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ABSTRACT

This study investigates the relationship that exists between the South African stock market and selected African stock markets. It employs the Johansen cointegration test and incorporate the Markov-Switching Vector Error Correction Model (MS-VECM) for this purpose. The MS-VECM nests appealing properties which provide insightful information regarding the interaction of the variables in the system within different regimes as well as the response to disequilibrium. The model enables one to classify regimes as contingent on the parameter switches in full sample and hence one can identify any transition in the system. The results indicate that these selected stock markets share the same stochastic trend in the long run, but cointegration is in its weak form. A weak form of cointegration suggests that these stock markets jointly offer potential gains for portfolio diversified investment suggesting international investors should consider these markets.

Key words: *African stock markets, Stock market integration, Johansen approach, linear VECM, MS-VECM, portfolio diversification*

1. INTRODUCTION

Events in the global financial markets during the past two decades have raised an important ongoing debate regarding the role of global integration in financial markets. As such, financial integration and transmission of stock market movement has since become an important subject under discussion in related literature. The Mexican peso crisis (1994), the Asian crisis (1997), the subsequent

Russian and Brazilian crisis (1998) and the most recent 2007-2008 financial crisis have provided with new information with which to examine stock market integration among different equity markets. Theoretically, a higher degree of financial integration stimulates macroeconomic stability through advanced economic growth rate as well as facilitating trade. This emerges from higher capital mobility as well as consumption in a globalized marketplace. In an integrated market, the law of one price holds and there are no arbitrage conditions. A financially integrated stock market enables risk -adjusted returns of assets of similar risk to converge to unity across market.

Studying stock market integration is vital in finance as this has a bearing on capital assets allocation decisions and portfolio diversification (Bhanja, Shah and Tiwari, 2013). Integration among international equity markets suggests that global investors seeking diversified investment opportunities have limited long-run benefits in these markets from diversifying their portfolio investments within these markets Solarin and Dalahan (2012) and Bhanja et al. (2013), whereas a segmented stock markets enable managers to diversify and benefit from differences in markets (Bhanja et al., 2013). According to Granger (1986) strong interlinkages between stock markets may result in the rejection of the efficient market hypothesis. Hypothesised on these implications of stock market integration, studies have attempted to ascertain the degree of integration among various stock markets notably in developed and emerging markets.

Several studies have investigated integration in different major global stock markets. Chakrabarti and Roll (2002) examined stock market integration between East Asia and Europe following the 1997 financial crisis. Evidence indicated that the markets were highly integrated eliminating returns from diversification. Lee (2014) examined stock market integration among 22 international stock markets and the Malaysian stock markets. The study found evidence to support that there is strong cointegration between Malaysia and European stock markets but weak cointegration between Malaysia and its Asian counterparts. In a similar study Loh (2013) investigated co-movement between the Asian stock markets and Europe and US in the long run. Evidence indicated that co-movement increased during the global financial crises and was temporary due to the crisis contagion effect. Graham (2013) analysed stock market integration among 22 emerging stock markets and the US. The results indicated strong integration between the US and Brazil, Mexico and Korea but weak integration with Egypt and Morocco. Despite showing varying results, the majority of these studies show evidence of strong linkages among major global equity markets with co-movement increasing between emerging and developed stock markets (Agarwal, Du and Wong, 2005)

The imperative question therefore is whether Africa stock markets are caught up in the same web. The significant increase in capital platforms and evolution of African stock markets to global standards show that these stock markets are beginning to impact on African economies. These notable advances of African stock markets have raised the matter of their integration. Unfortunately, both previous and current empirical work have concentrated on stock market integration in developed and emerging markets which are perceived significant and relevant in the global financial market. The foregoing discussion propose that African stock markets offer favourable investment opportunities which are currently underexploited with a possibility to enhance the risk –return trade off for global investors. To the best of our knowledge, studies which have addressed co-movement and integration of stock markets in Africa particularly between South African and other selected African markets) are very limited. Despite this limitation, there are some notable studies that examined integration of stock markets in Africa. Adjasi and Biekpe (2006), Dalahan et al. (2012) and Kapingura and Mishi (2014) examined integration among stock markets in Africa. The studies applied a Johansen integration test and used the linear VECM to explore on the relationship among variables in the long run. These studies have found a weak cointegrating relationship among African stock markets. All these studies have some limitations because the linear VECM without switching regimes is only able to capture the normal state of the system.

Contrary to previous research, this study contributes to recent literature by advancing its analysis from a linear VECM to a Markov regime switching VECM. The Markov regime switching VECM enables shocks to each variable in the system to influence transition probabilities of phase shifting. The Markov switching model is designed for nonlinear data series which are subject to regime shifts such as asset prices. Therefore, the Markov switching model provides with insightful information to solve structural problems and financial volatility issues as well as to understand the financial and economic dynamics within a data series which the linear model cannot. To the best of our knowledge, this is the first paper to examine the relationship between the South African stock market and selected African stock markets using the MS-VECM.

