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An Empirical Analysis of Stock Markets Integration in Selected African Countries

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Abstract: This study employs cointegration technique to determine the co-movement of ten national stock markets indexes in Africa. Using monthly indexes spanning February, 1997 to October, 2011, results demonstrate less than full cointegrating vectors, which suggest African stock markets are not fully integrated. Further findings indicate that big African stock markets indexes tend to influence fluctuations in small African markets indexes. Generally, these imply limited benefits accrue from portfolio diversification within African stock markets.

Keywords: financial markets; co-movement; unit roots tests; cointegration test

JEL classification: G15; F36

1. Introduction

Economic liberalization policies undertaken by several African countries in the 1980s were characteristically followed by financial markets liberalization policies. For instance, the Structural Adjustment Policy (SAP) in Nigeria of 1986 resulted into the deregulation of the Nigerian capital market in 1993, which allows prices of new issues to be determined by issuing houses and stockbrokers (ASEA, 2008). A natural consequence of liberalisation is financial integration as evident from the wave of stock markets integration and interdependence witness over the years, which is in turn, vividly exemplify by the rate of cross-border listing. These include cross listing between stock exchanges in South Africa and Botswana in 1997; stock exchanges in South Africa and Ghana in 2004; and stock exchanges in Nigeria and Ghana stock exchanges in 2006 (Adelegan, 2009). Beyond economic liberalisation, other factors responsible for financial market integration include introduction of innovative financial products and breakthroughs in information technology. Formation of common trading blocks and the development of integrated economic systems also foster closer linkages of stock markets within the constituent countries (Chen, Firth and Rui, 2002).

Although stock market integration phenomenon is barely two decades-old for most African countries, its importance can hardly be over-emphasised. Integration or co-movement among the prices of national stock markets suggests that international investors have limited long run gains from diversifying their portfolio investments within these markets. Strong global linkage reduces the insulation of the emerging markets from external shocks, hence limiting the scope for independent monetary policy. Within the framework of error correction model, Granger (1986) points out that strong linkage among world capital markets may facilitate the rejection of the efficient markets hypothesis. Premised on these implications of stock market integration, several authors have attempted to determine the extent at which various national stock markets are highly correlated and interdependent overtime. Unfortunately, previous empirical studies on the interrelationship of the stock markets indexes have concentrated on mature markets with few studies on interdependencies among emerging markets. Our survey of literatures indicates no study on African stock markets indexes of which economies are linked by similar business atmosphere and cultural legacy.

Our study investigates stock market linkages in ten African stock exchanges by adopting the cointegration techniques of Johansen (1988, 1991) maximum likelihood approach. The process of our analysis begins with Zivot and Andrews (1992) and Lee and Strazicich (2003) methods of unit root tests with structural breaks. This study has strong implications for investors, such as portfolio managers, local, foreign, private and institutional investors- who are heavily involved in African stock markets- as in whether they do benefit from diversifying within African stock markets. In 2008, foreign investors constitute 46% and 40% of the total portfolio holdings in the stock exchanges of South Africa and Kenya, respectively. According to a report, portfolio holdings of individuals accounts for 98% of the total investment in Nigeria stock market at the end year 2008, while institutional investors hold almost 60% of Kenya's exchange equities (ASEA, 2008). Secondly, understanding the extent of financial integration and monitoring its progress in the region is also important for African central banks or the respective regulatory bodies for monetary policies. Thirdly, increased international financial integration promotes financial development and hence enhances economic performance in the region. Fourthly, financial integration (of which stock market integration is a component) also has strong implications for financial stability (Yu, Fung and Tam, 2010).

Besides the introduction, which occupies the first section, the paper is organized in the following way. Section 2, which is entitled "review of literature", discusses related prior research, while the progress of stock market integration is reviewed in Section 3. Section 4 discusses the model, data and method of analysis in this paper and Second 5 presents the empirical results. Section 6 summarises the findings and outlines policy implications.

2. Review of Literature

Measuring the relationship between national stock markets is not a clear-cut task. Consequently, scholarships have over the years adopted different methodologies, different frequencies of observations (daily, weekly or monthly); different choices of markets; different sample periods, and different methodologies in trying to determine integration of national stock markets. Expectedly, the findings vary even for researches on the same markets. Few early studies on co-movement of stock markets utilise correlations among different markets and discover stability of the correlation structure over time (see Panton, Lessig and Joy, 1976), meanwhile, Kaplanis (1988) notes that correlation matrix of many national stock markets returns are unstable over time. Besides the traditional correlation tests, Autoregressive Conditionally Heteroscedastic model (ARCH) and its subsequent variants (such as Generalized Autoregressive Conditionally Heteroscedastic (GARCH) have been adopted by scholars in unravelling the relationship between national stock markets. The studies within the ARCH framework include Engel and Susmel (1993); Koutmos and Booth (1995). These studies use returns data, which has criticised on the basis that modelling of returns causes information loss on possible common trends when prices are cointegrated (see Baillie and Bollerslev, 1989). ARCH model itself has been challenged on the premise that it bears more similarity to moving average framework rather than an autoregressive specification (Engle, 1995).

