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Integration of African Stock Markets in the Context of the Global Financial Crisis: Some Implication for the NEPAD Framework

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ABSTRACT

This study examines Africa's integration in the context of the global financial crisis and the implication for the NEPAD framework using stock markets as a case study. The study is premised on the realization of increased integration in Africa as part of the expected outcome of achieving the NEPAD objectives. Granger causality test and the generalized error correction model (GECM) were the techniques employed for the analysis. The stock markets sampled were drawn from South Africa, Egypt, Tunisia, Ghana, Nigeria, Kenya and Lusaka. The study challenges the approach of regional integration and advocates for a continent approach based integration. The findings suggests that with more stock markets linked with the South African JSE and the Egyptian CASE, Africa is likely to achieve the desired increased integration stated in the NEPAD objective by 2015.

Key Words:
Integration, Stock exchange, granger causality, error correction model, Africa

JEL Classification: ***G10; C22; 055***

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<A>INTRODUCTION

The fragmentation of Africa into many nation states with scant economic coherence led African leaders, following political independence, to embrace regional integration as a central element of their development strategy (AfDB and ADF, 2000). Despite several regional economic integration efforts in Africa, the impact of these arrangements on the continents performance is still shaky. With increasing integration across the globe however, various studies (e.g. Shams, 2005; Nnanna, 2006) that have examined regional integration issues have pointed out one or two disadvantages associated with regional economic integration.While studies such as Sako (2006) have blamed this weak impact on factors such as inadequate political will and commitment to the process; high incidence of conflicts and political instability; poor design and sequencing of regional integration arrangements; multiplicity of the schemes; inadequacy of funding; and exclusion of key stakeholders from the regional integration process, the present study contributes to existing literature by examining the integration of a cross section of African stock markets in the context of the global economic crisis and the New Partnership for Africa's Development (NEPAD) framework. The theses of the study is that the global economic crisis distorted the integration process of Africa through stock markets in the short but that the disequilibrium created would be corrected before 2015 in line with the NEPAD objective. The study also argues that linking up other stock markets in Africa to the South African stock exchange would quicken the course for an integrated Africa as an expected outcome of the NEPAD framework.

The objectives of NEPAD can be summarized into four: to eradicate poverty; to place African countries, both individually and collectively, on a path of sustainable growth and development; to halt the marginalization of Africa in the globalization process and enhance its full and beneficial integration into the global economy; and to accelerate the empowerment of women (www.nepad.org). As stated in section 69 of the NEPAD framework in English (2001), the expected outcomes of NEPAD are: economic growth and development and increased employment; reduction in poverty and inequality; diversification of productive activities, enhanced international competitiveness and increased exports; and lastly, Increased African integration. It would therefore be important to examine Africa's integration as the continent draws close to the NEPAD date of 2015. Understanding how the integration process is affected by shocks would also be of important. In this regard, the data used for the study was collected from 2007 to 2009 so as to reflect the performance of the selected stock markets in the context of the global financial crisis.

The study differs from others in the following ways: first, it samples both small and major stock markets in Africa and employs specific econometric methods to identify the driving stock market while analysing the effect of such market on others. Secondly, using error correction model, the study examines the short and long run linkages of the selected African stock markets as well as the speed/rate at which disequilibrium in the system would be corrected before 2015.

The study is arranged into five sections. In section A, the background of the study, statement of the problem and objectives of the study are presented, while empirical and theoretical literatures are reviewed in section B. The methodology of the study is presented in section C and the discussion of results is presented in section D. Finally, summary and conclusion of the study are presented in section E.

<B>REVIEW OF LITERATURE

In recent years, and coupled with the wave of globalization, there has been a shift from bank–based capital market development to a more holistic approach that aims at globalizing securities' market as well as other financial institutions with the banks. Popiel (1990) emphasized that some of the strengths that make the stock markets focal point of the shifting emphasis are their ability to mobilize long–term savings for financing entrepreneurs, encourage broader ownership of firms, and improve the efficiency of resource allocation through competitive pricing mechanism. Demirguc-kunt and Levine (1996) argued that apart from these primary benefits, globalizing stock markets will accordingly ensure efficient financial intermediation and would bring further gains to the various economies. Integrating of stock market would also bring about a shift from debt to equity financing across countries (Tella and Adesoye, 2008).

Integration of stock markets however brings about increased exposure of countries to increased vulnerability and external shocks, through contagion, which raises a number of critical problems (Kibuthu, 2005). The problems associated with this include exchange and interest rates volatility and strong capital outflows having adverse effect on sustainable growth and macroeconomic management.

Integration refers to a process of unifying markets and enabling convergence of risk adjusted returns on the assets of similar maturity across the markets. On the other hand equity market (also known as stock market) is an aspect of capital market (market for long term funds) where the shares of quoted companies are bought or sold. Advancement in technology has facilitated rapid integration of this market across the globe in recent times.

<u>Theoretical Literature</u>

Cointegration and Error Correction Models

The concept of cointegration applies to a wide variety of economic models. The basic idea of cointegration was first proposed by Granger (1981) and formal analysis was developed by Engle and Granger (1987). According to Engle and Granger (1987), the tight linkage between cointegration and error correction model stems from the Granger representation theorem. The theorem states that two or more integrated time series that are cointegrated have an error correction representation, and two or more time series that are error correcting are cointegrated. They provide the following definition of cointegration:

The components of the vector $X_t = (x_{1t}, x_{2t}, \ldots, x_{nt})$ are said to be integrated of order *d*, *b*, denoted by $Xt \sim CI(d,b)$ if

(a) all components are integrated of order d. $X \sim I(d)$

(b) there exists a vector $ß = (ß_1, ß_2, ß_3, \ldots ß_n)$ such that the linear combination $ß = (ß_1 x_{1t} + ß_2 x_{2t} + ß_3 x_{3t} + \ldots + ß_n)$ is integrated of order (d-b) where b>0. The vector *ß* is called the cointegrating vector.

There are several important points in this definition. Firstly, cointegration refers to a linear combination of nonstationary variables. Secondly all variables must be integrated of the same order. However, this is only true for a two-variable case, if these two variables are integrated at different orders of integration, then these two series cannot possibly be cointegrated. However it is possible to have a mixture of different order series when there are three or more series under construction in which various subsets may be cointegrated. Thirdly, if Xt has n components, there may be as many as *n-1* linearly independent cointegrating vectors. If X_t contains only two variables, there can be at most only one independent cointegrating vector.

Series that are cointegrated are related over time. Any non-stationary series that are cointegrated may diverge in the short-run but they must be linked together in the long run. Therefore, cointegration implies that there must be granger causality in at least one direction, at least one of the variables may be used to forecast the other. Furthermore, it has been proved by Granger (1983) and Engle and Granger (1987) that if as set of series is cointegrated, there always exists a generating mechanism called *error correction model* that restricts the long run behaviour of the endogenous variables to converge to their cointegrating relationship while allowing a wide range of short run dynamics. Therefore, the cointegrated variables can be thought of as being generated by an error-correction model.

Test for cointegration

Testing for cointegration combines the problems of the unit root and a tst with parameters unidentified under the null. For the N-dimension multivariate case in which N variables are jointly determined in a system of equations, there are basically two methods to test for the existence of cointegration among these N variables. They are: the multivariate Engle-Granger two-step procedure and the Johasen's Maximum-likelihood test.

The multivariate Engle-Granger two-Step procedure

Engle and Granger proposed a two step procedure to test for cointegration. Prior to estimation, the variables are pre-tested for their order of integration. Based on the definition given by Engle and Granger (1987), cointegration necessitates that the variables be integrated of the same order. Therefore, each variable has to be pre tested by using the augmented dickey fuller (ADF) and Phillip Perron (PP) test to determine its order of integration. If the variables are integrated of different orders, possibly these variables are not integrated.

After determining the order of each variable in the model, a cointegration regression is run. Any one of the N variables can be normalized upon (whose coefficient is set equal to unity). The residuals obtained from each cointegration regression will then be tested for stationarity by performing ADF and PP tests. If the residuals are found to be stationary, the variables are non-stationary of order I (1).

If the variables are cointegrated, the second step of the EG procedure involves specifying an error-correction model (ECM) for each equation in the system. The multivariate EG two-step procedure for testing cointegration has distinct shortcomings. The estimation of each cointegration regression requires that one variable is placed on the left-hand side while using other variables as regressors. If one regression indicates that the variables are cointegrated whereas reversing the order indicates no cointegration, the meaning of cointegration is violated, since cointegration should be invariant to the choice of the variables selected for normalization. Most importantly, by using the EG method, it is not possible to identify the whole set of cointegrating relationships using this method. The method has no systematic procedure for the separate estimation of multiple cointegrating vectors.

