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Global Stock Market Linkages in Developed and Emerging Markets: A Case of United States, South Africa and Nigeria

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Abstract
This study investigated whether African stock markets of Nigeria and South Africa are integrated with the US market. Using the Engle-Granger cointegration approach, the study found evidence of the presence of a long run relationship between the US market with that of Nigeria but not with South Africa over the period 2003 to 2018. Furthermore, the Nigerian and South African markets are linked together in the long-run. No short-run association found between either Nigeria and the US market or Nigeria and South Africa. By implication, these findings make it possible to infer that scope for arbitrage and diversification benefits exist for international investors who are willing to hold stocks in both the US and South African market.

Keywords: Stock market, Cointegration, Diversification, Africa, US

1.0 Introduction

Integration of stock markets is one of the most topical issues in International finance and, thus, there is large number of studies that focused on the linkages and interdependence amongst different markets. This is because understanding the link between stock returns plays an important role in portfolio allocation, asset pricing and policy formulation (Voronkova, 2004; Li and Majerowska, 2008; Lucey and Zhang, 2010; Agyei-Ampomah, 2011; Carporale and Spagnolo, 2011; Egert and Kocenda, 2011; Guidi and Ugur, 2014). International investors tend to carefully observe the interdependence between markets as thorough understanding of its nature and extent will be valuable in portfolio choices and diversification strategies. Also policymakers are concerned about the extent of stock market linkages as it would help in formulating appropriate policies on how to mitigate the adverse impact of shocks and risk. Previous studies have concentrated on different markets, adopted differing methods and interpreted their results from different perspectives.

However, very few studies were conducted on the linkages between emerging African markets and the US market. This study aims to add to the existing debate in the literature on African finance by examining the integration of African stock markets namely – Nigeria and South Africa and the US market using the Engle-Granger cointegration approach.

This paper is categorized into five sections. Section 2 presents the literature review. Section 3 describes the research methodology and section 5, is the presentation, discussions and conclusions.

1.**Literature Review**

The pioneering contribution on stock market interdependence was conducted by Grubel (1968), who found that diversification of assets in lowly correlated markets would yield higher benefits for investors. Largely employing correlation technique, early research in this area built on this work in order to examine the degree of linkages between different stock markets (Jefferis and Okeahalam, 1999; Alkulaib et al., 2009). Alkulaib et al. (2009) examined the linkages amongst stock markets in the GCC and North African region using the Pearson correlations and daily data from January 1999 to December 2004. Accordingly, the authors reported interdependence between the sample markets. This finding contradicts Jefferis and Okeahalam (1999) who documented evidence of linkages between South Africa and Botswana in the Southern African region. However, the application of correlation test in examining linear dependence between random variables has been criticized. One of the drawbacks of using a correlation test is that, with the presence of ARCH effects in a data, linear association between any two series may be affected (Poon et al., 2004). Furthermore, because the Pearson correlation approach applies the same weight to both negative and positive returns, the risk involved is therefore underestimated from joint extreme events (Tastan, 2006). Thus, it has been criticized because it is a parametric test, particularly given that the returns data may not be normally distributed.

In an attempt to avoid the shortcomings of the Pearson correlation test, cointegration technique has been employed by many kinds of literature to investigate the long-term relation between stock returns in different markets and regions (Gilmore and McManus, 2002; Syriopoulos, 2004; Guidi and Ugur, 2014; Yang et al., 2014). In line, Yang et al. (2014) examined the relationship amongst 26 global stock markets including, South Africa over the period 2002 to 2012 using daily data. The study found that the developed stock markets influenced the emerging markets over the sample period. This study confirmed the findings of Guidi and Ugur (2014) who investigated the long-term relationship between South-Eastern European stock markets (Turkey, Croatia, Slovenia, Romania, and Bulgaria) with those of the US, UK and Germany. Specifically, using the Johansen cointegration test to analyze weekly share price data over the period 2000 to 2013, the authors found that the South Eastern European markets were weakly cointegrated with the UK and German markets. Thus, the study concluded that arbitrage and diversification opportunities existed for investors. Gilmore and McManus (2002) applied the Johansen cointegration technique and reported no long-run relationship between the three Central European Markets (Poland, Hungary, and the Czech Republic) and the US market. Extending on the work of Gilmore and McManus (2002), Syriopoulos (2004) found one cointegrating vector between Slovakia and Germany.