The study uses monthly data between February 2002 and July 2018. for 8 African indices: South Africa (ALSI), Egypt (EGX 30), Botswana (BGS-DCI), Mauritius (SEMDEX), Morocco (MASI), Tunisia (TUNINDEX), Kenya (NSE 20) and Nigeria (NGSE). The study employs a

Johansen cointegration approach to determine the whether stock markets are integrated and if there is a long run relationship between South Africa and selected African stock markets. The study employs the linear VECM and the Markov regime switching VECM to explain the long run dynamics between South African stock market with selected African stock markets.

The remainder of this study is structured as follows. Section 2 presents the literature on stock market integration. Section 3 presents the proposed methodology. Section 4 discuss the empirical results and section 5 provides conclusion and policy implication as well as scope for further research.

2. **LITERATURE REVIEW**

This section presents the theoretical considerations surrounding financial integration and focuses on stock market integration. It also discusses the most notable theoretical approaches to understanding the relationships between stock markets. Furthermore, the section presents and deliberates on the empirical research undertaking to investigate stock market integration in numerous settings using several different methodologies.

There is a myriad of empirical studies that have examined the relationship that exist among stock markets. The seminal work of Grubel (1968), constitutes the first treatise on the benefits of international portfolio diversification. It brought a new dimension to global financial linkages and this propelled investigation into stock market integration. At the beginning, studies mainly focused on major global markets such as the US, Canada, UK, Japan and Germany (Agmon, 1972, Lessard, 1976 and Hilliard, 1979). Measuring the relationship between national stock markets is not an unambiguous task. As a result, researchers over the years have adopted different model frameworks, choice of markets and sample periods to determine integration of stock markets. These findings, as can be expected, vary even for studies conducted on the same markets.

Darrat, Elkhal and Hakim (2000) assessed the level of integration in three MENA stock markets, namely, Egypt, Morocco and Jordan using monthly time series data. Results from the Johansen approach indicate that these emerging markets appear to be highly integrated within their region but globally segmented. The Gonzalo-Granger test and error correction model results revealed the dominance of the Cairo stock market as a leading stock market and hence drives other stock markets in within the MENA region.

Argarwal et al. (2005) investigated the long-run equilibrium relationship and short-run dynamic linkage `between the Indian stock market and the stock market of other key developed countries such as the US, the UK and Japan. Drawing on weekly closing price data from 1990 to 2003, the results from the Granger causality and fractional cointegration approach indicate that the Indian market is integrated with the UK, US and Japan stock markets. However, Mukherjee and Mishra (2005) carry out as similar investigation using daily data and produce contrasting results that the Indian stock market is not integrated with some of the countries used in Agarwal et al. (2005). The results found that the Indian stock market is integrated with that of other emerging Asian economies such as Malaysia, Indonesia, Korea, Phillipines, and Thailand.

Verma and Rani (2015) assess the level of stock market integration, for both short-run and long-run amongst Brazil, Russia, India and china (BRIC) market indices using Johansen integration, VAR and Toda-Yamamoto causality tests after the 2008 financial crisis. Results indicate that market returns of the BRIC nations do not move together in the long-run in the period after 2008 crisis. In the short-run, the study finds that there is no causality between Indian, Chinese and Russian stock market. However, there is one-way causality running from Brazilian market to the Indian market. Overall, the Indian stock market is largely affected by its own innovation, with those from other BRIC nations having no significant bearing on it.

Bhandari (2017) also use wavelet analysis to determine the relationship between Indian equity market and developed stock markets namely China, Germany, Japan and France. The study uses monthly data between January 2000 and March 2013. The results indicated a weak form of integration between the Indian stock market and other developed stock markets. However, the French and German markets display a strong cointegrating relationship.

Using daily data for the period 3 January 2002 to 3 October 2012, Gourne, Mendy and Elegbe, 2017) adopt the Wavelet Multiple Correlation (WMC) and the Wavelet Multiple Correlation Cross Correlation (WMCCC) to investigate integration between 6 largest stock markets in Africa namely South Africa, Egypt, Morocco, Nigeria, Kenya and the Western African Economic and Monetary Union area. The study concludes that integration between African stock markets is weak in the short run and medium run but steadily rises in the long run, offering the possibility of potential gains from diversification.

Ncube and Mingiri (2015) utilize the Johansen cointegration approach using monthly data from 2000 to 2008 to determine the relationship between 5 selected African stock markets namely South Africa, Botswana, Namibia, Mauritius and Nigeria. The results show that although African stock markets are improving in performance and generally growing, they are still segmented, that is, there are disintegrated. In addition the study findings indicate that developments in the international markets affect African stock markets thereby offering opportunities for portfolio diversification for investors.