Studies such as Kim and Rogers (1995) utilise GARCH models to examine the repercussions on the relationships between the stock markets of Korea, Japan, and the United States and observe an increasing spill over effect. Scheicher (2001) considers the returns and volatility of the national stock indices of Hungary, Poland and the Czech Republic for the period 1995–1997 via a multivariate GARCH. The author observes the integration of Hungary, Poland and the Czech Republic stock exchanges with the global market. On the other hand, Li and Majerowska (2008) investigate the linkages between the two emerging markets in Hungary and Poland and developed markets in Germany and U.S, by applying GARCH. The results demonstrate limited interactions among the markets, and also suggest emerging markets are weakly linked to the developed markets. However, GARCH models are largely symmetric, which imply a big positive shock will have the same effect in the volatility of the series as a big negative shock of the same magnitude (Asteriou and Hall, 2007:267).

In order to circumvent issues associated with ARCH and its variants, researchers have largely employed cointegration techniques to study dependencies in stock prices. Although there are numerous cointegration techniques including Engle and Granger (1987) two-step method and Johansen (1988, 1991) maximum likelihood approach, literatures prefer Johansen (1988, 1991) cointegration approach over the Engle and Granger (1987) method because of several reasons. Engle and Granger (1987) does not provide for more than one cointegration relationship in models with more than two variables and does not indicate the variable to be placed on the left side of the equation (Asteriou and Hall, 2007:317). Errors introduced in the first step of Engle and Granger (1987) is carried to the second step. All these problems do not exist in the Johansen (1988, 1991) maximum likelihood approach.

Seminally, Kasa (1992) estimates the relationship between US, Japan, Britain, Germany and Canada with the application multivariate cointegration model of Johansen (1988, 1991). With monthly and quarterly data from January 1974 through August 1990, the results illustrate the presence of a single common trend driving these countries' stock markets. In another study dedicated to developed countries, Pascual (2003) examines long-run co-movements in the UK, French, and German stock markets with the aid of cointegration techniques. The result indicates that the integration of stock markets does not perfectly exist in the three countries. Furthermore, Mylonidis and Kollias (2010) consider long-run relationship among four major European stock market indexes for the first post-euro decade. The empirical results suggest a limited convergence has been taking place over time.

Beyond studies on developed countries, few researches on Latin America have been conducted, which include Chen at al. (2002) and Diamandis (2009). In particular, Chen at al. (2002) utilised the cointegration method to examine stock market indexes of Argentina, Brazil, Chile, Colombia, Mexico and Venezuela, using daily data from February 1995 to 30 June 2000. The study notes one cointegrating vector, which suggests limited opportunities for potential investors. Similarly, Diamandis (2009) observe one cointegrating vector in a study including Argentina, Brazil, Chile and Mexico-and a benchmark market-US stock, using weekly data for the period January 1988 to July 2006. On Asian countries, Click and Plummer (2005) assess the co-movement of stock exchanges of Indonesia, Malaysia, the Philippines, Singapore, and Thailand in the aftermath of the Asian financial crisis, using cointegration techniques. Specifically, the coverage of the study spans July 1, 1998 through December 31, 2002 with the findings illustrating single cointegrating relationship, thus indicating benefits of international portfolio diversification across the five markets are reduced but not eliminated, aftermath of the Asian financial crisis. Other studies on Asian countries with less than full cointegration relationship include Huyghebaert and Wang (2010) for seven major East Asian stock exchanges for the period covering before, during, and after the Asian financial crisis; Jang and Sul (2002) for seven Asian countries; and Francesco (2010) for Indian and Asian developed equity markets. Beyond Asian countries, less than full cointegration relationship findings are Aggarwal and Kyaw (2005) for North American Free Trade Agreement (NAFTA) countries; and Ratanapakorn and Sharma (2002) for regional stock indices, which include US index, European index, Asian–Pacific index, Latin American index Eastern European–Middle East index. Clearly omitted from the previous studies are African countries.

3. Stock Market Integration in Africa

In Africa, there is the need to mobilize necessary domestic resources to support its development objectives. Harnessing domestic resources requires efficient, deep and well-established financial markets, including stock exchanges. Part of the efforts to ensure well-established financial markets include its integration, as integrated market would reduce costs, facilitate capacity building, provide regional and international services and infrastructure. Other advantages resulting from integration of African financial markets include economies of scale, and increased competition. Besides, it is expected that stronger integration of stock markets will provide a wider range of instruments available for both investors and savers; supports private sector by providing platforms for productive financial capital. Lastly, it facilitates capacity building in countries with less developed capital markets.