Johansen's maximum-likelihood procedure

The cointegration test carried out by using the Johasen's Maximum-Likelihood procedure provides more robust results when there are more than two variables in the model. The multivariate maximum likelihood cointegration testing procedure was developed by Johansen (1988) and Stock and Watson (1988) and Johansen and Juselius

(1990). The multivariate procedures utilize test statistics that have a unique distribution which is a function of a single parameter and can be used to evaluate cointegration relationships among group of two or more variables. Thus, it is a superior test in a situation involving three or more variables in which there may be more than one cointegrating vector in the system.

To determine the number of unique cointegrating vectors, two likelihood ratio (LR) test statistics are constructed by using the residual vectors. There are two basic test statistics involved in Johansen and Juselius's maximum likelihood test. The first test statistic is the *trace test* while the second is the maximal *eigenvalue test*.

The tracetest tests the null hypothesis that the number of coingrating vectors in Xt is less than or equal to r (where $r \leq N - 1$). The maximal eigenvalue test on the other hand, evaluates the null hypothesis that there are exactly r cointegrating vectors.

The critical valus of the τ_{trace} and τ_{max} statistics are calculated by Johansen and Juselius (1990). They noted that if r (i.e. the number of cointegrating vectors) is equal to N (i.e. the Number of variables in the system), the vector process, X_t is said to be stationary (that is all the variables in X_t are integrated of order zero). In other words, the variables are not cointegrated.

Vector Error Correction Model

Cointegrated variables are always thought of as being generated by error-correction equations. The vector error-correction model (VECM) allows a long run component of variables to obey equilibrium constraints while short run components have flexible dynamic specifications. In fact, cointegration implies that there is some adjustment process which guides the variables to the long run relationship. VECM are basically applied to capture the short run dynamic adjustment of cointegrated variables (Ahmed 2005: 67). It relates the changes in one variable (y_t) to the changes in another variable(s) (x_t) and the past periods disequilibrium, ε_t. Where ε_t is the residual equilibrium error that measures the extent to which the system is out of equilibrium. If the coefficient on the error correction term (ε_t) is statistically insignificant, it implies that this variable does not adjust to deviations from equilibrium. If the constant in each system is statistically insignificant, it means that the process is not generated by a linear trend.

Autoregressive Distributed Lag Approach to Error Correction Models

From the review of cointegration and error correction models, the ecm is generally thought to be isomorphic to integrated data and the modelling of cointegrated process. Keele and DeBoef (2004) presented a theoretical discourse on the generalized error correction model (GECM) and the autoregressive distributed lag (ADL) approach to error correction modelling. The discussion below relies heavily on Keele and DeBoef (2004).

Autoregressive distributed lag (ADL) model approach to ECM

The standard way to derive the error correction model is to show that if X and Y are linear functions of a latent integrated process, the residuals of Y regressed on X should be stationary. This derivation of the error correction model starts with the assumption that both Y and X are integrated and demonstrates that the error correction model captures the equilibrium causal movements between these two cointegrated processes. Occasionally, however, some authors derive the error correction model from a different and more promising starting point (Bannerjee, Juan, John and David 1993; Davidson and MacKinnon 1993; Verbeek 2000). In these derivations, the starting point for the error correction model is the autoregressive distributed lag (ADL) model. The ADL model is a flexible model for time series data, and is often seen in the following bivariate form:

$Y_t = a_o + a_1Y_{t-1} + b_oX_t + b_1X_{t-1} + U_t$ (2.1)

Specifically, this is an ADL (1, 1) model, where the notation refers to the number of lags included in the model. It generalizes to an ADL (*p*,*q*) where *p* refers to the number of lags of Y and *q* refers to the number of lags of X included in the model. Given that the ADL (1, 1) has a lagged dependent variable on the right side, it could be estimated by OLS and with the stationarity condition, that *Yt* must be stationary (Davidson and MacKinnon 1993).

To estimate an ADL (1, 1) model with Y_t and X_t, the short-run effects are readily estimated in the model by the coefficients b_o and b_1, which give the immediate effect of a change in *X* at some given *t*. The long-run equilibrium effects would be given by the unconditional expectations or the expected value of Y_t. Let $y^* = E(Y_t)$ and $x^* = E(X_t)$ for all *t*. If the two processes moved together with out error, in the long-run, they would converge to the following equilibrium values:

$y^* = a_o + a_1y^* + b_ox^* + b_1x^*$ (2.2)
Solving y*t in terms of x*t, yields: $y^* = a_o/(1 - a_1) + (b_o + b_1/1 - a_1)x^*$ (2.3)
Let $k_o = a_o/(1 - a_1)$, and $k_1 = (b_o + b_1/1 - a_1)$,
yields $y^*_t = k_o + k_1x^*$
(2.4)

This equation represents the values for which *Y* and *X* are in equilibrium in the long run, and *k*1 represents the long-run multiplier of *X* with respect to *Y*. Any deviation from equilibrium should induce change back to the equilibrium in the next period. However, Keele and DeBoef (2004) noted that the rate of return to equilibrium would not be directly estimated from this technique, unless off course with some transformation. It is this transformation that yields the generalized error correction model (GEM).

Generalized error correction model (GECM)

As noted in Keele and DeBoef (2004) much of the proof for the GECM has been provided in Davidson and MacKinnon (1993) and Bannerjee *et al.* (1993). Once again, the study will touch on its preliminary level relying on Keele and DeBoef (2004).
Consider an ADL (1, 1) model:

$Y_t = a_0 + a_1Y_{t-1} + b_oX_t + b_1X_{t-1} + U_t$ (2.5)
Taking first difference produce

$\Delta Y_t = a_0 + (a_1 - 1)\, Yt_{-1} + b_oX_t + b_1X_{t-1} + U_t$ (2.6)
Subtracting b_0X_{t-1} from the right hand side yields
$\Delta Y_t = a_0 + (a_1 - 1)\, Yt_{-1} + b_o\Delta X_t + (b_o + b_1)\, Xt_{-1} + U_t$ (2.7)

Then add and subtract $(a_1 - 1)\, Xt_{-1}$ from the right hand side and rewrite. The equation produced is the Generalized Error Correction Model (GECM) specified below:

$\Delta Y_t = a_0 + \gamma\, (Y_{t-1} - X_{t-1}) + \lambda_1\Delta X_t + \lambda_2X_{t-1} + U_t$ (2.8)
Where $\gamma = (a_1 - 1)$, $\lambda_1 = b_0$, and $\lambda_2 = b_1 + b_o + a_1 - 1$

The GECM, unlike the ADL model, directly tells us how quickly the system reacts to any disequilibrium, as γ the coefficient on the lag of *Y* is the error correction rate. In other words, the term $(a_1 - 1)$ can be interpreted as the speed at which *Y* adjusts to any

discrepancy between *Y* and *X* in the previous period. One can see that γ must be negative since it is just
a_1 -1. The term ($Y_{t-1} - X_{t-1}$) is zero when *X* and *Y* are in equilibrium and measures the extent to which the long-run relationship is not satisfied.
The Long Run Multiplier would be the same as that of the ADL i.e. k1 = - ($\lambda_2 - \gamma$)/ γ which is the same as ($b_1 + b_0$)/ ($1 - a_1$).
To estimate the GECM in a much easier form that also incorporates the long run multiplier, Keele and DeBoef (2004) re-specified the model in the form:

$$\Delta Y_t = a_0 + \gamma (Y_{t-1} - \eta_2 X_{t-1}) + \eta_1 \Delta X_t + U_t \qquad (2.9)$$

Where γ, measures the long run equilibrium relation and the speed of adjustment, η_1, the short run relationship, a_0 the constant in the system that tells if the process is generated by a linear trend or not, η_2/ γ is the long run multiplier and U_t is the residual in the equation.

In Summary, the GECM apart from providing an additional measure of the long run multiplier offers a consistent estimate with the Cointegration and error correction approach. The GECM specified in Keele and DeBoef (2004) is therefore adopted for the study. Even though the one step cointegration approach to ECM is superior to the two-step approach, the use of vector avoids specifying any variable on the left hand side. This study is however interested in knowing the driving stock market. Thus, granger causality was used to determine the market causality so as to determine the left hand side variable. The equations will thus be estimated separately for each stock market in connecting to the South African JSE. Besides, compared to the Engle Granger (1987) approach and the Johansen and Juselius (1990) approach to cointegration and error correction model, the generalized error correction model approach by Bannerjee *et al*. (1993), Davidson and MacKinnon (1993) and Verbeek (2000) is a more recent approach.