This section discusses the empirical studies that investigated stock market integration in various settings using numerous methodologies. Correlation and cointegration techniques are the chief methods of analysis on this topic in developed, Asian and MENA economies. African stock markets are now seen to present favourable investment opportunities that are currently not fully exploited. Studies that assess stock market integration in African stock markets are very limited and this study fill the void in literature by attempting to investigate financial market integration in African markets. Most of these studies use the Johansen cointegration approach and a linear VECM with very few studies employing the wavelet analysis to investigate stock market integration. This study incorporates the MS-VECM in its analysis. The MS-VECM nests appealing properties which provide insightful information regarding the interaction of the variables in the system within different regimes as well as the response to disequilibrium. The model enables one to classify regimes as contingent on the parameter switches in full sample and hence one can identify any transition in the system. It is to the author's knowledge that no such study has incorporated the MS-VECM technique in its empirical analysis.

3. METHODOLOGY

3.1 Empirical Model

To investigate the interrelationships between the South African Stock market and other African stock markets, the study relies on the standard methodology in the literature. The model employed is similar to one used by Dalahan et al. (2012). The general model is given by the following representation:

$$w_i = f(w_t^i) \tag{1}$$

where w_i is the stock market index for South Africa and w_t^i represents the stock market index for Nigeria, Kenya, Egypt, Tunisia, Mauritius, Morocco and Botswana. Since the study seeks to uncover the relationship between South Africa and selected African stock markets, the following linear model is estimated:

$$w_i = \alpha + \beta_1 x_{i1} + \cdots + \beta_k x_{i1} + e_i \text{ for } i = 1, \ldots, n \tag{2}$$

where w_i is the stock market index for South Africa and $x_{i1}, x_{i2}, \ldots, x_{ik}$ are the stock market indices for Nigeria, Kenya, Egypt, Tunisia, Mauritius, Morocco and Botswana respectively.

As such, from Equation 2, we expectβ_1,β_2,β_3,… β_k to be either positive or negative. The estimated coefficients are based on economic theories which set out the basic economic reasoning and hence determine whether the observed values differ from the expected results.

3.2 DATA

The study make use of 8 largest and highly capitalized stock markets in Africa namely: South Africa (ALSI), Nigeria (NSE-ALSI), Morocco (MASI), Kenya (NSE20), Egypt (EGX 30), Tunisia (TUNINDEX), Mauritius (SEMDEX) and Botswana (BSE-DCI).Data on the stock market indices for these 8 countries was obtained from INET BFA website. The study makes use of monthly data from January 2002 to July 2018.The study uses monthly data make sure the sample size is large enough a pre-requisite in selecting the optimal lag length (Patra, 2006). The data was transformed to natural logarithm to make the variables linear so that coefficients can be explained as elasticities

3.3 ESTIMATION TECHNIQUE

3.3.1 Johansen Cointegration Test

Cointegration explains how time series variables are integrated of the same order and share a common stochastic trend in the long run (Engle & Granger,1987).In our empirical model, the co-integrating vector is assumed to be unknown and yet to be estimated, hence the unit root test cannot be directly applied to check if stationarity exists (Enders,2010).Once the cointegrating vector is estimated, we assume stationary linear relationships to represent the long run cointegration among time series variable. The Johansen approach test for cointegration by examining the number of linear combination k for an m time series variable set that results in a stationary process (Johansen and Juselius, 1990). The Johansen (1988) maximum likelihood reproduce a VAR (k) model:

$$Z_t = u + A_1 Z_{t-1} + A_2 Z_{t-2} + \cdots + A_k Z_{t-k} + e_t \tag{3}$$

where Z_{t-1} represents the $I - th$ lag of Z , u is a vector of constant coefficient, A_i is the $n\ x\ n$ time invariant matrix of parameters and $e_t\ is\ k\ x\ 1$ vector of the error term. The VAR approach developed by Sims (1980) establishes the extent to which variables are integrated. The VAR models treats all variables to be symmetric and hence no need to specify endogenous and exogenous variables (Tsay,2015). Any VAR model can be re specified as a VECM. The VECM is a form of a VAR with restriction. The restrictions are imposed when the data series is non-stationary but cointegrated such that the VECM incorporates the cointegration restriction information into its specifications (Enders, 2010). The VECM is that represented as follows:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \cdots + \Gamma_{t-k-1} + \pi \Delta Z_{t-1} + e_t \qquad (4)$$

$\Gamma_i = (1 - A_1 - A_2 - \cdots - A_k)(i = 1,2, \dots, k-1)$ and $\pi = -(1 - A_1 - A_2 - \cdots - A_k)$.$\pi$ matrix is a $3X3$ matrix if we assume three variables in $Z_t = (V_t, W_t, X_t)$.The π matrix contains information with regards to the equilibrium relationships among variables. It shows the extent to which any deviation in the previous period is being adjusted to equilibrium in the long run. e_t denotes the vector of residuals. In the VAR model, we assume that π has a reduced rank such that $\pi = \alpha\beta'$. α denotes the speed of adjustment to equilibrium coefficients. β' denotes the matrix of long run coefficients.$\beta' Z_{t-1}$ becomes the error correction term if we decompose $\pi - \alpha\beta'$.

