linear and nonlinear cointegration approach. *Asian Econ. Financ. Rev.* 4 (5), 563–587. Retrieved from: <https://ideas.repec.org/a/asi/aeafjr/2014p563-587.html>.
- Ahmad, W., Mishra, A.V., Daly, K.J., 2018. Financial connectedness of BRICS and global sovereign bond markets. *Emerg. Mark. Rev.* 37 (c), 1–16. Press.
- Alagidede, P., 2008. African Stock Market Integration: implications for portfolio diversification and international risk sharing. In: *Proceedings of the African Economic Conference 2008*, pp. 25–54. Retrieved from: https://www.afdb.org/fileadmin/uploads/afdb/.../AEC2008_English_p024-054.pdf.
- Ali, U.A., Adam, A., Zunaidah, S., Ahmad, T.A., 2015. Causal relationship between stock market returns and macro economic variables in Nigeria. *IOSR J. Human. Soc. Sci.* 20 (5), 74–96. Retrieved from: <https://pdfs.semanticscholar.org/9dee/47ca56680dcc579bb1861dc86fc2946954dc.pdf>.
- Anaraki, N.K., 2010. The European stock market impulse to the US financial crisis. *J. Int. Busin. Cult. Stud.* 3, 1–11. Retrieved from: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.624.9806&rep=rep1&type=pdf>.
- Brueggemann, R., Luetkepohl, H., Saikkonen, 2004. Residual Autocorrelation Testing for Vector Error Correction Models. *Economics Working Papers. ECO2004/08*. European University Institute. Retrieved from: <https://cadmus.eui.eu/bitstream/id/1957/ECO2004-8.pdf/>.
- Dasgupta, R., 2014. Integration and dynamic linkages of the India stock market with BRIC- an Empirical Study. *Asian Econ. Financ. Rev.* 4 (6), 715–731. Retrieved from: <https://econpapers.repec.org/RePEc:asi:aeafjr:2014p:715-731>.
- Diebold, X.F., Yilmaz, K., 2009. Measuring financial asset return and volatility spillovers, with application to global equity markets. *Econ. J.* 119 (534), 158–171.
- Gregory, A.W., Hansen, B.E., 1996. Residual-based tests for cointegration in models with regime shifts. *J. Econom.* 70, 99–126.
- Iheanacho, E., 2016. Dynamic Relationship between crude oil prices, exchange rate and stock market performance in Nigeria. *Afr. Res. Rev.* 10 (4), 224–240. Serial No. 43.
- Lawal, A.I., Somoye, R.O., Babajide, A.A., 2016. Impact of oil price shock and exchange rate volatility on stock market behaviour in Nigeria. *Binu Busin. Rev.* 7 (2), 177–177. <http://journal.binus.ac.id/index.php/BBR/article/view/1453>.
- Lean, H.H., Smyth, R., 2014. Stock market co-movement in ASEAN and China. In: Aroui, M., Boubaker, S., Nguyen, D.K. (Eds.), *Emerging Markets and Global Economy*. Academic Press, Massachusetts, USA.
- Lee, J., Srazicich, M.C., 2003. Minimum Lagrange multiplier unit root test with two Structural Breaks. *Rev. Econ. Stat.* 85 (4), 1082–1089.
- Maher, M.R., Asif, M., Batool, S.N., 2017. Dynamic linkages among selected South Asian countries stock markets. *J. Bus. Financ. Aff.* 6 (4), 1–6.
- Manasseh, C.O., Chukwu, N.O., Abada, F.C., Ogbuabor, J.E., Lawal, A.I., Alio, F.C., 2019. Interactions between stock prices and exchange rates: an application of multivariate VAR-GARCH model. *Cogent Econ. Fin.* 7 (1), 1681573.
- Mroua, M., Trabelsi, L., 2019. Causality and dynamic relationship between exchange rate and stock market indices in the BRICS countries: panel/GMM and ARDL analyses. *J. Econ. Fin. Adm. Sci.*
- Obadiaru, D.E., 2012. Appraisal of the Effect of the Global Financial Meltdown on Security Values in the Nigerian Capital Market. Master's Thesis. Department of Banking and Finance, University of Benin. Lambert Academic Publishers.