Empirical Literature

Ngbede, Ochoche and Joseph (2009) used co-integration and error correction modelling to examine the combine effect of producer’s price, hectarages, rainfall and fertilizer on the output of groundnut. The result indicated the existence of the one co-integrating vector at 5 percent significance’s level, thus rejecting the null hypothesis of no co-integrating vector. As a result a parsimonious error-correction model was set-up. The statistical significance of the error correction model validated the existence of an equilibrium relationship among the variables. The study is relevant in terms of technique of data analysis. It provides an empirical basis that co-integration error correction model and the parsimonious error correction model can be employed for analysis and both approaches would likely yield robust results. The approach was also used by Nkang, Abang, Akpan and Offem (2006) to examine the response of exports to prices and non-price variables in Nigeria. Rao (2005) also examined some methodological difficulties encountered in choosing between alternative techniques for time series estimation. The study found that employing general to specific (GETS) methods or vector error correction model (VECM) to time series analysis on estimating short and long run relationships yields relatively the same result.

In January 2006, the African Union Commission conducted a study on the feasibility of establishing an African Stock exchange. Some the problems they identified that confront the realization of an African stock exchange were: dependency of African countries on external resources for financing their investments and their development; as well a multitude of limited and inefficient national stock markets. To keep with the June 1991 Abuja commitments the African Union Commission was envisaged to establish a continental stock market (African Union Department of Economic Affairs (AU-DEA), 2008). The study also noted that substantial progress has been made in Africa since the beginning of the 21st Century towards the integration of African financial markets in general and stock exchanges in particular. At the end of 2006, the capitalization of all African stock exchanges for instance, represented less than 2% of the world total, and was equivalent to that of the 15th world stock exchange. Apart from the JSE Limited, which was the 19th world stock exchange in 2006, all the other African stock exchanges were characterized by low liquidity and volume of transactions. The study makes clear Africa's intention and plan to establish a continental stock market as a channel of ensuring ease of capital mobility at regional and continental level. It also identifies the significant role that the South African stock exchange (the JSE Limited) plays not just in the continent but globally as well.

Studies by the African Development Bank Group (2010) and the World Bank (2007) have argued that regional financial integration (RFI's) have a positive and significant impact on growth and poverty reduction. The channels through which this result can be achieved were identified to include: through stimulating domestic financial reforms; increasing efficiency of the system by enhancing the operations and competition of financial markets; inducing inflow of foreign direct investment (FDI); and by enabling African systems to grow into regional and ultimately global players in financial markets (AfDBG 2010). The AfDBG however noted that fragile states and countries with relatively less developed systems could lose out in the initial stages of RFI. However, implementing appropriate compensatory policies as part of RFI strategy would produce a win situation for member countries. The study focused on three regional economic communities (RECs): the Common Market for Eastern and Southern Africa (COMESA); the Arab Maghreb Union (UMA); and the Central African Economic and Monetary Community. The World Bank (2007), on the other hand, examined similar issues for the East African Community (EAC) and the Economic Community of West African States (ECOWAS). Drawing from the experience of the European Union (EU) and Asia the study suggested that trade integration and financial integration should be promoted simultaneously and not considered as a sequential process since capital market development for instance can facilitate the inflow of foreign capital. The study therefore calls on African countries to take a proactive approach toward financial sector development and integration.

The German Development Institute (GDI) and the South African Institute of International Affairs (SAIIA) (2010) argued that despite political and institutional change in Africa over the last 50years, the prospect of successful continental integration has suffered a loss of political drive and clear minded political leadership. The study also noted that the interaction between institutions such as the New Partnership for Africa's Development (NEPAD), the African Union (AU) and the African Peer Review Mechanism (APRM), has been poor. The study suggests that a coordinated action plan among African institutions is required for Africa's integration to be achieved.

In the study on *Industry Development, Trade and Market Access*, Mucavele (2007) noted that trade and market access are important for eradicating poverty in the context of the NEPAD framework. The study also noted that deepening the integration of Africa would help smaller markets exploit economies of scale and build competitive industries. Though the study was not particular on financial markets, it suggests that smaller markets gain greater access when integrated.

United Nations Institute for Training and Research (UNITAR) in 2002 examined the role of NEPAD eradicating poverty in Africa. The study noted that the source of funding required to close the funding gap for NEPAD could have consequences for Africa. It however concluded that existing or new African capital markets could help in mobilizing funds. The study

NEPAD objectives and expected outcome

As stated in section 68 of the NEPAD framework in English (2001), the goals of NEPAD are:

- To achieve and sustain an average gross domestic product (GDP) growth rate of over 7 per cent per annum for the next 15 years;
- To ensure that the continent achieves the agreed International Development Goals (IDGs), which are:

. To reduce the proportion of people living in extreme poverty by half between 1990 and 2015;
. To enrol all children of school age in primary schools by 2015;
. To make progress towards gender equality and empowering women by eliminating gender disparities in the enrolment in primary and secondary education by 2005;
. To reduce infant and child mortality ratios by two-thirds between 1990 and 2015;
. To reduce maternal mortality ratios by three-quarters between 1990 and 2015;
. To provide access for all who need reproductive health services by 2015;
. To implement national strategies for sustainable development by 2005, so as to reverse the loss of environmental resources by 2015.

Section 69 of the framework clearly spells out the expected outcomes of the NEPAD framework to include:

- Economic growth and development and increased employment;
- Reduction in poverty and inequality;
- Diversification of productive activities enhanced international competitiveness and increased exports;
- Increased African integration.

<C>RESEARCH METHODOLOGY

The data used for the study are 5-day weekly time series data of the closing stock prices for the seven African stock markets namely: Nigeria, South Africa, Ghana, Egypt, Kenya, Tunisia and Zambia from 2007 to 2009. The choice of the selected stock exchanges is based on their individual performance in their respective regions in Africa. Magnusson and Wydick (2004) in testing the weak form efficient market hypothesis have included most of these markets in their sample. The inclusion of the Lusaka stock exchange for Zambia is to include small stock markets in the sample (see Marone, 2004). The data were collected on a daily basis from www.africanfinancialmarkets.com. The data were collected in dollar denominated form so as to remain currency neutral in the interpretation of results.

The study adopts the generalized error correction modelling approach of Bannerjee *et al*. (1993), Davidson and MacKinnon (1993) and Verbeek (2000) as specified in Keele and DeBoef (2004). To determine the left hand side variable, the variables were tested for causality using the granger causality technique. The South African JSE and the Egyptian CASE were found to have more significant uni-directional influence on the other stock markets. This test was also necessary to determine the driving stock market in line with the argument by Sako (2006). The GECM model as specified by Keele and DeBoef (2004) is:

$$\Delta Y_t = a_0 + \gamma (Y_{t-1} - \eta_2 X_{t-1}) + \eta_1 \Delta X_t + U_t \quad (2.9)$$

Where γ, measures the long run equilibrium relation and the speed of adjustment, η_1, the short run relationship, a_0 the constant in the system that tells if the process is generated by a linear trend or not, η_2/γ is the long run multiplier and U_t is the residual in the equation.
In relation to the JSE, the models to be estimated for all the stock markets are specified thus:

$$\Delta NSE_t = a_{01} + \gamma (NSE_{t-1} - \eta_{21} JSEt_{-1}) + \eta_{11}\Delta JSE_t + U_{t1} \quad (3.1)$$
$$\Delta GSE_t = a_{02} + \gamma (GSE_{t-1} - \eta_{22} JSEt_{-1}) + \eta_{12}\Delta JSE_t + U_{t2} \quad (3.2)$$
$$\Delta CASE_t = a_{03} + \gamma (CASE_{t-1} - \eta_{23} JSEt_{-1}) + \eta_{13}\Delta JSE_t + U_{t3} \quad (3.3)$$
$$\Delta KNSE_t = a_{04} + \gamma (KNSE_{t-1} - \eta_{24} JSEt_{-1}) + \eta_{14}\Delta JSE_t + U_{t4} \quad (3.4)$$
$$\Delta TUN_t = a_{05} + \gamma (TUN_{t-1} - \eta_{25} JSEt_{-1}) + \eta_{15}\Delta JSE_t + U_{t5} \quad (3.5)$$
$$\Delta LUSE_t = a_{06} + \gamma (LUSE_{t-1} - \eta_{26} JSEt_{-1}) + \eta_{16}\Delta JSE_t + U_{t6} \quad (3.6)$$

Where Δ = the first difference of the variables to ensure stationarity at I(1). JSE = the Johannesburg Stock Exchange, NSE = the Nigerian Stock Exchange, GSE = the Ghanaian Stock Exchange, CASE = the Cairo and Alexandria Stock Exchange (Egypt), KNSE = Kenyan Stock Exchange, TUN = the Tunisian Stock Exchange, and LUSE = the Lusaka Stock Exchange (Zambia). If the constant (i.e. a_{01} to a_{06}) in each system is statistically insignificant, it would mean that the process is not generated by a linear trend. The variables are log transformed and are also tested for stationarity using the augmented dickey fuller unit root test. To save space, equations 3.1 to 3.6 will also be estimated by substituting JSE for any other market that granger causes all the other stock markets. These equations will be labelled 3.7 to 3.12