3.3.2 Granger Causality

If variables are found to be cointegrated, then according to Granger (1969) there must be causality running from at least on direction between variables. The Granger causality test by Granger (1969) suffers from both spurious regression and bias hence Toda and Yamamoto (1995) and Dalado and Lutkepohl (1996) (TYDL) developed the Modified Wald Test (MWALD). The TYDL granger causality test is done within the VECM as it imposes restrictions on the estimated parameters and mitigate on the shortcomings of the standard Granger causality test. The first stage in the TYDL is to identify the appropriate lag length (k) and (d) which is the maximum order of integration of the variables to be used in the model. Assuming that there are three variables and according to an ADF test variables are found to be I(0), I(1), I(1), the $d(max)$ will be given by 1. The information criterion determines the appropriate lag length within the VAR framework. The second stage proceeds to apply the standard Wald test, confining parameters of the $k - th$ appropriate lag order of the VAR. The null hypothesis states that there is no causality between variables and the alternative that states that there causality between variables.

3.3.4 Impulse Response Function and Variance Decomposition

The impulse response function (IRF) and the forecast error variance decomposition (FEVD) are useful innovation tools used in examining integration of variables within a VAR framework (Enders,2008). The IRF helps to uncover the time path of various shocks emanating within from the VAR model on the variables. The forecast error variance decomposition helps to uncover the interrelationship among variables within a VAR system. The variance decomposition indicated the proportion of the movement in a sequence due to its own shocks against shocks of other variables (Enders, 2008).

3.3.5 Markov Regime Switching VECM

The Markov switching model is designed for nonlinear data series which are subject to regime shifts. The Markov switching VECM model provides with insightful information to solve structural problems and financial volatility issues as well as to understand the financial and economic dynamics within a data series. This study closely follows the methodology adopted in (Phoong, Ismail & Sek, 2014)[1]. Phoong et.al (2014) conducted an empirical investigation the movement of stock market index in 4 Asian countries using a MS-VECM model.

Assuming two states, the MS (2)-VECM (1) is given by the following formula:

$$\Delta \boldsymbol{z} = \boldsymbol{v}(\boldsymbol{s_t}) + BECM_{t-1} + A_1 \Delta z_{t-1} + u_t \tag{5}$$

where B denotes the error correction term, A_1 denotes the coefficient vector and $u_t \sim NID(0, \Sigma(s))$, $s_t = 1,2$ corresponds with state 1 and state 2. The transition probability matrix is thus given by:

$$P = \begin{pmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{pmatrix}$$

4. EMPIRICAL RESULTS

4.1 Descriptive Statistics

[1] Krolzig, Marcellino & Mizon (2002) ; Cramon-Taubadel & Ihle (2008) ; Idier (2008)

A preliminary analysis in table 1 of summary statistics for the stock market returns reveal that Egypt, Mauritius and Tunisia have the highest mean. The rest of the stock markets also reveal positive average monthly returns with Kenya having the least mean (0.0044). The variability of relative stock markets is measured with standard deviation. Relative to other stock markets, the Egyptian stock market is the most volatile as seen by the highest standard deviation (0.0928). Furthermore, the summary statistics show the excess kurtosis and skewness. The excess kurtosis and skewness statistics measures suggest evidence against normality. Our preliminary finding is consistent with previous findings and we observe that stock market returns exhibit negative market skewness except for Morocco and Kenya (Claver, Dinga, Louis, Felix & Gabriel, 2019 and Gourene et al, 2019). All stock markets exhibit excess kurtosis, NSE20 has the highest kurtosis whereas TUNINDEX has the least kurtosis.

Insert Table 1 about here

4.2 Unit Root Test

Table 2a and 2b presents the statistical unit root test results based on both the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test. According to table 2a he ADF and PP test report that at level, all variables are non-stationary and hence contain a unit root. However, when differenced once according to table 2b, the series become stationary since at all levels of significance the actual values are smaller than the McKinnon's critical values since they are more negative than the critical values. This means that the variables are integrated of the same order I(1).If variables are I(1), the next step is to check if they are cointegrated.

Insert Table 2a about here

Insert Table 2b about here

4.3 JOHANSEN COINTEGRATION TEST RESULTS

Prior to performing a cointegration test, the appropriate number of lags has to be determined. Table 3 below suggests the selected lags denoted by (*) for the (AIC), (SC) and (HQ). The selected lags have the smallest value for each criterion. While the SC and HQ suggest 1 lag, the AIC suggests 2 lags. We consider using 2 lags according to the AIC for subsequent analysis and manipulation of further results within this study.