This paper contributes to the literature in twofold. First, the most recent data is used to examine stock market interdependence between African stock markets and the US market. Second, we employed the pairwise Engle-Granger (1987) cointegration technique and the Error Correction Model to examine the long and short run linkages between Nigeria, South Africa, and the US stock markets.

2.**Methodology**

The first objective of this study that has to do with testing the long run linkages between African stock markets and that of the US is achieved using the Engle and

Granger (1987) approach for cointegration; the procedure involves examining the stationarity of residual series derived from an equation of non-stationary variables. Therefore, when the residual series is stationary, it implies that a long run cointegration exists between the two variables.

The first step of the Engle-Granger (1987) approach is estimated in the following equation as follows:

$$Y_t = \beta_0 + \beta_1 x_{i,j} + e_t \quad (1)$$

Where y_t and x_t are the respective stock market indices, whereas *i* stands for Nigeria and *j* represents South Africa. The estimated error term series from equation (1) is then generated and investigated for stationarity using the ADF test as follows:

$$\Delta\tilde{e}_t = \alpha_1 \tilde{e}_{t-1} + \sum_{i=2}^{n} \alpha_i \Delta\tilde{e}_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta y_t = \alpha_{10} + \alpha_{11}(y_{t-1} - \beta_0 - \beta_1 x_{t-1}) + v_t^y \quad (3)$$

$$\Delta x_t = \alpha_{20} + \alpha_{21}(y_{t-1} - \beta_0 - \beta_1 x_{t-1}) + v_t^x \quad (4)$$

with α_{11} and α_{21} standing for the error correction coefficients; and they try to show how much change in x and y responds to the co-integrating error given as:

$$e_{t-1} = y_{t-1} - \beta_0 - \beta_1 x_{t-1} \quad (5)$$

Lastly, causality between the two markets in Africa and the US would be tested using the causality approach of Granger (1969).

$$\Delta x_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta x_{t-1} + \sum_{i=1}^{m} \beta_{2i} \Delta y_{t-1} + \varepsilon_{1t} \quad (6)$$

$$\Delta y_t = \propto_0 + \sum_{i=1}^{n} \propto_{1i} \Delta x_{t-1} + \sum_{i=1}^{m} \beta_{2i} \Delta y_{t-1} + \varepsilon_{1t} \quad (7)$$

The result of the causality test would be validated based on F-statistics, with a null hypothesis stating that stock market *x* does not Granger cause stock market *y* and vice versa. On the other hand, for ensuring the reliability of the result estimates, the study would utilize Akaike information criteria to specify the optimal lag lengths.

Here, α and ε stand for the estimated parameters and error terms respectively. This technique tests a hypothesis on the estimated parameter, where the decision is that when t-statistics is higher than the critical value in absolute terms, then we reject the null hypothesis and conclude that the series is stationary and hence, the markets *x* and *y* have a long run relationship. In the event where a long run cointegration between these markets is established, it is part of the aim of the study to further explore on the short run dynamics among the cointegrated markets- through estimating an error correction model (ECM). The ECM is employed to ascertain speed at which the markets come back to equilibrium after drifting apart due to variations in one of the market. So, the error correction models for the two markets are specified as:

Impliedly, the causality test would try to assess if there exist any causation or influence between the two sets of stock markets. That is if activities in one market determine the behavior in the other markets. Therefore, consider the two series x_t and y_t as:

3.1*Variables Description*

Stock markets in the three countries are measured by the weekly closing stock price index for Nigeria (NSE All-share index), South Africa (FTSE/JSE All-share index) and the US (NYSE) as reported in the Thomson Reuters Datastream. The period covered by the data ranges from 20th March 2003 to 22nd March 2018. Moreover, it worth noting that weekly data is used in order to avoid the problem of non-synchronous trading effects that normally happens as a result of disparities in the opening and closing times of the sampled markets.