Envisaging these potential benefits, some African countries have over the years relaxed regulations on cross border listing, which afford investors the opportunity to mobilize or allocate resources outside their countries of residence. For instance, Ecobank Transnational Inc (incorporated in Togo) is listed on the Nigeria Stock Exchange. In 2009, a Tunisian company-"Ennakl Automobiles" of Princess Holding Group - dual listed on both floors of Tunisia and Morocco stock exchanges. Foreign investors' participation on local stock exchanges in Africa has also improved over the years. On the floor of Botswana Stock Exchange, 11 of the 32 listed are foreign companies. Foreign investors accounted for 55.77% of the total value of shares traded in 2009 as against 40.14%, in 2008, in Kenya stock exchange. In South Africa, for the year 2009, foreign investors transacted about 17.4 percent of the total value of shares traded (ASEA, 2009). Cooperation efforts among stock markets in Africa include the signing of Memorandum of Understandings (MoUs) between Ghana Stock Exchange and the Nigerian Stock Exchange regarding staff training, surveillance procedures, self-regulation, and communication of information. Johannesburg Stock Exchange signed MoUs with Ghana, Kenya, Egypt, Nigeria and Uganda. The Kenya Stock Exchange has similarly signed MoUs with Nigeria and Ghana (Irving, 2005). The extreme form of stock market integration in practice is a single formal regulator and stock exchange. There is one of such market in Africa. Known as Abidjan Stock Market (BVRM), it is the regional e-stock exchange for eight West Africa countries- Benin, Mali, Togo, Senegal, Ivory Coast, Burkina Faso, and Guinea Bissau.

4. Model, Data and Methodology

4.1 Model

To investigate relationships among stock indexes across geographical regions, the following model is analyzed:

$$W = f\,(W_t^i) \tag{1}$$

W is stock market index, i represents stock market index of Botswana (BOT): Cote D'Ivoire (COT); Egypt (EGY); Ghana (GHA); Kenya (KEN); Mauritius (MAU); Morocco (MOR); Nigeria (NIG); South Africa (SOU); and Tunisia (TUN).

4.2 Data

Our study utilises monthly indexes of Botswana, Cote D'Ivoire, Egypt, Ghana, Kenya, Mauritius, Morocco, Nigeria, South Africa and Tunisia stock markets for the period February, 1997 to October, 2011. The use of monthly data avoids distortions associated with weekly and daily data, which arise not only from non-trading but also from non-synchronous trading (that are particularly prevalent in African stock markets). The indexes were constructed by Standard and Poor (S&P) and obtained from *Thomson Financial Datastream*. With the exception of South Africa and Egypt indexes, which are in the investable category, all other indexes are Broad Market Index (BMI) variants of the S&P classification. The stock price indexes are expressed in local currencies, which eliminates problems associated with exchange rates fluctuations (Guidi, 2010)

4.3 Stationarity test

Based on Perron (1989) seminal paper on the fallibility of conventional unit root tests in the presence of structural shift, authors propose alternative unit-root tests that consider structural changes. Perron (1989) proposes a method that requires arbitrarily selection of structural break date. Consequently, Zivot and Andrews (1992) introduce a sequential Dickey-Fuller unit root test that most importantly considers break dates as endogenous. By so doing, Zivot and Andrews (1992) suggest three types of tests that include unit root test of trend stationarity process in the presence of a shift in mean (Model A) and a shift in slope and intercept (Model C). These two models are specified below:

$$\Delta Y_t = \mu_1^A + \beta_1^A t + \mu_2^A DU_t + \alpha^A Y_{t-1} + \sum_{j=1}^{k} c_j^A \Delta Y_{t-j} + \varepsilon_t \qquad (2)$$

$$\Delta Y_t = \mu_1^C + \beta_1^C t + \mu_2^C DU_t + \mu_3^C DT_t + \alpha^C Y_{t-1} + \sum_{j=1}^{k} c_j^C \Delta Y_{t-j} + \varepsilon_t \qquad (3)$$

Δ is difference symbol, while $t = 1, 2, 3.. . .. T$, is an index of time and ε is a white noise that follows the classical properties $E(\varepsilon_t) = 0$ and $E(\varepsilon_t^2) = \sigma^2$ for all t. DU_t and DT_t are dummy variables for breaks in mean (level) and trend, respectively. If break date is depicted by T_B, then $DU_t = 1$ if $t > T_B$, alternatively 170
0; and $DT_t = t - T_B$ if $t > T_B$, alternatively 0. T_B is determined by the minimum *t*-statistic on coefficient of the Autoregressive variable, over the entire possible break dates, in some pre-specified range for the break fraction, where the choice in our case is 0.15 *to* 0.85, (which corresponds to April, 1999 to September, 2009 in our study) that is similar to Zivot and Andrews (1992) recommended trimming range. This trimming is necessary because, with the presence of the end points, asymptotic distribution of the statistics tend to diverge to infinity (Andrews, 1993). The purpose of ΔY_{t-j} terms (similar to the way in which Augmented Dickey Fuller unit root tests enhance Dickey-Fuller unit roots test) included in equations (2) and (3) are to ensure that, disturbance terms are white noise and serial correlation free. The two equations are specified under the assumption of unit root without a break under the null hypothesis, while the alternative is a broken trend stationary process.