Insert Table 3 about here

The presence of any cointegrated vectors is assessed to ascertain probable linkages and interrelationships among the variables. Table 4 summarizes the Johansen cointegration rank summary. The data shows that there are at least two cointegrating vectors according to the trace statistics. According to the maximum eigenvalue statistic, all specification indicates at least one cointegrating except for the no-intercept no-trend specification.

Insert Table 4 about here

Empirical findings of the cointegration between our selected stock markets are presented in Table 5. According to both the trace and maximum eigenvalue statistics, we reject the absence of cointegration between our selected stock markets. The trace statistic at the 5% level suggests 2 cointegrating vectors between our selected stock markets whilst the maximum eigenvalue statistic, also at the 5% level, suggests at least one cointegrating vector. This implies an existence of an equilibrium relationship between the South African stock market and selected African stock markets. These findings have a very important implication for global investors willing to invest in these stock markets. A weak form of cointegration suggests that these stock markets jointly offer potential gains for diversified portfolio investments at all time scales.

Insert Table 5 about here

4.3.1 Long Run Results

Having established the existence of cointegration, the study explains the dynamics within a linear VECM model. The study is more interested in explaining the long run relationships between South African stock markets with the rest of the selected stock markets. The linear VECM estimates are represented in the equation 6. The numbers in brackets are t-statistics values and if the absolute values are greater than 2 then the estimated coefficients are significant.

$$lalsi = -15.4107 + \underset{(-5.2795)}{1.6785}\, legx - \underset{(2.1280)}{1.1802}\, lmasi + \underset{(-3.8210)}{2.1555}\, lnse - \underset{(2.7381)}{1.4488}\, lnse_{alsi} - \underset{(1.0554)}{1.0715}\, lsemdex + \underset{(-0.0031)}{0.0022}\, ltunindex \qquad (6)$$

The results are for the long run estimates are presented in table 6. In the long run ceteris paribus, Egypt, Kenya and Tunisia positively affect the South African stock market. The coefficients are statistically significant for Egypt and Kenya except for Tunisia inferring that the coefficient for Tunisia is not statistically significant in explaining the change in the dependent variable. Morocco, Mauritius and Nigeria impact the South African stock market negatively ceteris paribus. Both the $lmasi$ and $lnse_{alsi}$ are statistically significant in explain any change in the dependent variable except for $semdex$. This contrast to the results found by Kapingura et al. (2014) who found the impact of Egypt, Nigeria and Mauritius to be negative and insignificant.

The results for the error correction model are given in table 7. As expected, the error correcting term is negative and statistically significant. Should there be any drift from equilibrium temporarily in the short run, the error correcting mechanism induces the market into long run equilibrium. The adjustment factor for South Africa is given by -0.0032.This means that only 0.32% of the deviation from long run equilibrium induced by a short run disturbance is corrected in one month. The error correcting mechanism is rather slow in inducing long run equilibrium.

Insert Table 6 about here

Insert Table 7 about here

4.3.2 Causality Test Results

The VECM alone cannot fully explain the dynamics between the 8 stock markets under study. The study therefore explores more on the relationship by using the Toda -Yamamoto Procedure of Granger causality. Results of the Granger causality test from table 8 indicate that there is a unidirectional causality running from Egypt, Kenya, Nigeria and Mauritius to the South African stock market. However, there is no causality either way between South African and Morocco or South Africa and Botswana. Furthermore, there is no causality running from the South African stock market to any of these stock markets except for Tunisia. Moreover, there is no evidence of causal link from Tunisia stock markets to South Africa.

Insert Table 8 about here

4.3.3 Variance Decomposition

The variance decomposition results are presented in table 9 and the forecast horizon is monthly. The influence of past ALSI shocks dominates in the short term but gradually declines into the long run. However, the ALSI is largely affected by its own innovation and contribute to about 60% of its own forecast error variance in the long run. The influence of BSEDCI, EGX30, NSE_ALSI and MASI in explaining fluctuation in the ALSI appear to be very minimum in the short term but dominates after the 100thth period. The three contribute to about 40% of the ALSI forecast variance error variance in the long term. Their forecast error variance dies away, and they are also practically insignificant in explain the fluctuation of the ALSI. The influence of NSE and SEMDEX in explaining fluctuation in the ALSI increases insignificantly throughout the entire period whilst the TUNINDEX fades away into the long run. The NSE, TUNINDEX and SEMDEX contribute to about 2% of the ALSI forecast error variance in the long term.