<D> RESULTS AND DISCUSSION

Stationarity

The variables were log transformed and tested for stationarity using the ADF test. It was found that all the variables were I (1) i.e. stationary at first difference. The ADF result is shown below:

Table 4.1: STATIONARITY TEST: Augmented Dickey Fuller (ADF) Test				
Level test *I*(0)		Critical Values		
ADF Stat	Stock markets	1%	5%	10%
-0.08	NSE	-3.44	-2.86	-2.57
-1.49	JSE	-3.44	-2.86	-2.57
-0.16	GSE	-3.44	-2.86	-2.57
-0.72	CASE	-3.44	-2.86	-2.57
-0.69	KNSE	-3.44	-2.86	-2.57
-0.27	TUN	-3.44	-2.86	-2.57
-0.33	LUSE	-3.44	-2.86	-2.57
First Difference Test *I*(1)				

Source: Author's Presentation from Eviews Output

-12.73	NSE	-3.44	-2.86	-2.57
-23.30	JSE	-3.44	-2.86	-2.57
-24.65	GSE	-3.44	-2.86	-2.57
-17.52	CASE	-3.44	-2.86	-2.57
-13.35	KNSE	-3.44	-2.86	-2.57
-19.20	TUN	-3.44	-2.86	-2.57
-22.88	LUSE	-3.44	-2.86	-2.57

The column labelled ADF Stat in the upper part table 4.1 shows that the absolute value of the figures for all the stock markets are less than the absolute values at 1 percent, 5 percent and 10 percent critical values. This implies that the variables are not stationary at levels. Taking first difference however, the variables became stationary i.e. I (1) as shown in the lower part of table 4.1. The absolute values of the ADF stat at this point, are greater than the ADF values at 1 percent, 5 percent and 10 percent critical values. This is in conformity with requirement for estimating the generalized error correction model.

Granger Causality

The granger causality result (to determine the variables that have more causal influence on others) showed that the CASE granger caused all the other stock markets while the JSE as well granger caused all the stock markets except the TUNINDEX. The summary of the granger causality result is shown in table 4.2 below and the full result in table 1 of the appendix.

Table 4.2: Summary of the Granger Causality Result

Stock markets	JSE	TUN	NSE	CASE	GSE	KNSE	LUSE
JSE	−	≠	→	←	→	→	→
TUN	≠	−	≠	←	→	≠	≠
NSE	←	≠	−	←	←	←	→
CASE	←	→	→	−	←	→	←
GSE	←	←	←	←	−	←	←
KNSE	←	≠	←	←	←	−	≠
LUSE	←	≠	←	←	←	≠	−
Summary	JSE granger cause 5	TUN granger cause 1	NSE granger cause 3	CASE granger cause 6 (ALL)	GSE granger cause 4	KNSE granger cause 2	LUSE granger cause 2

Source: Author's presentation, 2010

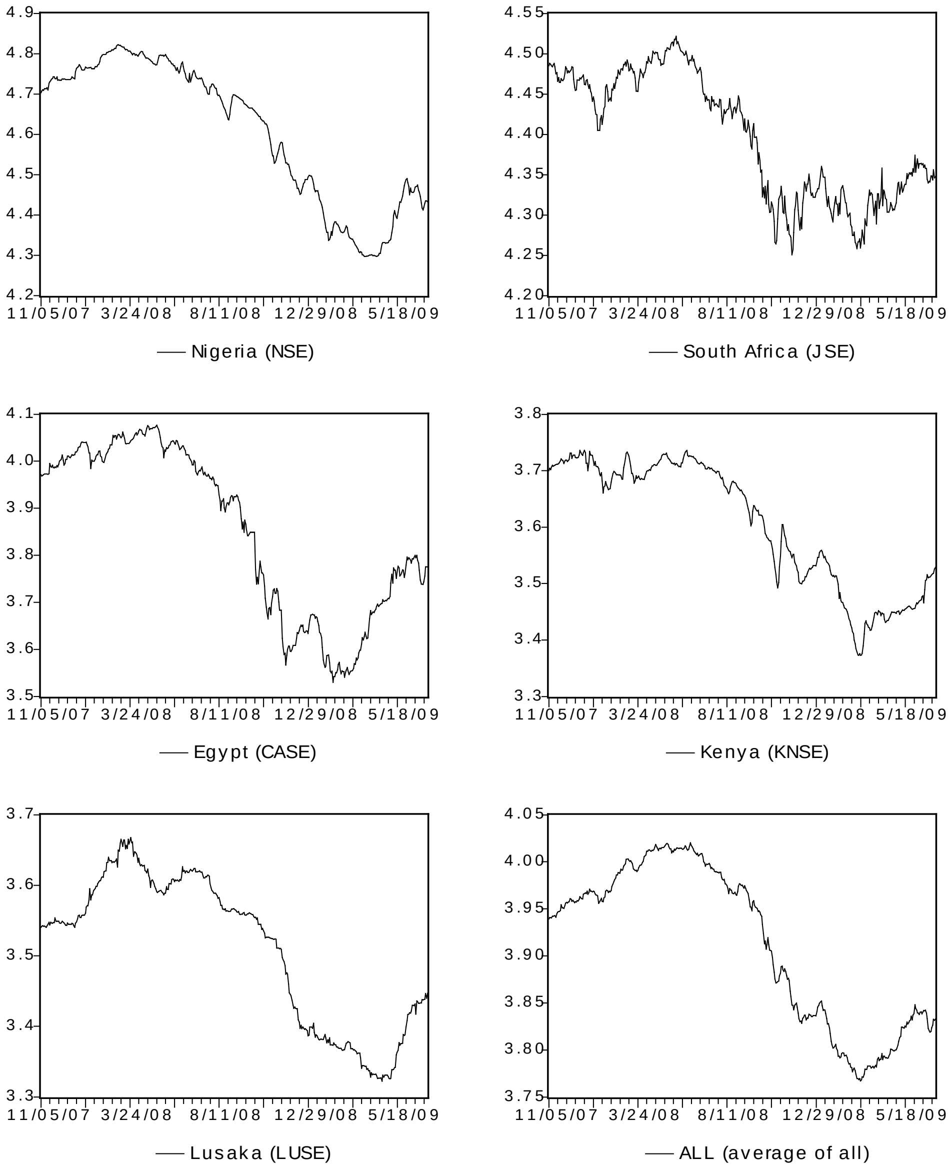
Note: Rejection of null hypothesis was at 5 percent critical value.

The '≠' sign implies no causality; the '←' implies causality runs from the column stock market to the row stock market; the '→' means causality runs from the row stock market to the column stock market, while the '−' sign is the point were the same stock market meets it self on the table. As shown in the summary part, the JSE and the CASE granger cause the highest number of stock markets. This implies that the JSE and the CASE would be used differently as the right hand side variables to examine their role in the enhancing stock market integration in Africa.

Line Graph Analysis

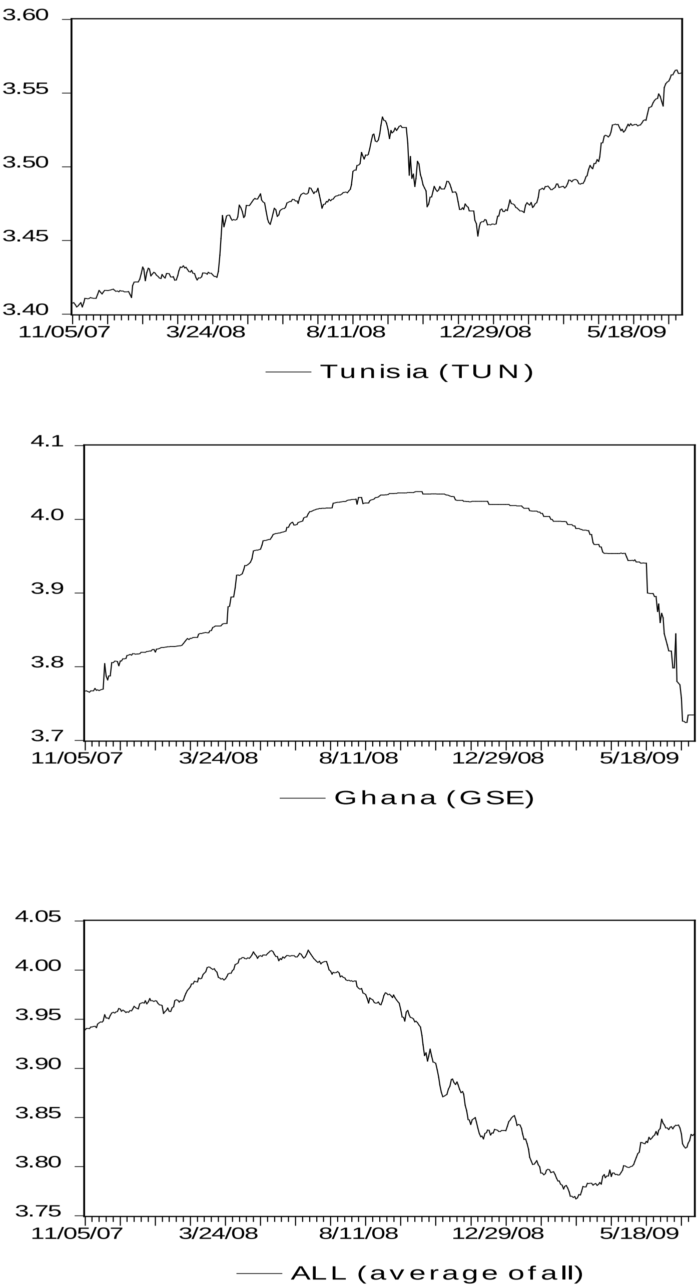
The line graphs for the individual stock markets are presented below.