The asymmetric treatment of unit root process with no break under null hypothesis and a stationary process with break under the alternative hypothesis can lead to spurious rejections, especially if a break exists under the null hypothesis of unit root. Zivot and Andrews (1992) provide for single structural break, while in reality, several unit roots are plausible. As a result, Lee and Strazicich (2003) introduce two-break minimum Lagrange Multiplier (LM) unit root test, which are not affected by structural breaks under the null hypothesis. Lee and Strazicich (2003) unit root tests with two structural breaks are modified versions of Schmidt and Phillips (1992) unit root tests, based on the LM principle and allow for structural break(s) in mean (Model A); both in mean and in trend (Model C). These are exemplified below:

$$y_t = \delta' Z_t + X_t, \qquad X_t = \beta X_{t-1} + \varepsilon_t \tag{4}$$

Z_t is vector of exogenous variable defined by data generating process and ε_t is the contemporaneous error term that satisfies classical assumptions. The representation of Model A in Lee and Strazicich (2003), which allows for double breaks in mean (level) is: $Z_t = [1, t, D_{1t}, D_{2t}]'$ where $\mathrm{D_{jt}} = 1$, if $\mathrm{t} \geq T_{Bj} + 1$, $j = 1,2$ and 0 otherwise, where T_B is the break date. The representation of Model C in Lee and Strazicich (2003) that provides for double breaks in both mean (level) and linear time trend is represented by: $Z_t = [1, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t}]'$ where $DT_{jt} = t$ if $\mathrm{t} \geq T_{Bj} + 1$, $j = 1,2$ and 0 otherwise. The Lee and Strazicich (2003) minimum two-break LM unit root test statistics are conducted via the following regression;

$$\Delta y_t = \delta' \Delta Z_t + \phi \bar{S}_{t-1} + \sum_{i=1}^{p} \gamma \Delta \bar{S}_{t-i} + \varepsilon_t \tag{5}$$

$\bar{S}_t = y_t - \hat{\psi}_x - Z_t \hat{\delta}_t,$ $t = 2\ldots T$, $\hat{\delta}$ represents the coefficients in the equation of Δy_t on ΔZ_t while $\hat{\psi}_x$ is $y_t - Z_t \delta$, and y_1 and Z_1 are the first observations of y_t and Z_t respectively. The testing of the null hypothesis of unit root ($\phi = 0$) is conducted by (LM) t-statistic, against the alternative hypothesis of trend-stationarity. Critical values are provided in Lee and Strazicich (2003) and the augmented terms of $\Delta \bar{S}_t$ are included to provide for the likelihood of serial correlation in errors.

4.4 Johansen Cointegration Approach

Measuring integration is typically done by utilising correlation tests and cointegration. As shown by Pukthuanthong and Roll (2009), correlation across markets is a poor measure, as perfectly integrated markets can exhibit weak correlation. In this study, we employ the cointegration techniques of Johansen (1988, 1991);

$$\Delta X_t = \delta + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \prod X_{t-k} + \varepsilon_t \tag{6}$$

X_t is the column of vector of the endogenous variables, Γ and $\prod$ are coefficient matrices. If $\prod$ has zero rank (r), no stationary linear combination can be identified, thus X_t are not cointegrated. If the rank of $\prod$ is greater than zero or less than the number of $\prod$ endogenous variables, there will exist r possible stationary combinations i.e cointegration. With cointegration, $\prod$ may be decomposed into two matrices α and β, where $\prod = \alpha\beta'$. In this case, β consists of coefficients of the r distinct cointegrating vectors that renders $\beta' X_t$ stationary even though X_t is non-stationary by itself. α is the speed of adjustment of the coefficients for the equation. The cointegration rank can be tested by using the procedures outlined by Johansen (1991). These include trace and maximum eigenvalue tests which are based upon likelihood ratio test. The trace test used by Johansen (1988) for testing H_0: cointegrating vectors $\leq r$ versus H_a: cointegrating vectors $> r$ is:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{p}\ln(1-\hat{\lambda}_i) \qquad (7)$$

The maximum Eigenvalue test involves testing H_0 **:** cointegrating vectors $= r$ versus H_a **:** cointegrating vectors $= r+1$ is:

$$\lambda_{\max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1}) \qquad (8)$$

4.5 Granger Causality

Furthermore, the study utilizes the resulting Granger causality tests to investigate the flow of causations among the variables in the long run and the short run. Granger (1988) integrated the concept of cointegration into causality. With cointegrated variables, causal relations among variables should be examined within the framework of error correction model. Thus, we denote the following representation:

$$\Delta W_t = \partial_0 + \partial(L)\Delta W_{t\text{-}i} + \gamma EC_{t-1} + \varepsilon_t \qquad (9)$$

∂_0 is a constant term and $\partial(L)$ is a *pth* degree matrix polynomial of coefficients to be estimated in the lag operator, with *p* represents the number of lagged periods used in the model, EC_{t-1} is the vector of error correction term, which represents residuals or deviations from the long run equation and ε_t is a vector of error term, which is assumed to fulfil the classical assumptions. Thus, there are two channels of causality: one is through individual elements of $\Delta W_{t\text{-}i}$, which is referred to as the short run causality and the other is through EC_{t-1} which is referred to as the long run causality.