Insert Table 9 about here

4. 4 MARKOV REGIME SWITCHING VECM

4.4.1 Estimation Results

The conventional p value and the Davies (1987) upper bound for the p value, the linearity test rejects the linear VECM model. This motivates the use of a Markov regime switching VECM model. The desired model is based on the nature of data as well as the optimum interval hence the use of 2 regimes in a MS (2)-VECM (1) to describe the relationship between the South African stock market and selected African stock market indices.

We assume two regimes where regime 1 is the high growth state and regime 2 is the slow growth state. Regime 1 is characterized by a major upward movement of the stock market, highest persistence probability and low volatility. Regime 2 on the other hand is associated with a depression in the stock market as investors are rather pessimistic about the investment prospects and is characterized with low returns and high volatility. Table 10 presents the transitional probabilities. Given information from table 11, the transitional probabilities are represented as a matrix of p as follows:

$$p = \begin{bmatrix} 0.881 & 0.119 \\ 0.488 & 0.512 \end{bmatrix}$$

The results of transition probabilities between the regimes where ALSI is the dependent variable in the estimated model MS (2)- VECM (1). The probability of switching from regime 1 to regime 2 is given 0.119 comparatively the probability of switching from regime 2 to regime 1 is 0.488. Moreover, there is a higher probability of regime 1 staying in the same regime state (0.881) compared to regime 2 staying in the same regime state (0.512). Regime 1 appear to be more stable and persistent compared to regime 2. The expected duration that the ALSI stays in the growth state and recession state respectively is 9 days and 2 days. This implies that the South African stock market stays in the growth state slightly longer than in the recession state.

Upon examining the estimation results from table 10, it can be concluded that regime 1 is the low volatility regime since the variance is lower comparatively to the regime 2 (higher volatility regime) with higher variance. The constant term is higher is regime 2 compared to regime 1 but in both instances significant.

Insert Table 10 about here

One of the objectives of this study is to see the asymmetrical adjustments towards the long-run equilibrium across the two regimes. According to the estimates of the short run correction parameters in Table 10, we observe that the adjustment of ALSI is negative as expected in both regimes and exhibit significantly asymmetricity in both regimes. More specifically, the speed of ALSI adjustment to long-run equilibrium is quicker under low-volatility regime.

The parameters in the estimated model have varying effects across regimes. In some instances, parameters have reversed signs, or the influence is either significant or insignificant across regimes. The estimation results indicate a feedback relationship between the ALSI and BSEDCI, EGX, MASI, NSE, NSE_ALSI, SEMDEX and TUNINDEX. The ALSI index have a significant negative influence on its own variable in regime 1. Moreover, the BSEDCI, MASI and SEMDEX have a positive and significant influence on the ALSI whilst the EGX, NSE, NSE_ALSI and TUNIDEX have a negative and significant influence on the ALSI. Only the ALSI and SEMDEX have a positive and significant on the ALSI in regime 2. The BSEDCI, EGX, NSE and NSE_ALSI, SEMDEX and TUNINDEX have a negative influence on the ALSI but the SEMDEX and TUNINDEX appear to be insignificant in influencing the dependent variable. The insignificant coefficients therefore cannot explain any changes on the ALSI.

The stability of the South African stock market is investigated using smoothed probabilities of the dependent variable being in one of the two regimes. Figure 1 presents the graphed smoothed probabilities in regime 1 and regime 2. The time path of smoothed probabilities exhibits many structural changes in the data set between February 2002 and July 2018. Most notably, we identify short and long recession period between February 2002 and July 2018. During the 2000s the system stays in the high volatility regime following the world energy crisis. Following the 2007-2009 global financial crisis, the smoothed probability indicates that the system stays in regime 2 with high probabilities suggesting erratic fluctuation in stock markets and investor's pessimism during this period. April 2010 to June 2011 is also identified as a short recession period post the global financial crisis. However, following post crises the system takes an adjustment course and switches to the low volatility regime. These findings indicate that the system corrects itself to normality for most of the post crises periods

Insert Figure 1 about here

4.4.2 Impulse Response Functions

The IRF shows the responses of the dependent variable to Cholesky standard innovation from independent variables within the MS-VECM model. Figure 2 shows the response of the ALSI to innovation from other African stock market indices over 22 periods. All shocks appear to be significant as they lie within the upper and lower bands of significant in both regimes. Results reveal that a one positive standard deviation shock (innovation) to the ALSI appears to have little no significant response on itself in regime one but slightly increase in regime 2 until period two thereafter it returns to its steady state. Similarly, a one positive standard deviation shock to the EGX30 and MASI results in a slight positive increase in the ALSI index until the 2nd period in both regimes. Thereafter the ALSI index hits its steady state. Furthermore, the results indicate that a one positive standard deviation shock to MASI, NSE and TUNINDEX have no influence on the ALSI in regime 1. A one positive standard deviation shock to BSE_DCI initially has no significant influence on the ALSI in regime 1. In regime 2, one positive standard deviation shock to BSEDCI initially results in a decrease in the ALSI. After the 2nd period, it grows steadily until the 22nd period before it reaches its steady state. Thereafter, the ALSI index returns to its steady state in the positive region. Again, a one positive standard deviation shock to the NSE results in a sharp positive increase in the ALSI in regime 2 until the 4th period, thereafter, it reaches its steady state. The ALSI responds to a one positive standard deviation shock from NSE_ALSI, MASI and TUNINDEX by a very insignificant increase in the negative region until the 3rd period. After the 3rd period, it hits its steady state value.