Figure 1: Line Graph of the NSE, JSE, CASE, KNSE and LUSE compared to the average line graph for ALL the Stock Markets



A line graph labelled **ALL**, the average of the stock markets plotted in one graph, is also presented along the individual graphs so as to have a picture of the impact of the financial crisis on the performance of each of the stock markets.

Figure 2: Line Graph for teh GSE and TUN Compared to the average line graph for the Stock Markets



Asides the GSE and the TUN, the behavioural pattern of the other stock markets, resembles closely the line graph for **ALL**. This shows that the negative impact of the financial crisis was more on the other stock markets (i.e. Nigeria, Kenya, Lusaka, Egypt and South Africa). The line graphs for the GSE and the TUN clearly shows that these markets moved in different direction despite the impact of the crisis.

GENERALIZED ERROR CORRECTION MODEL: The JSE as Driver

The estimated equations 3.1 to 3.6 are presented in a summarized form in table 4.3 below and their eview result in table 2 to table 7 in the appendix. The first column in table 4.3 shows the each stock market in relation to the JSE. The second column shows the number of the GECM model estimated. The third column, specifies the ordinary least square (OLS) coefficient obtained from the ADL (1, 1) estimation of the I(0) variables as a requirement for the GECM procedure. The GECM long run slope coefficient is presented in the fourth column. Dividing column three by four, yields the result seen in column five; that is the long run multiplier. The short run coefficient, a measure of the contemporaneous effect, is written in column six. Columns seven, eight and nine, states the F-statistic value, the Durbin Watson (DW) statistic value and the adjusted coefficient of determination respectively. The F-statistic is used to judge the over all goodness of fit of the model, while the Durbin-Watson statistics tells whether the model has autocorrelation problems or not. Lastly, the adjusted r-square value tells the extent to which the dependent variable would respond to changes in the explanatory variable.

Table 4.3: Generalized error correction coefficients for equations 3.1 to 3.6

(1) Stock Market	(2) Equation Number	(3) OLS Slope Coefficient	(4) GECM Long run slope coefficient	(5) GECM Long run multiplier (3)/(4)	(6) GECM Short run slope coefficient	(7) F-Statistic	(8) Durbin-Watson Statistic	(9) Adjusted r-square (percentage)
$NSE\|_{JSE}$	(3.1)	1.96***	-0.015***	130.67***	$0.029^{n.s}$	9.37***	1.11	3.73
$GSE\|_{JSE}$	(3.2)	-0.43***	$0.0048^{n.s}$	$89.58^{n.s}$	$0.022^{n.s}$	$1.20^{n.s}$	2.36	0.00
$CASE\|_{JSE}$	(3.3)	2.18***	-0.043***	50.69***	0.23***	20.18***	1.75	8.14
$KNSE\|_{JSE}$	(3.4)	1.31***	-0.033***	39.69***	0.052*	15.45***	1.216	6.25
$TUN\|_{JSE}$	(3.5)	-0.25***	$0.002^{n.s}$	$125^{n.s}$	0.042***	3.72**	1.82	1.20
$LUSE\|_{JSE}$	(3.6)	1.11***	-0.013***	85.38***	$-0.001^{n.s}$	6.22***	2.22	2.35

Source: Author's Computation using Eviews

Note: *** = Significant at 1 percent critical value; ** = Significant at 5 percent critical value;

* = Significant at 10 percent critical value; $^{n.s}$ = Not Significant

The result for the estimated equation 3.1 shows that the long run equilibrium relationship between the JSE and the NSE is significant while the short run coefficient is not significant. This implies that the short run disequilibrium created between the JSE and the NSE would be corrected in the long run. This correction would follow if the NSE all share index increases by 1.5 percent on a daily basis. If this adjustment continues, rising and falling in times of positive and negative shocks respectively, the implication of the long run multiplier is that the integration of the JSE and the NSE would grow stronger over a period of 653.35 days (i.e. 130.67 x 5 years: the number of years left to 2015). The f-statistic is significant implying that the model generally has a good fit. The DW statistics however shows that the model has first degree autocorrelation problem, while the adjusted r-square value implies that only 3.73 percent of the changes in the NSE is attributable to changes in the JSE. This is an indication that the risk that is likely to be transferred to the NSE through the JSE in times of shocks (like during the financial crisis period) is only 3.73 percent.

For equation 3.2, the results connecting the GSE and the JSE were not significant. This implies that the Ghanaian stock exchange cannot be said to have a cointegrating relationship with the JSE.

The result for equation 3.3 shows that the JSE and the CASE have significant short and long run relationship: one that can be quickly restored even when there is disequilibrium in the system. The error correction rate was at 4.3 percent on a daily basis. In achieving increased integration in the context of the NEPAD framework, the results shows that increased integration between the JSE and the CASE would be achieved over a period of 253.45 days before 2015. The f-statistics shows that the model have a good fit, while the DW statistic value of approximately two is an indication that the model do not have first degree autocorrelation problem. The adjusted r-square value shows that 8.14 percent variation in the CASE is due to variation in the JSE. It also implies that during the financial crisis, 8.14 percent of the shock transmitted the JSE could be passed on to the CASE.

The result for equation 3.4 was also significant. It shows that the JSE and the KNSE are in equilibrium both in the short and long run. Any disequilibrium in the system attributed to the global financial crisis that pass through the JSE would also be corrected by the KNSE adjusting by 3.3 percent on a daily basis over a period 198.45 days. This implies that increased integration between the KNSE and the JSE would be achieved before 2015. The f-statistic shows that the model has a good a fit while the DW statistic shows that the model has first degree autocorrelation. The adjusted r-square value of 6.25 percent means that, 6.25 percent of the shocks that originate from the JSE or pass through the JSE could be transmitted to the KNSE.

Though the granger causality result showed no evidence of causality between the JSE and the TUN, the short run equilibrium coefficient in the GECM showed that the JSE and the TUN maintained short run equilibrium during the global financial crisis but the equilibrium could not be sustained in the long run because the long run coefficient was not significant. The implication is that it is not likely that increased integration would be recorded between the TUN and the JSE by 2015.

Though conceptualized in the literature as a small stock market, the LUSE showed promising evidence of achieving increased integration before 2015. The long run coefficient was significant implying that 1.3 percent of the short run disequilibrium created by the global financial crisis between the LUSE and the JSE would be corrected over a period of 426.9 days. The f-statistic showed that the model had a good fit and the DW statistic showed that the model is free of first degree autocorrelation problem. Distortions in the JSE however is likely to drag the LUSE down by 2.35 percent in the short run but would be corrected in the long run.

In summary, the evidence from the analysis shows that there is divergence between the Ghanaian stock exchange (GSE) and the South African JSE both in the short and long run. Though the data used for the study reflected the performance of the stock markets during the global financial crisis, the disequilibrium found between the GSE and the JSE cannot be attributed to the financial crisis. The implication for the NEPAD framework is that, it is not likely that the GSE would achieve increased integration with the JSE by 2015. The evidence for the Tunisian stock market (TUN) however was mixed. It showed that the JSE and the TUN maintained short run equilibrium during the financial crisis but the equilibrium could not be sustained in the long run. As for achieving increased integration with the JSE before 2015 however, it is also not likely that this expectation would be the outcome.

For the Nigerian stock exchange (NSE), the Nairobi stock exchange (KNSE), Cairo and Alexandria stock exchange (CASE), and the Lusaka stock exchange (LUSE), the results showed that the global financial crisis had impact on the short run equilibrium connecting the NSE and the LUSE to the JSE. The effect could be said to be slight in the short run for the KNSE and the JSE because the result was only significant at 10 percent. The financial crisis however, had no effect on the short run equilibrium relationship connecting the CASE to the JSE. On the possibility of achieving increased integration by 2015 in the context of NEPAD, the study found that increased integration connecting the NSE, CASE, KNSE and LUSE to the JSE could be achieved requiring longer period however for the NSE and LUSE but shorter for KNSE and CASE.