5. Findings

Table 1. Correlation Coefficient

Variables	BOT	COT	EGY	GHA	KEN	MAU	MOR	NIG	SOU	TUN
BOT	1.000									
COT	0.828	1.000								
EGY	0.746	0.880	1.000							
GHA	0.873	0.776	0.630	1.000						
KEN	0.821	0.872	0.896	0.791	1.000					
MAU	0.873	0.910	0.851	0.836	0.907	1.000				
MOR	0.710	0.823	0.822	0.566	0.761	0.830	1.000			
NIG	0.921	0.817	0.782	0.826	0.859	0.833	0.634	1.000		
SOU	0.955	0.849	0.749	0.888	0.850	0.872	0.671	0.906	1.000	
TUN	0.701	0.788	0.711	0.541	0.686	0.702	0.789	0.608	0.741	1.000

The variables are in natural logarithms.

Table 1 reports the contemporaneous correlation coefficients among the stock indexes. With Spearman's rank correlation coefficient, there is the easiness of identifying the strength and direction (whether the correlation is positive or negative) of each pair wise relationship. Most of the correlation coefficients are high among the stock markets. For example, the coefficient linking SOU and BOT is around 95%, which is not surprising because SOU has significant presence in BOT (ASEA, 2009). NIG has very high correlation with its West Africa neighbours, which include COT at about 82.6% and GHA at about 81.7%. In practice, NIG and GHA are so connected that NIG provided technical assistance for the establishment of GHA in the 1990s. Overall, these suggest restricted benefit in the short run from portfolio diversification. Nevertheless, Pukthuanthong and Roll (2009) argue correlation coefficient is not sufficient to measure the co-movement in the stock markets indexes, therefore the study proceeds with cointegration analysis, but starting with stationarity test.

Table 2. Unit root tests

	Zivot-Andrews test for unit roots				Lee-Strazicich test for unit roots					
	Model A		Model C		Model A			Model C		
Variables	T-stat	Break	T-stat	Break	T-stat	Break	Break	T-stat	Break	Break
BOT	-3.124	2008:10	-3.807	2006:09	-1.601	1999:07	2008:11	-4.201	1999:08	2006:09
COT	-3.537	2005:10	-2.800	2005:10	-1.807	2005:12	2008:11	-4.906	2002:11	2007:08
EGY	-3.933	2004:07	-2.678	2004:07	-1.351	2006:06	2008:11	-4.286	2002:11	2005:11
GHA	-4.573	2002:12	-4.517	2002:12	-3.275	2002:11	2004:11	-4.537	2002:10	2005:05
KEN	-4.074	2002:12	-3.749	2002:12	-1.756	2003:10	2008:03	-4.052	2002:12	2006:03
MAU	-3.789	2006:06	-3.634	2006:06	-2.352	2005:08	2009:04	-5.527[a]	2001:12	2007:04
MOR	-3.734	2006:01	-3.104	2006:01	-1.969	2005:12	2009:01	-3.415	2001:02	2006:06
NIG	-4.664	2008:10	-4.912	2008:10	-1.679	1999:10	2008:10	-4.388	2003:03	2008:08
SOU	-3.739	2005:05	-4.022	2005:05	-1.984	1999:04	2003:04	-4.074	2005:09	2008:07
TUN	-3.588	2001:02	-3.573	2001:02	-1.054	1999:02	2009:03	-3.080	2002:08	2006:06

The critical values of Zivot and Andrews (1992) for 1% and 5% levels are -5.340, -4.800 and -5.570, -5.080 for Model A and C. Critical values of Lee and Strazicich (2003) for 1% and 5% levels are -4.545, -3.842 and -5.825, -5.286 for Model A and Model C. The optimal lag is set to 6, due to the monthly nature of the data.

The null is no stationarity with the presence of endogenous structural break.[a] implies significance at 5% level.

A requirement for conducting Johansen (1988, 1991) is to determine the series order of integration. Hence, the study commences the econometrics analysis by finding the order of integration of the variables with Elliott, Rothenberg and Stock (DF-GLS), which is an improvement on Augmented Dickey Fuller test (ADF) and which de-trend the data prior to unit root tests. The DF-GLS test suggests that all the variables attain stationarity at first difference. Due to space, these results are not reported here. A major drawback of DF-GLS is that the test ignores the possibility of structural breaks in the series. Hence, in Table 2, the study presents methods – Zivot and Andrews (1992) and Lee and Strazicich (2003) –that inculcate structural break(s) in testing for unit roots. The results of Zivot and Andrews (1992) accept the null hypothesis of non-stationarity of both series at level, thereby confirming the results of DF-GLS. The findings of Zivot and Andrews (1992) may not be too reliable due to the possibility of two or more structural breaks on the one hand and on the other hand the presence of breaks under the null hypothesis. Additionally in Table 2, findings of Lee and Strazicich (2003) are reported, which outmanoeuvres the enumerated limitations associated with Zivot and Andrews (1992). Coincidentally, similar to the previous tests on unit roots, Lee and Strazicich (2003) test accepts the null hypothesis of non-stationarity of all series, except in the case of MAU, in which the test reject the null at 5% significance level. However, at 1%, Lee and Strazicich (2003) accept the null hypothesis of non-stationarity of all the variables including MAU. Conclusively, this is an evidence the variables are integrated of order one.