- Obadiaru, D.E., Oloyede, J.A., Omankhanlen, A.E., Asaley, A.J., 2018. Stock market volatility spillover in West Africa: regional and global perspectives. *J. Appl. Econ. Sci.* XIII, 1597–1604. Fall 6(60), Retrieved from: <http://cesmaa.org/Extras/JAESCcurrent>.
- Obadiaru, E.D., Omankhanlen, A.E., Obasaju, O.B., Inegbedion, H.E., 2019. Correlation of stock market returns in the West African region from 2008 to 2016. *Invest. Manag. Financ. Innovat.* 16 (3), 120–130.
- Osamwonyi, I.O., Omorounwa, G.O., 2017. Presidential election and portfolio selections in the Nigerian stock exchange. *Int. J. Financ. Res.* 8 (4), 184–194.
- Osuala, A.E., Onoh, U.A., Nwansi, G.U., 2018. Presidential election results and stock market performance evidence from Nigeria. *Appl. Econ. Fin.* 5 (2), 117–124.
- Quattara, S.B., 2017. Re-examining stock market integration among BRICS countries. *Eur. J. Econ. Fin.* 5 (3), 109–132.
- Özen, E., Tetik, M., 2019. Did developed and developing stock markets react similarly to Dow Jones during 2008 crisis? *Front. Appl. Math. Stat.* 5 (49), 1–7.
- Perron, P., 1989. The great crash, the oil price shock, and the unit root hypothesis. *Econometrica* 57, 1361–1401.
- Pesaran, H.H., Shin, Y., 1998. Generalized impulse response analysis in linear multivariate models. *Econ. Lett.* 58 (1), 17–29.
- Pesaran, H.M., Shin, Y., Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. *J. Appl. Econ.* 16 (3), 289–326.
- Polanco-Martinez, J.M., Fernandez-Macho, J., Numann, M.B., Faria, S.H., 2018. A pre-crisis vs. crisis analysis of peripheral EU stock markets by means of wavelet transform and a nonlinear causality test. *Physica A* 490, 1211–1227.
- Sahar, N., Shah, S.Z.A., 2017. Stock market return and volatility spillovers: the case of selected Muslim majority countries. *J. Islam. Busin. Manag.* 7 (1), 68–86.
- Singh, A., Singh, M., 2016. Inter-linkages and causal relationships between US and BRIC equity markets: An empirical investigation. *Arab Econ. Busin. J.* 11, 115–145.
- Suwanpong, P., 2011. Measuring Return and Volatility Spillovers in Global Financial Markets. Working Paper. Faculty of Economics, Chulalongkorn University, Bangkok, Thailand. Retrieved from: https://www.bot.or.th/Thai/Segmentation/Student/seth/atat/.../pongsakorn1_text.pdf.
- Tella, S.A., 2009. The global economic crises and Nigeria Stock Exchange: issues on contagion. *Nig. J. Sec. Fin.* 14, 101–116.
- Toda, H.Y., Yamamoto, H., 1995. Statistical inference in vector autoregressions with possibly integrated processes. *J. Econom.* 66, 225–250.
- Uwubanmwun, A.E., Omorokunwa, O.G., 2015. Oil price volatility and stock price volatility: evidence from Nigeria. *Acad. J. Interdiscip. Stud.* 4 (3), 253–260.
- Wakeman-Linn, J., Wagh, S., 2011. Regional financial integration as an engine for financial development. In: Quintyn, Marc, Verdier, Geneviève (Eds.), *African Finance in the 21st century*. Palgrave Macmillan.
- WAMA, 2011. Financial System Integration in ECOWAS: Opportunities, Challenges and Prospects. West Africa Monetary Agency, Freetown. Retrieved from: <https://amao-wama.org/wp-content/uploads/.../Financial-System-Integration2011.pdf>.
- Zivot, E., Andrews, W.K., 1992. Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *J. Bus. Econ. Stat.* 10, 251–270.