GENERALIZED ERROR CORRECTION MODEL: The CASE as Driver

Substituting the JSE with the CASE, equations 3.1 to 3.6 were re-estimated as equations 3.7 to 3.12 (the eviews result are presented in tables 8 to 13 in the appendix). The justification for this re-estimation is because just like the JSE, the CASE was also found to have a significant uni-directional influence on all the selected stock markets as shown by the granger causality test. The summary of the results is presented in the table 4.4 below:

Table 4.4: Generalized error correction coefficients for equations 3.7 to 3.12

(1) Stock Market	(2) Equation Number	(3) OLS Slope Coefficient	(4) GECM Long run slope coefficient	(5) GECM Long run multiplier (3)/(4)	(6) GECM Short run slope coefficient	(7) F-Statistic	(8) Durbin-Watson Statistic	(9) Adjusted r-square (percentage)
$NSE\|_{CASE}$	(3.7)	0.89***	-0.025***	35.6***	$0.042^{n.s}$	19.53***	1.16	7.88
$GSE\|_{CASE}$	(3.8)	0.21***	$0.0051^{n.s}$	$41.18^{n.s}$	$0.002^{n.s}$	$1.03^{n.s}$	2.36	0.00
$KNSE\|_{CASE}$	(3.9)	0.58***	-0.027***	21.48***	0.11***	19.53***	1.25	7.88
$LUSE\|_{CASE}$	(3.10)	0.52***	-0.022***	23.64***	0.053**	16.65***	2.25	6.74
$TUN\|_{CASE}$	(3.11)	-0.099***	$0.0012^{n.s}$	$82.5^{n.s}$	0.033**	2.62*	1.89	0.74
$JSE\|_{CASE}$	(3.12)	0.416***	-0.075***	5.55***	0.214***	15.65***	2.24	6.33

Source: Author's Computation using Eviews
Note: *** = Significant at 1 percent critical value; ** = Significant at 5 percent critical value;
* = Significant at 10 percent critical value; $^{n.s}$ = Not Significant

The short and long run equilibrium results for the GSE were not significant implying that the GSE was not integrated with the CASE during the global financial crisis. In terms of achieving increased integration with the major stock markets in Africa (the JSE and CASE) by 2015, though the result as well was not significant, the GECM multiplier showed that the GSE would achieve faster integration going with the CASE than with the JSE.

The finding for the TUN in relation to the CASE is also consistent with the finding of the TUN in relation to the JSE: both markets were in equilibrium in the short run but the evidence for long run equilibrium was not significant. This implies that the global financial crisis had no impact on the short run equilibrium of both markets but long run equilibrium was distorted. Though the results were not significant, the GECM multiplier showed that increased linkage between the TUN and the CASE would enhance increased stock market integration compared to increasing the TUN's linkage with the JSE.

For the NSE, the result showed no evidence of short run equilibrium between it and the CASE. However, the short run disequilibrium would be corrected in the long run by the

NSE adjusting by 2.5 percent on a daily basis over 178 days. This is faster compared to the error correction rate and GECM multiplier found when the analysis was done in relation to the JSE. Another implication is that short run shocks that pass through the CASE would not immediately be transmitted to the NSE. However, the distortions it would create between the CASE and the NSE would be corrected in the long run. The model had a good fit but had evidence of first order autocorrelation. The adjusted r-square value of 7.88 percent implies that 7.88 percent variation observed in the NSE is attributable to variations in the CASE.

The results for KNSE and LUSE were also significant; an evidence that the financial crisis did not distort the short run equilibrium connecting them to the CASE. The GECM multiplier also showed that increased integration of the KNSE and LUSE in relation to the CASE would occur faster than when both markets are analysed in relation to the JSE. For KNSE however, the adjusted r-square with the CASE is higher (i.e. 7.88 percent) compared to the adjusted r-square value with the JSE. Because its short run equilibrium relationship was more significant in relation to the CASE (i.e. at 1 percent) than when related to the JSE (i.e. at 10 percent), shocks that pass through the CASE would have more severe impact on the performance of the KNSE than shocks that pass through the JSE. By implication, the KNSE could achieve increased and more stable integration with the JSE than with the CASE.

Lastly, as found when the CASE was related to the JSE, the result for the JSE in relation to the CASE is also significant. The result implies that despite the global financial crisis, both markets maintained their short and long run equilibrium relationship. Any deviation from these relationships was quickly restored through the error correction mechanism of 7.5 percent on a daily basis over a period of 118.2 days.

In summary, it was found that the short run relationship of Tunisia (the TUN) with Egypt (the CASE) was not affected by the global financial crisis. However, the insignificant long run equilibrium relationship implied that it is not likely that increased integration between both markets would be achieved by 2015 since their long run multiplier were not significant. As for Ghana (GSE), the evidence found did not show that the performance of the GSE was affected by the global financial crisis as well as in its short run equilibrium relationship with the CASE. The long run equilibrium relationship and the long run multiplier were also insignificant. This implies that achieving increased integration for the GSE with the major stock markets in Africa might not be feasible by 2015. For the KNSE and LUSE, the results showed that the global financial crisis affected the equilibrium relationship of both stock markets in the short run, but the distortion it created was restored in the long run. The long run multiplier for both markets also suggested that increased integration in relation to the CASE could be achieved by 2015. In the case of Nigeria, the result for the NSE showed that the financial crisis did not affect its short run equilibrium relationship. And the significant long run relationship and long run multiplier however suggested that stronger integration of the NSE in relation to the CASE could be achieved by 2015. Lastly, the result for the JSE in relation to the CASE was also significant. It confirmed the CASE and the JSE as major stock markets in Africa and also showed that increased integration between both markets could be achieved before 2015.

<E> SUMMARY AND CONCLUSION

Achieving increased integration in Africa is one of the expected outcomes of the NEPAD framework for monitoring the achievement of its objectives. The study draws its sample from a cross section of stock markets in Africa not based on a regional divide but on a continental basis. Such approach is necessary so as to provide empirical evidence on increased African integration (as expected in the NEPAD framework) rather than on regional integration. Of the seven stock markets sampled (Nigerian, Kenya, Ghana, Egypt, South Africa, Lusaka and Tunisia), granger causality test was used to identify the market(s) that have more uni-directional influence on others. It was found that the South African JSE and the Egyptian CASE were the major driving stock markets. Generalized error correction model (GECM) was then used to examine the short and long run equilibrium relationship connecting other stock markets to these driving stock markets. The results showed that the performance of the Ghanaian and Tunisian stock exchange, were not significantly affected by the global financial crisis however, in terms of achieving increased integration with the driving stock markets in the context of the NEPAD objective, it is not likely that the desired outcome would be achieved by 2015. For the Nigerian, Kenyan and Lusaka stock exchanges, their performances were affected by the global financial crisis and the GECM results showed that all the stock markets could achieve increased integration with the driving stock markets in Africa by 2015. Between the driving stock markets however, the GECM showed that integration would be faster for all the stock markets in relation to the Egyptian CASE compared to the JSE.

The choice of which stock market to integrate with would depend on the stock market that has the lowest adjusted coefficient of determination: an indication of minimum transfer of shocks. For Nigeria, the JSE had the minimum adjusted r-square value of 3.73 percent. For Ghana the value was 0.00 percent in both cases. For Kenya, the JSE as well had the lowest adjusted r-square value (i.e. 6.25 percent). For Tunisia, the adjusted r-square value was lowest with the Egyptian CASE (i.e. 0.74 percent), while Lusaka had the lowest value with the JSE (i.e. 2.35 percent). Lastly, for the CASE and the JSE, the adjusted r-square value was lower for CASE integrating with the JSE (i.e. 6.33 percent) than for the JSE integrating with the CASE (with an adjusted r-square value of 8.14 percent): these stock markets are deeply integrated into the global economy thus; integrating other African stock markets to them would help in enhancing Africa's integration into the global economy.

The policy recommendation is that capital market regulators in Africa should relax their listing requirement so that more firms/industries operating in Egypt and South Africa would get listed in their stock markets. This sought of integration is necessary so as to increase capital mobility in Africa and also provide long term funds for local investors.

BIBLIOGRAPHY

African Development Bank Group (AfDBG), 2010, *Financial Sector Integration in Three Regions of Africa: How Regional Financial Integration Can Support Growth, Development, and Poverty Reduction (Making Finance Work for Africa),* Tunis: SILDAR

AfDB and ADF, 2000, *Economic Cooperation and Regional Integration Policy*, Ethiopia: African Development Bank (AfDB) and African Development Fund (ADF), February

African Union-Department of Economic Affairs (AU-DEA), 2008, *Report of the Feasibility Study on the Establishment of the Pan African Stock Exchange*. Ethiopia: African Union

Ahmed, Uddin Kamal, 2005, Open-Economy Relationships among the Exchange Rate, Price Level, Output and Money in Three Asean Countries: Evidence Based On Cointegration and Error-Correction Modelling Analysis. Athesis submitted in fulfilment of the requirements for the degree of doctor of philosophy, University of Sydney: Department of Economics

Bannerjee, A., Juan D., John W. G., and David F. H., 1993, *Integration, Error Correction, and the Econometric Analysis of Non-Stationary Data.* Oxford: Oxford University Press.