Table 3. Tests for the number of cointegrating vectors

Eigenvalues	Hypotheses			Hypotheses			Critical values (95%)		Critical values (99%)	
	H_0	H_1	λ-Max	H_0	H_1	λ-Trace	λ-Max	λ-Trace	λ-Max	λ-Trace
0.378	$r = 0$	$r = 1$	80.622[a]	$r = 0$	$r > 0$	384.146[a]	64.505	239.235	71.261	253.235
0.365	$r = 1$	$r = 2$	77.118[a]	$r \leq 1$	$r > 1$	303.525[a]	58.434	197.371	64.996	210.055
0.337	$r = 2$	$r = 3$	69.807[a]	$r \leq 2$	$r > 2$	226.407[a]	52.363	159.530	58.669	171.091
0.213	$r = 3$	$r = 4$	40.793	$r \leq 3$	$r > 3$	156.600[a]	46.231	125.615	52.308	135.973
0.196	$r = 4$	$r = 5$	37.062	$r \leq 4$	$r > 4$	115.807[a]	40.078	95.754	45.869	104.962
0.188	$r = 5$	$r = 6$	35.349	$r \leq 5$	$r > 5$	78.745[a]	33.877	69.819	39.370	77.819
0.128	$r = 6$	$r = 7$	23.241	$r \leq 6$	$r > 6$	43.396	27.584	47.856	32.715	54.682
0.074	$r = 7$	$r = 8$	13.029	$r \leq 7$	$r > 7$	20.155	21.132	29.797	25.861	35.458
0.038	$r = 8$	$r = 9$	6.538	$r \leq 8$	$r > 8$	7.126	14.265	15.495	18.520	19.937
0.003	$r = 9$	$r = 10$	0.589	$r \leq 9$	$r > 9$	0.589	3.841	3.841	6.635	6.635

[a] Indicates rejection of the null hypothesis of no cointegration at the 5% level of significance The critical values for λ-Max and λ-Tace statistics are from MacKinnon-Haug-Michelis (1999)

After ensuring that all variables are I(1), the findings of multivariate cointegration test as suggested by Johansen (1988, 1991) are reported in Table 3. The λ-max and λ-trace statistics produce different results. While the λ-max statistic suggests three cointegrating vectors at 1%, λ-trace statistic demonstrates six cointegrating vectors at 1%. Since the λ-trace takes all the (m-r) of the smallest eigenvalue into account, it tends to have more power than the λ-max statistic (Serletis and King, 1997) and more robust to the presence of non-normal errors than the maximal eigenvalue test (Cheung and Lai, 1993). We base our results on λ-trace statistic and accept six cointegrating vectors out of a possible ten relationships. This finding reveals four common stochastic trends driving these ten stock markets. This implies that the long-run integration among the ten markets is incomplete, although the convergence process is underway but in the meantime, there are potential gains from portfolio diversification among the stock markets (Diamandis, 2009). Our finding of less than full cointegration is similar to those conducted on other regions such as Chen at al. (2002) for Latin American countries.

Table 4. Granger Causality Results

Variables	BOT	COT	EGY	GHA	KEN	MAU	MOR	NIG	SOU	TUN	ECT_{t-1}
BOT	-	15.462**	5.156	9.877	3.439	5.031	7.041	16.764**	11.408*	13.897**	-3.930***
COT	9.966	-	4.178	9.401	5.990	7.761	0.561	4.265	3.377	9.895	-3.014***
EGY	12.942**	6.156	-	2.167	3.290	8.449	6.949	9.501	8.558	10.675*	-1.027
GHA	7.060	3.501	8.968	-	4.202	7.731	6.005	3.226	9.259	6.175	-2.802***
KEN	2.201	9.924	5.459	10.362	-	3.129	12.986**	20.095***	12.988**	6.105	-2.082
MAU	3.796	3.242	10.426	4.259	1.148	-	5.284	13.117*	9.675	10.552	-4.430***
MOR	7.035	7.930	9.909	6.387	19.550***	4.327	-	0.725	4.953	0.876	-5.270***
NIG	10.291	9.298	7.469	17.505***	10.972*	1.317	7.121	-	2.823	6.558	-1.814
SOU	10.708*	4.340	3.584	3.240	8.443	5.960	5.864	4.731	-	2.718	-0.342
TUN	17.805***	12.187*	4.973	15.869**	6.211	5.944	5.228	18.268***	3.482	-	-0.866

*, **, *** Imply 10%, 5% and 1% level of significance respectively.