Insert Figure 2 about here

4.5 MODEL COMPARISON

The log-likelihood for the MS-VECM is larger compared to the log likelihood for the linear VECM. The model regime switching VECM is derived by adding more properties to the linear model. As expected, the information criterion for the two models are closer to each other since the Markov regime switching VECM nests VECM properties. The AIC, HQ and SC are smaller for the MS-VECM when compared to the linear VECM. Based on these results from table 9 we can deduce that the MS-VECM fits the data well and performs better.

Insert Table 11 about here

5 CONCLUSIONS

The study fills the gap in limited research focusing on African stock market integration. The main purpose of this study was to empirically determine stock market integration among African stock market and subsequently examine the long run relationship between the South African stock market and selected African stock markets. The results suggest that cointegration among these African stock markets is incomplete hence the stock markets are not fully integrated. These results concur with finding by Dahalan (2012) who found a weak cointegrating relationship among African stock markets. The study incorporated the regime switching VECM to explain the long run relationship between the South African stock market and selected African stock markets. The estimated parameters have varying effects across regimes. In some instances, parameters have reversed signs, or the influence is either significant or insignificant across regimes. The regime switching VECM are compared using the log likelihood and the information criterion. Results suggest that the regime switching VECM better fits the data well and performs better than the linear VECM.

The cointegrating results indicate that integration is incomplete hence there exists opportunities for diversified investment for investors. International investors are probing for such markets with higher than average diversified returns since diversification allows hedging hence minimizing risk inherent within a portfolio. Similar implications appeal to South African investors and portfolio and fund managers who stand a chance to reap diversified benefits that accrue from investing in these selected African stock markets. The results also confirm that foreign direct investment and foreign portfolio investment inflow will increase much to the beneficial of the South African economy through investment in sectors such as communication, energy and the industrial sector. This will have the effect of strengthening the South African rand thereby reducing the dependency of South Africa on foreign debt, reducing imports of capital items and promoting a favourable budget. Moreover, this will also help boot foreign exchange reserves which of late have been decreasing substantially for South Africa.

Economic integration in Africa has become a very important topic over the years to an extent that is no longer a matter of choice. The African Development Bank highlights that intra-African trade is the lowest of all global regions at approximately 15%, compared to 54% in the North American Free Trade Area, 70% within the European Union and 60% in Asia. Given this, it goes without saying that despite the implementation of such reforms to promote complete integration across Africa, African stock markets are far from being integrated. It therefore, become imperative for policy makers and authorities to intensify their efforts in implementing common standards promoting the stock markets integration and trade between African stock exchanges (Fish & Biekpe 2002).

The proposed model for Africa is that of linear market integration, resulting in stepwise integration of goods, labour and capital markets, and ultimately monetary and fiscal integration. The preliminary phase will be a free trade area then a customs union, a common market, and then the integration of monetary and fiscal matters to establish an economic union. Capital market particularly, stock market integration between South Africa and other African countries could be beneficial as it can lead to the development of African stock markets and institutions, boost liquidity across Africa, increases competitiveness, reduce costs and encourage innovation across Africa, and provide institutions and investors more financing opportunities.

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Table 1

Group Descriptive Statistics

	LALSI	LBSEDCI	LEGX	LMASI	NSE	LNSE_ALSI	LSEM	LTUNIN
Mean	0.0087	0.0059	0.0177	0.0059	0.0044	0.0062	0.0090	0.0095
Median	0.0107	0.0040	0.0207	0.0024	0.0063	0.0032	0.0089	0.0073
Maximum	0.1313	0.1384	0.3126	0.2053	0.2798	0.2430	0.1538	0.1252
Minimum	-0.1503	-0.1070	-0.3148	-0.1175	-0.2057	-0.2782	-0.2056	-0.1426
Std. Dev.	0.0447	0.03270	0.0928	0.0419	0.0639	0.0704	0.0417	0.0360
Skewness	-0.3232	0.2418	-0.2310	0.4975	0.3883	-0.0706	-0.4642	-0.2065
Kurtosis	4.0748	6.3038	4.2627	5.3573	6.3618	4.3240	8.8244	5.0617
Observations	198	198	198	198	198	198	198	198