Davidson, R., and Mackinnon, J. G., 1993, *Estimation and Inference in Econometrics*. New York: Oxford University Press.

Demirguc-Kunt, A. and Levine, R., 1996, 'Stock Market Development and Financial Intermediaries: Stylized Facts', *The World Bank Economic Review*, Vol. 10, No. 2, pp. 291-232.

Engle, R.F., and Granger, C.W.J., 1987, 'Cointegration and Error Correction Representation, Estimation and Testing', *Econometrica* March 1987, pp 255-276

German Development Institute (GDI) and South African Institute of International Affairs (SAIIA), 2010, *African Developments: Continental Integration in Africa − AU, NEPAD and the APRM*, Briefing Paper. Available online at http://www.die-gdi.de/CMS-Homepage/openwebcms3.nsf/(ynDK_contentByKey)/ANES-82JKD8/$FILE/BP%204.2010.pdf

Granger, C.W.J., 1981, 'Some Properties of Time Series Data and Their Use in Econometric Model Specification', *Journal of Econometrics*, Vol 16, pp 121-130

Johansen, S., 1988, ' Statistical Analysis of Cointegration Vectors', *Journal of Economic Dynamics and Control*, Vol. 12, pp 231-254

Johansen, S., and 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

Keele, L., and DeBoef, S., 2004, *Not Just for Cointegration: Error Correction Models with Stationary Data*. Available online at http://www.nuffield.ox.ac.uk/politics/papers/2005/keele%20deboef%20ecm%20041213.pdf

Kibuthu, G.W., 2005, *Capital Markets in Emerging Economies: A Case Study of the Nairobi Stock Exchange*. http://Fletcher.Tufts.Edu Accessed November, 2010

Magnusson, M.A., and Wydick, B., 2004, *How Efficient are Africa's Emerging Stock Market?,* in Mensah, S., and Moss, T. (ed.), Accra: African Capital Markets Forum (ACMF) contemporary issues vol. II, pp 130-142

Maronne, H., 2004, '*Small African Stock Markets – The Case of the Lusaka Stock Exchange'* in Mensah, S., and Moss, T. (ed.), Accra: African Capital Markets Forum (ACMF) contemporary issues vol. II, pp 143-162

Mucavele, F.G., 2007, *Industry Development, Trade and Market Access: The NEPAD Agenda*. Regional Consultation Meeting of the African Union, May, 3rd – 4th. Available online at http://www.unido.org/fileadmin/import/67330_Agenda03_NEPADindustrytradeAgenda.pdf

Ngbede, S., Ochoche, A. and Joseph, O., 2009, 'Co-integration and Error-Correction Modeling of Agricultural Output. A Case of Groundnut', *Researcher*, Vol. 1, No. 6, pp. 27-32

Nkang, N.M.., Abang, S.O., Akpan, O.E. and Offem, K.J., 2006, 'Co-integration and Error-correction Modelling of Agricultural Export Trade in Nigeria: The Case of Cocoa', *Journal of Agriculture and Social Sciences*, Vol. 2, No. 4 pp. 249-255

Nnanna, O.J., 2006, *Economic and Monetary Integration in Africa*, Singapore: G24 meeting, September 14th. Available online at http://www.g24.org/nnan0906.pdf

Popiel, P.A., 1990, *Developing Financial Markets in Sub-Saharan Africa*, Washington D.C.: The World Bank (working papers)

Rao, B.B., 2005, *Estimating Short and Long Run Relationships: A Guide to the Applied Economist*. Methodological Issues (May). Available online at http://129.3.20.41/econ-wp/em/papers/0508/0508013.pdf

Sako, S., 2006, Challenges Facing Africa's Regional Economic Communities In Capacity Building, Harare: The African Capacity Building Foundation Occasional Paper No. 5

Shams, R., 2005, *The Drive to Economic Integration in Africa*. Germany: Hamburg Institute of International Economics (HWWA) Discussion Paper 316. Available online at http://ageconsearch.umn.edu/bitstream/26199/1/dp050316.pdf

Stock, J.H., and Watson, M.W., 1988, 'Testing Common Trends', *Journal of the American Statistical Association,* Vol. 83, pp 1097-2007

The New Partnership for Africa's Development (NEPAD), 2001, *NEPAD Framework in English*, Nigeria

United Nations Institute for Training and Research (UNITAR), 2002, *Promoting Growth in African Capital Markets*, Geneva: UNITAR Training Programmes in the Legal Aspects of Debt and Financial Management Document No. 18. Available online at http://www2.unitar.org/dfm/Resource_Center/Document_Series/Document18/DocSeries18.pdf

Verbeek, M., 2000, *A Guide to Modern Econometrics*. New York: John Wiley and Sons.

World Bank, 2007, *Financial Sector Integration in Two Regions of Sub-Saharan Africa*, January, Washington DC.

APPENDIX

Table 1: Pairwise Granger Causality Tests Results
Date: 11/17/10 Time: 20:10
Sample: 11/05/2007 7/03/2009
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
JSE does not Granger Cause NSE	433	6.81140	0.00122
NSE does not Granger Cause JSE		0.68498	0.50465
GSE does not Granger Cause NSE	433	2.84208	0.05941
NSE does not Granger Cause GSE		17.4780	5.1E-08
CASE does not Granger Cause NSE	433	12.3086	6.3E-06
NSE does not Granger Cause CASE		2.11486	0.12191
KNSE does not Granger Cause NSE	433	4.18628	0.01583
NSE does not Granger Cause KNSE		3.87555	0.02147
TUN does not Granger Cause NSE	433	0.24707	0.78119
NSE does not Granger Cause TUN		0.50543	0.60361
LUSE does not Granger Cause NSE	433	0.46497	0.62847
NSE does not Granger Cause LUSE		14.7234	6.5E-07
GSE does not Granger Cause JSE	433	1.01579	0.36299
JSE does not Granger Cause GSE		14.1704	1.1E-06
CASE does not Granger Cause JSE	433	2.54163	0.07993
JSE does not Granger Cause CASE		14.4528	8.4E-07
KNSE does not Granger Cause JSE	433	0.73936	0.47803
JSE does not Granger Cause KNSE		12.5232	5.2E-06
TUN does not Granger Cause JSE	433	1.38930	0.25037
JSE does not Granger Cause TUN		1.49043	0.22644
LUSE does not Granger Cause JSE	433	0.79124	0.45394
JSE does not Granger Cause LUSE		10.6485	3.1E-05
CASE does not Granger Cause GSE	433	12.7790	4.1E-06
GSE does not Granger Cause CASE		4.51726	0.01144
KNSE does not Granger Cause GSE	433	19.2646	9.7E-09
GSE does not Granger Cause KNSE		3.51936	0.03048
TUN does not Granger Cause GSE	433	20.2165	4.1E-09
GSE does not Granger Cause TUN		1.14831	0.31815
LUSE does not Granger Cause GSE	433	16.5213	1.2E-07
GSE does not Granger Cause LUSE		13.5636	1.9E-06
KNSE does not Granger Cause CASE	433	1.95913	0.14224
CASE does not Granger Cause KNSE		12.6265	4.7E-06
TUN does not Granger Cause CASE	433	1.36820	0.25568
CASE does not Granger Cause TUN		5.66385	0.00373
LUSE does not Granger Cause CASE	433	4.43495	0.01241
CASE does not Granger Cause LUSE		20.4342	3.3E-09
TUN does not Granger Cause KNSE	433	0.83327	0.43533
KNSE does not Granger Cause TUN		0.28144	0.75483
LUSE does not Granger Cause KNSE	433	1.34064	0.26277
KNSE does not Granger Cause LUSE		2.78660	0.06275
LUSE does not Granger Cause TUN	433	0.94367	0.39000
TUN does not Granger Cause LUSE		0.35931	0.69837

Source: Eviews Output

Table 2: Generalized Error Correction Results for Equation 3.1

Dependent Variable: D(NSE)
Method: Least Squares
Date: 11/18/10 Time: 10:03
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000614	0.000306	-2.009022	0.0452
UT	-0.015460	0.003617	-4.274385	0.0000
D(JSE)	0.029169	0.030958	0.942220	0.3466

R-squared	0.041701	Mean dependent var	-0.000623
Adjusted R-squared	0.037254	S.D. dependent var	0.006483
S.E. of regression	0.006361	Akaike info criterion	-7.270236
Sum squared resid	0.017442	Schwarz criterion	-7.242081
Log likelihood	1580.641	F-statistic	9.377642
Durbin-Watson stat	1.116196	Prob(F-statistic)	0.000103