The cointegration techniques enumerated above does not capture the direction of the influences between stock indexes. Table 4 presents the summary of Granger causality tests which demonstrate the direction of relationship among the stock market indexes in the short run and long run. Examining the flow of causality, it is observed that changes in big markets such as NIG, SOU and TUN affect movements in BOT in both the short term and the long term, with BOT having only a feedback to SOU in the short term but without any feedback to NIG and TUN. Moreover, short term movement in SOU and NIG trigger short term changes in KEN, without KEN explaining changes in SOU. Moving to other relationships, it is observed that in the long run, fluctuations in NIG has unidirectional causality towards GHA. This is discernible as Nigeria stock exchange usually serves as a bigger counterpart to Ghana stock exchange in the sub region, with perennial technical assistance. In general most of the causations in the long run are towards small stock markets in Africa-BOT, COT, GHA and MAU, signalling that small market indexes follow the big markets.

Table 5. Diagnostics tests

Test Statistics	LM test
Serial Correlation:	LM(6) = [0.144]
Heteroscedasticity	CHSQ(6) = [0.448]

The optimal lags are in bracket, while the probability values are stated in the parenthesis.

The diagnostics tests are reported in Table 5. The Breusch-Godfrey test for serial correlation in the residuals indicate no evidence of six-order (we set the optimal lag at six in this study) autocorrelation as the p-value is greater than 10%, while Autoregressive Conditional Heteroscedasticity (ARCH) test of heteroscedasticity suggest that the residuals are independent of the regressors (homoscedasticity) as the p-value is greater than 10%.

6. Conclusion

This paper fills the void of non-existence of study on the co-movement among national stock market indexes in Africa. Using monthly data covering February, 1997 and October, 2011, the sample consists of ten African stock exchanges-Botswana, Cote D'Ivoire, Egypt, Ghana, Kenya, Mauritius, Morocco, Nigeria, South Africa and Tunisia. Although there are 22 stock markets in Africa, the sample has been selected based on data availability. The use of monthly data is to avoid distortions common in weekly and daily data, which are fallouts of non-trading and non-synchronous trading. The indexes are expressed in local currency as against dollar because of distortions associated exchange rate fluctuations. After ensuring that the variables are I(1), within Zivot and Andrews (1992) and Lee and Strazicich (2003) unit root tests, the study checks the co-movement of stock market indexes with the aid of Johansen cointegration technique. The results demonstrate six out of a possible ten cointegrating vectors, which suggest that African stock markets are not fully integrated. With Granger causality tests, evidence indicate that in both short term and long term, big African stock markets indexes influence fluctuations in small African markets indexes. Summarily, these symbolise limited benefits accrue from portfolio diversification within Africa stock markets.

7. References

Adelegan, O. (2009). Can Regional cross-listings accelerate stock market development? Empirical evidence from sub-Saharan Africa. *IMF Working Paper* 08/218.

Aggarwal, R. & Kyaw, N. (2005). Equity market integration in the NAFTA region: evidence from unit root and cointegration tests. *International Review of Financial Analysis,* Vol. 14, pp. 393–406.

Andrews, D. (1993). Tests for parameter stability and structural change with unknown change points. *Econometrica,* Vol. 61, pp. 821–856.

ASEA (2008, 2009). Yearbooks of the Africa securities exchange association for the years 2008 and 2009, respectively.

Asterious, D. & Hall, S. (2007). *Applied econometrics a modern approach using Eviews and Microfit Revised Edition* Macmillan New York: Palgrave.

Baillie, R. & Bollerslev, T. (1989). The message in daily exchange rates: A conditional variance tale. *Journal of Business and Economic Statistics,* Vol. 7, pp. 297–305.

Chen, G. Firth, M. & Rui, O (2002). Stock market linkages: evidence from Latin America. *Journal of Banking & Finance,* Vol. 26, pp. 1113–1141.

Cheung, Y. & Lai, K. (1993). Finite-sample sizes of Johansen's likelihood ratio tests for cointegration. *Oxford Bulletin of Economics & Statistics*, Vol. 55, pp. 313−328.

Click, R. & Plummer, M. (2005). Stock market integration in ASEAN after the Asian financial crisis. *Journal of Asian Economics,* Vol. 16, pp. 5-28.

Diamandis, P. (2009). International stock market linkages: evidence from Latin America. *Global Finance Journal*, Vol. 20, pp: 13–30.

Elliott, G. Rothenberg, T. & Stock J. (1996). Efficient tests for an autoregressive unit root. *Econometrica*, Vol. 64, pp: 813-836.

Engel, R. & Susmel, R. (1993). Common volatility in international equity markets. *Journal of Business and Economic Statistics*, Vol. 11(2), pp: 167–176.