Note: LALSI, LBSEDCI, LEGX, LMASI, LNSE, LNSE_ALSI, LSEM and LTUNIN represents logged returns for the 8 selected African stock exchange indices in real form.
Source: The results are author's own computation based on the INET BRIDGE database

Table 2a
Unit Root Results (Level Series)

	ADF			PP		
Variable	**Intercept**	**Trend and intercept**	**None**	**Intercept**	**Trend and intercept**	**None**
ALSI	-0.9845	-1.9617	-2.200	-0.9600	-1.7522	2.4338
BSEDCI	-1.8506	-0.1640	2.3160	-1.9300	-0.4444	2.1300
EGX	-2.3882	-2.0687	2.5942	-2.6000	-2.0715	2.5624
MASI	-1.7057	-1.0680	1.7305	-1.7110	-1.0270	1.8000
NSE	2.6308	-1.8016	0.9331	-2.6151	-1.7500	0.9621
NSE_ALSI	-2.4574	-2.1187	1.1327	-2.4200	-2.0940	1.1127
SEMDEX	-2.3684	-1.2638	2.7490	-2.4730	-1.4050	2.6804
TUNINDEX	-0.1840	-1.1950	4.0803	-0.1778	-1.2440	3.9470

Source: Author’s own computations

Table 2b
Unit Root Results (First Difference Series)

	ADF			PP		
Variable	**Intercept**	**Trend and intercept**	**None**	**Intercept**	**Trend and intercept**	**None**
ALSI	- 64.0075***	-64.0024***	-63.9423***	-64.3358***	-64.3327***	-64.1876***
BSEDCI	-17.9349***	-18.0600***	-16.4575***	-79.6120***	-79.2367***	-80.1522***
EGX	-57.4551***	-57.4910***	-57.3256***	-57.5230***	-57.6265***	-57.4029***
MASI	-50.1322***	-50.1547***	-50.0858***	-50.0292***	-49.9800***	-50.0858***
NSE	-36.6070***	-36.6854***	-36.5913***	-47.7725***	-48.3548***	-47.8821***
NSE_ALSI	-41.2380***	-41.2594***	-41.2174***	-64.1354***	-64.1345***	-64.1607***
SEMDEX	-27.9818***	-28.0633***	-27.8024***	-52.7223***	-52.6380***	-53.0904***
TUNINDEX	-38.1423***	-38.1387***	-37.8513***	-51.5906***	-51.5851***	-52.0006***

Note: Source: Author's own computations
*, **, *** imply 10%, 5%, 1% significance level respectively

Table 3
Lag Length Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	325.1149	NA	4.99E-12	- 3.32058	-3.18435	-3.2654
1	2582.576	4302.177	5.29E-22	-26.2888	-25.06277*	-25.79217*
2	2665.714	151.476	4.34e-22*	-26.48915*	-24.1734	-25.5512
3	2717.077	89.27962	5.00E-22	-26.3568	-22.9513	-24.9774
4	2764.604	78.63124	6.03E-22	-26.1843	-21.689	-24.3635
5	2815.247	79.54391	7.13E-22	-26.0445	-20.4594	-23.7823
6	2874.122	87.54185*	7.82E-22	-25.9908	-19.316	-23.2872
7	2914.931	57.26104	1.05E-21	-25.748	-17.9834	-22.603
8	2947.452	42.90742	1.58E-21	-25.4183	-16.564	-21.8319

LR: Likelihood ratio, FPE: Final Prediction error, AIC: Aikaike Information Criterion, SC: Schwarz Criterion, HQ: Hannan-vfc Quinn Criterion, * optimal lag length.

Table 4
Johansen Cointergration Rank Summary

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	2	2	2	2
Max-Eig	0	1	1	1	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 5

Johansen cointegration test results

Hypothesized no of CE(s)	Eigenvalue	Trace Statistic	0.05 CV	Max-Eigen Statistic	0.05 CV
None*	0.0243	214.2033*	159.5297	106.0447*	52.3626
At most 1	0.0089	125.6154*	108.1586	38.6651	46.2314
At most 2	0.0058	69.4936	95.7537	24.8893	40.0776
At most 3	0.0044	44.6042	69.8189	19.1074	33.8769
At most 4	0.0026	25.4969	47.8561	11.4021	27.5843
At most 5	0.0019	14.0947	29.7971	8.1882	21.1316
At most 6	0.0014	5.9066	15.4947	5.8798	14.2646
At most 7	0.0000	0.0268	3.8415	0.0268	3.8415

Note: Trace test indicates 2 cointegrating equations at 5% significance level* denotes rejection of the null hypothesis at 0.05% level, Max – Eigen test indicates 1 cointegrating equation(s) at 5% significance level.* denotes rejection of the null hypothesis “there is no cointegration equation” at 5% significance level , Critical values (CV) from MaKinnon-Haug Michelis p-values. The lag-length criteria of the AIC used in this study suggested that the lag-length = 2.