3.Results and Discussion

In order to understand the behavior of our data, a summary statistic of the weekly data is presented in table 1; and based on that, Nigeria has the highest average returns, closely followed by South Africa. The standard deviation for South Africa is higher than that of Nigeria and the US respectively. South Africa and the US have negative skewness which implies that their distributions have a long right tail. Whereas given the conducted Jarque-Bera test, the distribution of all the returns in our sample appeared non-normal.

Table 1: Summary statistics

	US	SOUTH AFRICA	NIGERIA
Mean	9.037428	10.26495	10.27049
Median	9.033036	10.33609	10.20189
Maximum	9.511382	11.02979	11.09923
Minimum	8.358807	8.921652	9.498085
Standard dev.	0.228640	0.541721	0.317155
Skewness	-0.293613	-0.675534	0.380604
Kurtosis	2.405675	2.547148	3.016287
Jarque-bera	22.80313	66.32843	18.93697
Probability	0.000011	0.000000	0.000077
Sum	7085.344	8047.724	8052.067
Sum sq. Dev	40.93238	229.7807	78.76000
Observations	784	784	784

Note: All weekly returns were transformed to log using weekly closing prices

Further, based on the plots depicted for all the three markets (Figure 1), there is an upward trend across all the markets starting from 2003 through 2007. However, with the effects of the 2007/2008 global financial crisis, virtually all the stock market prices in the three markets experienced a sudden decline. Figure 2 shows the plots of weekly stock market returns for Nigeria, South Africa, and the US respectively. It can be observed that there is the presence of high and low volatility clustering across the three markets.

Table 2: Unit root Tests

Market	ADF		PP	
	Levels	**First Difference**	**Levels**	**First Difference**
Nigeria	-2.090620	-26.33763*	-2.385979	-26.99730*
South Africa	-2.376415	-31.51862*	-2.242210	-31.56639*
US	-2.482213	-19.06485*	-2.504519	-32.19704*

Note: (*) denotes statistically significant at 1%. The critical values of the ADF and PP test in level forms are -3.96, -3.41, & -3.13 at 1%, 5% and 10% correspondingly.

As a prerequisite for cointegration test, the stationarity of the variables was examined using Augmented Dickey-Fuller (ADF) and Phillips-Perron (1988) tests; and according to the results shown in both the two unit root tests (table 2), the null hypothesis indicating the presence of unit root was not rejected for all the indices. However, after taking the first difference, the results in both ADF and PP test reveal evidence to reject the null hypothesis whereby the test statistics is greater than the critical values for the three indices. Thus, by implication, all the series are integrated of order (1), hence satisfied the requirement for cointegration test.

Table 3: Long-run Cointegration

	ADF test Statistic
Ln_ng and ln_us Residuals	-2.275**
Ln_sa and ln_us Residuals	-1.462
Ln_ng and ln_sa Residuals	-1.946**

Note: (**) denote statistically significant at 5%. The test critical values of the ADF at 1%, 5% and 10% are -2.567, -1.941 and -1.616 respectively.

Having established that all our series are I(1), an OLS equation is estimated is the first step needed for accomplishing the two-step cointegration test of the Engle-Granger. In accordance, the first category of the model's specifications put the African markets as the dependent variables and the US market as the independent variable. Going by the result estimates reported in table 3, evidence on the long run relation between Nigeria and US markets have been found at 5%, and also Nigeria and South Africa at 10%. On the other hand, the test of cointegration between South Africa and US stock markets prices show no long-run co-movement. We argue that our finding here is in line with some earlier empirical studies (Jefferis & Okeahalam, 1999) which reported the absence of long-run relation between southern African markets and the developed markets of US and UK.

Table 4: Short-run and ECM for Nigeria and US markets

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001374	0.001172	1.172743	0.2413
DLOG_US	0.049941	0.047640	1.048285	0.2948
RESID01(-1)	-0.017744	0.004642	-3.822317	0.0001

However, as highlighted by Gupta and Guidi (2012), one of the major drawbacks of the Engle-Granger cointegration approach is its lack of proper guidance as to the model specification- which variable should be the dependent variable and which should be the independent variable. Therefore, in order to overcome this problem, another set of OLS regressions with the US being the dependent variable for all the two markets have been estimated. And according to the result obtained (table 4), a long run relation between all the three markets was found, albeit at a 10% significance level.