Engle, R. & Granger, C. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica* Vol. 55, pp. 251–275.

Engle, R. (1995). *ARCH: Selected Readings*. Oxford, UK: Oxford University Press.

Granger, C. (1986). Developments in the study of cointegrated economic variables. *Oxford Bulletin of Economics and Statistics*, Vol. 48, pp. 213-228.

Granger, C. (1988). Some recent development in a concept of causality. *Journal of Econometrics,* Vol. 39, pp. 199-211.

Guidi, F. (2010). Cointegration relationship and time varying co-movements among Indian and Asian developed stock markets. *MPRA Paper No. 19853*.

Huyghebaert, N. & Wang, L. (2010). The co-movement of stock markets in East Asia Did the 1997–1998 Asian financial crisis really strengthen stock market integration? *China Economic Review,* Vol. 21, pp. 98–112.

Irving, J. (2005). Regional integration of stock exchanges in Eastern and Southern Africa: Progress and prospects. *IMF Working Paper* 05/122.

Jang, H. & Sul, W. (2002). The Asian financial crisis and the co-movement of Asian stock markets. *Journal of Asian Economics,* Vol. 13, pp: 94-104.

Johansen, S. & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and Statistics* Vol. 52, pp. 169–210.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Dynamics and Control,* Vol. 12, pp. 231-254.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica,* Vol. 59, pp. 1551–1580.

Jong, H. & Sul, W. (2002). The Asian financial crisis and the co-movement of Asian stock markets. *Journal of Asian Economics Vol.* 13 pp. 94-104.

Kaplanis, E. (1988). Stability and forecasting of the comovement measures of international stock returns. *J. Int. Money Finance,* Vol. 7(1), pp. 63–75.

Kasa, K. (1992). Common stochastic trends in international stock markets. *Journal of Monetary Economics,* Vol. 29, pp. 95–124.

Kim, S., & Rogers, J. (1995). International stock price spillovers and market liberalization: Evidence from Korea, Japan, and the United States. *Journal of Empirical Finance,* Vol. 2, pp. 117–133.

Koutmos, G. & Booth, G. (1995). Asymmetric volatility transmission in international stock markets. *Journal of International Money and Finance,* Vol. 14(6), pp. 747–762.

Lee, J. & Strazicich, M. (2003). Minimum Lagrange multiplier unit root test with two structural breaks. *The Review of Economics and Statistics*, Vol. 85, pp. 1082-1089.

Li, H. & Majerowska, E. (2008). Testing stock market linkages for Poland and Hungary: A multivariate GARCH approach. *Research in International Business and Finance,* Vol. 22, pp. 247-266.

MacKinnon, J. Haug, A. & Michelis, L. (1999). Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration. *Journal of Applied Econometrics*, Vol. 14(5), pp. 563-577.

Mylonidis, N. & Kollias, C. (2010). Dynamic European stock market convergence: Evidence from rolling cointegration analysis in the first euro-decade. *Journal of Banking & Finance,* Vol. 34, pp. 2056-2064.

Panton, D. Lessig, V. & Joy, O. (1976). Comovement of international equity markets: A taxonomic approach. *Journal of Financial and Quantitative Analysis*, Vol. 11, pp. 415–432.

Pascual, A. (2003). Assessing European stock markets (co)integration. *Economics Letters* Vol. 78, pp. 197–203.

Perron, P. (1989). The great crash, the oil price shock and the unit root hypothesis. *Econometrica*, Vol. 57, pp. 1361-1401.

Pukthuanthong, J. & Roll, R. (2009). Global market integration: an alternative measure and its application. *Journal of Financial Economics,* Vol. 94, pp. 214-232.

Ratanapakorn, O. & Sharma, S. (2002). Interrelationships among regional stock indices. *Review of Financial Economics,* Vol. 11, pp: 91-108

Scheicher, M. (2001). The comovements of stock markets in Hungary, Poland and the Czech Republic. *Int. J. Finance Econ*, Vol. 6, pp. 27–39.

Schmidt, P. & Phillips, P. (1992). LM tests for a unit root in the presence of deterministic trends. *Oxford Bulletin of Economics and Statistics*, Vol. 54, 257-287.

Serletis, A. & King, M. (1997). Common stochastic trends and convergence of European union stock markets. *The Manchester School,* Vol. 65, pp. 44-57.

Tai, C. (2007). Market integration and contagion: Evidence from Asian emerging stock and foreign exchange markets. *Emerging Markets Review,* Vol. 8, pp. 264-283.

Wang, P. (2003). *Financial Econometrics, Methods and Model*. Routledge Company.

Yu, I. Fung, K. & Tam, C. (2010). Assessing financial market integration in Asia – Equity markets. *Journal of Banking & Finance,* Vol. 34 pp. 2874-2885.

Zivot, E. & Andrews, D. (1992). Further evidence of the great crash, the oil-price shock and the unit-root hypothesis. *Journal of Business and Economic Statistics,* Vol. 10, pp. 251-270.