Source: Eviews Output

Table 3: Generalized Error Correction Results for Equation 3.2

Dependent Variable: D(GSE)
Method: Least Squares
Date: 11/18/10 Time: 12:25
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.73E-05	0.000295	-0.228179	0.8196
UT	0.004875	0.003487	1.397991	0.1628
D(JSE)	0.022817	0.029901	0.763076	0.4458

R-squared	0.005553	Mean dependent var	-7.45E-05
Adjusted R-squared	0.000938	S.D. dependent var	0.006144
S.E. of regression	0.006141	Akaike info criterion	-7.340680
Sum squared resid	0.016255	Schwarz criterion	-7.312525
Log likelihood	1595.928	F-statistic	1.203346
Durbin-Watson stat	2.362734	Prob(F-statistic)	0.301194

Source: Eviews Output

Table 4: Generalized Error Correction Results for Equation 3.3

Dependent Variable: D(CASE)
Method: Least Squares
Date: 11/18/10 Time: 12:28
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000378	0.000481	-0.786134	0.4322
UT	-0.043100	0.008992	-4.793139	0.0000
D(JSE)	0.230757	0.048991	4.710211	0.0000

R-squared	0.085656	Mean dependent var	-0.000451
Adjusted R-squared	0.081413	S.D. dependent var	0.010447
S.E. of regression	0.010013	Akaike info criterion	-6.363016
Sum squared resid	0.043210	Schwarz criterion	-6.334861
Log likelihood	1383.774	F-statistic	20.18812
Durbin-Watson stat	1.752948	Prob(F-statistic)	0.000000

Source: Eviews Output

Table 5: Generalized Error Correction Results for Equation 3.4

Dependent Variable: D(KNSE)
Method: Least Squares
Date: 11/18/10 Time: 12:33
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000377	0.000293	-1.286136	0.1991
UT	-0.033067	0.006185	-5.345949	0.0000
D(JSE)	0.051737	0.029683	1.743009	0.0820

R-squared	0.066923	Mean dependent var	-0.000393
Adjusted R-squared	0.062593	S.D. dependent var	0.006305
S.E. of regression	0.006105	Akaike info criterion	-7.352651
Sum squared resid	0.016062	Schwarz criterion	-7.324496
Log likelihood	1598.525	F-statistic	15.45619
Durbin-Watson stat	1.216111	Prob(F-statistic)	0.000000

Source: Eviews Output

Table 6: Generalized Error Correction Results for Equation 3.5

Dependent Variable: D(TUN)
Method: Least Squares
Date: 11/18/10 Time: 17:55
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000373	0.000152	2.449174	0.0147
UT	0.002062	0.004553	0.452942	0.6508
D(JSE)	0.041996	0.015456	2.717054	0.0069

R-squared	0.016975	Mean dependent var	0.000360
Adjusted R-squared	0.012414	S.D. dependent var	0.003192
S.E. of regression	0.003172	Akaike info criterion	-8.661984
Sum squared resid	0.004337	Schwarz criterion	-8.633829
Log likelihood	1882.651	F-statistic	3.721337
Durbin-Watson stat	1.819841	Prob(F-statistic)	0.024983

Source: Eviews Output

Table 7: Generalized Error Correction Results for Equation 3.6

Dependent Variable: D(LUSE)
Method: Least Squares
Date: 11/18/10 Time: 12:37
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000215	0.000229	-0.940093	0.3477
UT	-0.013436	0.003813	-3.523601	0.0005
D(JSE)	-0.001001	0.023179	-0.043201	0.9656

R-squared	0.028088	Mean dependent var	-0.000215
Adjusted R-squared	0.023578	S.D. dependent var	0.004823
S.E. of regression	0.004766	Akaike info criterion	-7.847643
Sum squared resid	0.009791	Schwarz criterion	-7.819488
Log likelihood	1705.939	F-statistic	6.227956
Durbin-Watson stat	2.228578	Prob(F-statistic)	0.002156

Source: Eviews Output

Table 8: Generalized Error Correction Results for Equation 3.7

Dependent Variable: D(NSE)
Method: Least Squares
Date: 11/18/10 Time: 17:34
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000604	0.000299	-2.019764	0.0440
UT	-0.025567	0.004373	-5.847130	0.0000
D(CASE)	0.042499	0.028843	1.473465	0.1414

R-squared	0.083118	Mean dependent var	-0.000623
Adjusted R-squared	0.078863	S.D. dependent var	0.006483
S.E. of regression	0.006222	Akaike info criterion	-7.314416
Sum squared resid	0.016688	Schwarz criterion	-7.286262
Log likelihood	1590.228	F-statistic	19.53564
Durbin-Watson stat	1.164223	Prob(F-statistic)	0.000000

Source: Eviews Output

Table 9: Generalized Error Correction Results for Equation 3.8

Dependent Variable: D(GSE)
Method: Least Squares
Date: 11/18/10 Time: 17:37
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.36E-05	0.000295	-0.249206	0.8033
UT	0.005116	0.003574	1.431297	0.1531
D(CASE)	0.002124	0.028536	0.074434	0.9407

R-squared	0.004766	Mean dependent var	-7.45E-05
Adjusted R-squared	0.000148	S.D. dependent var	0.006144
S.E. of regression	0.006144	Akaike info criterion	-7.339889
Sum squared resid	0.016268	Schwarz criterion	-7.311735
Log likelihood	1595.756	F-statistic	1.032087
Durbin-Watson stat	2.364409	Prob(F-statistic)	0.357141

Source: Eviews Output

Table 10: Generalized Error Correction Results for Equation 3.9

Dependent Variable: D(KNSE)
Method: Least Squares
Date: 11/18/10 Time: 17:59
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000342	0.000291	-1.176278	0.2401
UT	-0.027524	0.006512	-4.226878	0.0000
D(CASE)	0.114045	0.028037	4.067645	0.0001

R-squared	0.083126	Mean dependent var	-0.000393
Adjusted R-squared	0.078871	S.D. dependent var	0.006305
S.E. of regression	0.006051	Akaike info criterion	-7.370169
Sum squared resid	0.015783	Schwarz criterion	-7.342014
Log likelihood	1602.327	F-statistic	19.53778
Durbin-Watson stat	1.253882	Prob(F-statistic)	0.000000

Source: Eviews Output

Table 11: Generalized Error Correction Results for Equation 3.10

Dependent Variable: D(LUSE)
Method: Least Squares
Date: 11/18/10 Time: 18:01
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000191	0.000224	-0.854124	0.3935
UT	-0.021692	0.004456	-4.868412	0.0000
D(CASE)	0.052583	0.021614	2.432822	0.0154

R-squared	0.071736	Mean dependent var	-0.000215
Adjusted R-squared	0.067429	S.D. dependent var	0.004823
S.E. of regression	0.004658	Akaike info criterion	-7.893592
Sum squared resid	0.009351	Schwarz criterion	-7.865438
Log likelihood	1715.910	F-statistic	16.65389
Durbin-Watson stat	2.259659	Prob(F-statistic)	0.000000

Source: Eviews Output

Table 12: Generalized Error Correction Results for Equation 3.11

Dependent Variable: D(TUN)
Method: Least Squares
Date: 11/18/10 Time: 18:03
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000375	0.000153	2.453965	0.0145
UT	0.001201	0.004437	0.270707	0.7867
D(CASE)	0.033531	0.014671	2.285552	0.0228

R-squared	0.011996	Mean dependent var	0.000360
Adjusted R-squared	0.007412	S.D. dependent var	0.003192
S.E. of regression	0.003180	Akaike info criterion	-8.656932
Sum squared resid	0.004359	Schwarz criterion	-8.628777
Log likelihood	1881.554	F-statistic	2.616586
Durbin-Watson stat	1.886983	Prob(F-statistic)	0.074212

Source: Eviews Output

Table 13: Generalized Error Correction Results for Equation 3.12

Dependent Variable: D(JSE)
Method: Least Squares
Date: 11/18/10 Time: 18:04
Sample(adjusted): 11/06/2007 7/03/2009
Included observations: 434 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000220	0.000460	-0.477258	0.6334
UT	-0.075147	0.019915	-3.773306	0.0002
D(CASE)	0.214958	0.044898	4.787713	0.0000

R-squared	0.067715	Mean dependent var	-0.000316
Adjusted R-squared	0.063389	S.D. dependent var	0.009892
S.E. of regression	0.009573	Akaike info criterion	-6.452852
Sum squared resid	0.039498	Schwarz criterion	-6.424698
Log likelihood	1403.269	F-statistic	15.65250
Durbin-Watson stat	2.244906	Prob(F-statistic)	0.000000

Source: Eviews Output