That is to say, other than the result for the US and South Africa; the findings corroborate with what is reported earlier in table 3 when the US market was taken as the regressor. The revelation in the current specification still is in line with a work done Agyei-Ampomah (2011), where a positive long-run correlation was found between the developed stock markets and the South African market using a linear correlation method. But for the fact that the results

reported in table 3 based on earlier specification (where US was taken as the independent variable) was significant at 5%, coupled with the limitations in the method used by Agyei-Ampomah (2011) as highlighted in Poon et al. (2004), we chose to continue with the earlier findings as it appears more convincing.

Table 5: Short run and the ECM for Nigeria and South Africa

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001331	0.001184	1.124475	0.2612
DLOG_SA	0.040705	0.047324	0.860122	0.3900
RESID03(-1)	-0.009531	0.004254	-2.240612	0.0253

Therefore, having obtained a long run cointegration between Nigerian market and the US (see table 3), an error correction model (ECM) that would highlight on the short-run equilibrium relation for the two markets (Nigeria and US) was estimated. Although the coefficients for the short run relation between the markets in Nigeria and those in the US appear not significant (table 4), but interestingly, the error correction term is found to be negative and statistically significant (-0.017744). Thus by implication, in an event where the two markets drifted apart, correcting the disequilibrium will be done in the near future. Similarly, in examining the short-run relation between Nigerian and South African markets, we have obtained no evidence of a short-run relation as presented in table 5; however, the error correction term is negative and significant (-0.009531) indicating the correction of the disequilibrium in the nearest future.

Table 6: Granger causality test

Null Hypothesis:	Observations	F-Statistic	Prob.
Log_US does not Granger Cause Log_NG	782	10.8000	2.E-05
Log_NG does not Granger Cause Log_US	782	3.67098	0.0259
Log_SA does not Granger Cause Log_NG	782	2.97875	0.0514
Log_NG does not Granger Cause Log_SA	782	1.89204	0.1515
Log_SA does not Granger Cause Log_US	782	2.90596	0.0553
Log_US does not Granger Cause Log_SA	782	0.45897	0.6321

In line with our earlier arguments, it is among the objectives of this study to test on the causality between the studied markets as reported in table 3. Therefore, the Granger causality method is employed; and accordingly, a presence of bidirectional causality between the US and Nigerian market is obtained (see table 6). Our finding could said to be not surprising observing the number of reforms and increased trade links between the two countries in recent years. However, no causality was found between South African markets and the US, and vice versa.

4.**Conclusion**

Examining the integration and co-movement between stock markets across different global regions may have important implications for international investors and policy-making in designing appropriate policies on financial markets interdependence as well as portfolio selection. This is particularly true where policymakers and private investors may wish to know about whether

interdependence relation does exist between markets situated in less developed regions such as Africa and that of the west. Using Engle-Granger (1987) cointegration technique, the current study adds to the understanding of the long run relationship between stock markets in Africa and the US. Although we could not find evidence on the presence of long-run relation between markets in South Africa and those in the US, our results reveal otherwise for Nigeria and the US. Meaning, a long run relation was found between markets in Nigeria and the US. This thus could be attributed to the increased trade relations between Nigeria and the US over recent years. Consequently, the presence of an equilibrium relationship does indeed limit diversification benefits for international investors that are intending to diversify their investments across the two countries.

For South Africa and the US market nevertheless, results reveal no evidence of integration between the two markets. These findings make it possible to infer that scope for arbitrage and diversification benefits exist for international investors who are willing to hold stocks in both the US and South African market. On estimating the error correction model for the markets in Nigeria and US, evidence based on the results indicate the absence of short-run relation between the two, albeit with a negative and significant error correction term. This implies that any disequilibrium between the two markets could be corrected shortly, all things being equal.

Given the scope of our study, future studies could consider employing a more advanced technique in examining the likely interdependence between African markets and the US; perhaps by taking into account post and pre-global financial crisis periods, and how it might have affected the level of market integration across the respective continents. Similarly, a study that would employ a uniform unit of measurement (currency) between the countries in the sample could be of additional relevance.

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