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The status quo of East African stock markets: Integration and volatility

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This paper presents the current stock markets' situation of East African markets compared to Johannesburg Stock Exchange (JSE). The study uses weekly price indices of Kenya, Tanzania, Rwanda, and Uganda, South Africa as a performance benchmark for the African market. The period used is from 17th January 2008 to 31st March 2017. The stock indices' returns results show in general that there is relatively moderate-to-low volatility. The Dar-es-Salaam stock index and the Johannesburg stock index show a higher volatility relative to the other stock market indices with the JSE showing the highest return of 0.117089 when compared to the East African market indices. The Vector Autoregressive (VAR) and Granger causality results capture the linear interdependencies among the given markets and illustrate that JSE has a low contributory impact on the returns on the East African markets. Besides, evidence shows that East African markets are independent, thus offering regional diversification benefits. However, integration is still underway.

Key words: East African stock markets, stock market integration, vector autoregressive, Johannesburg stock exchange, correlation coefficient, volatility.

INTRODUCTION

Less attention has been put on the African Stock Exchange Market, as this market is considered fragmented and full of risk (Alagidede, 2008). This attribution poses risk on the African market, as many investors get reluctant in venturing these markets. Therefore, in order to attract investors in the African market, a higher degree of financial African market integration should be achieved in the future. Integrated markets have a positive impact on the cross-border capital inflows and a decrease in the cost of capital that enhance the investment opportunities in the given markets (Boamah, 2016). Due to the rapidly changing structure in the financial markets, during the post financial-crisis period, some studies like that of Caporale and You (2017) have proven the convergence in these markets that show the high degree of integration in these markets; consequently, low diversification opportunities. Therefore, investors try to find opportunities to invest abroad and realize the benefits of diversifying in other markets, like in the East African markets, due to the positive market trends in these markets in relation to the Gross Domestic Product (GDP) changes and growth

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opportunities in these markets over the years. Hence, there is a need to investigate volatility and co integration of East African stock markets regionally (in East Africa and using South Africa as a performance benchmark for the African region), and then examine which markets are least integrated and less volatile, and come with the most diversification chances.

According to Ncube and Mingiri (2015), integrated stock markets appear to be more efficient and effective as compared to fragmented stock markets due to the ease of flow of information and low transaction costs. Furthermore, it is worth mentioning that discrepancies between stock market indices offer good possibilities for international investors to diversify in African markets. Alagidede (2008), who investigated the linkage between African stock markets and the other stock markets in the world, has also proved the fact that integrated stock markets are more efficient than segmented markets.

Financial integration can be advantageous for East African economies by improving information sharing among the financial institutions across East Africa. It can also enhance liquidity by providing companies and consumers more financing options, which results in increased competitiveness on the international stock market. Nevertheless, there are risks that arise from stock market linkages, for instance contagion (Roman et al., 2016). Wongswan (2003) defines contagion as surfeit conditional correlations among countries' asset returns that cannot be explained by economic fundamentals or systematic risks.

However, there is a risk of market disruptions when one market is affected by a crisis. Researchers like Xiong and Han (2015) illustrate volatility spill over effects between foreign exchange and stock markets in their work. Therefore, volatility spillover effect reflects the variable's second moment relationship, in which market volatility is influenced not only by its own early stage, but also by volatility coming from other markets (Xiong and Han, 2015). International investors interested in diversifying in East African stock markets will carefully observe the trend of stock returns before making any investments. Hence, volatility plays a key role in measuring the stocks' riskiness using standard deviation.

According to Alagidede (2008), volatility is a metric that indicates stock returns' deviations from the mean or average return. Thus, the higher the volatility, the riskier the investment on the security. The trend of volatility in East African securities is mostly outlined by illiquidity of the markets, operational inefficiency and the size of the markets (Alagidede, 2008). This study ascertains the interdependencies between the East African Area (EAA) stock markets, which include the Nairobi Securities Exchange (NSE), Uganda Securities Exchange (USE), Dar-es-salaam Stock Exchange (DSE), and Rwanda Stock Exchange (RSE) as well as to uncover diversification opportunities within the region. There is a gap in the literature concerning a comparison between

the best performing African Stock Exchange with regional stock markets like the East African Area stock markets. Johannesburg Stock Exchange (JSE), South Africa, is the most pronounced stock exchange in Africa, thereby, expressing the performance benchmark in African stock markets. This study therefore, contributes to the global financial integration literature. The stock return behaviour illustrated in this paper, would be useful for academic research, for regulators and for investors interested in venturing East African markets.

Furthermore, this paper also explores volatility in stock returns and the causal relationship between East African markets and Johannesburg Stock Exchange. The study implements weekly data from 7th January 2008 until 8th April 2017. Therefore, the following research questions are introduced:

1). Is the East African stock markets affected by the shocks and changes from the Johannesburg stock market?
2). Is there a relationship between East African stock markets and Johannesburg stock market?
3). Is the stock market movements related to each other in reference to volatility of stock returns?

Defining capital market integration

Capital market integration is a situation where prices in different markets move together. Price co-movements are exhibited by the correlation between the returns in each market (Lumenga-Neso Mbuku, 2001). According to Lumenga-Neso (2001), assets with the same risk in completely integrated markets have comparable returns regardless of the market. Therefore, the correlation coefficient between concurrent returns in these markets can illustrate the degree of market integration. The higher the correlation coefficient, the stronger the market integration.

In addition, other researchers define capital market integration as the free movement of capital across the boundaries in a region with minimal transaction costs or friction. Therefore, there is a perfect capital mobility in integrated financial markets (Mensah, 2006). Nevertheless, there are certain pre-conditions that need to be fulfilled for a market to be defined as fully integrated. Firstly, there should be the same set of rules for all participants in the market, and secondly, the participants should have a uniform access to the set of financial instruments or services (Mobarek and Mollah, 2016). These pre-conditions are important to ensure that no market participant is discriminated in any way.

Lumenga-Neso (2001), states that, in perfect integrated markets, the expected real interest rates are similar in the markets of interest. Additionally, direct financial integration, implies the law of one price, which means that an investor can expect similar returns on investments on distinct markets after the required adjustment for risk

Table 1. List of East African Stock Exchanges and Johannesburg Stock Exchange (JSE).

Economy	Exchange	Location	Founded	Listings	Mkt cap (US $ billions)
Kenya	Nairobi Securities Exchange	Nairobi	1954	64*	18.8*
Uganda	Uganda Securities Exchange	Kampala	1997	15*	7*
Tanzania	Dar-es-Salaam Stock Exchange	Dar-es-Salaam	1997	15*	11*
Rwanda	Rwanda Stock Exchange	Kigali	2010	8*	2*
Burundi	NA	NA	NA	NA	NA
Eritrea	NA	NA	NA	NA	NA
Ethiopia	NA	NA	NA	NA	NA
Somalia	Somali Stock Exchange	Mogadishu	2011	20***	NA
South Sudan	NA	NA	NA	NA	NA
Sudan	Khartoum Stock Exchange	Khartoum	1992	NA	NA
South Africa	Johannesburg Stock Exchange	Johannesburg	1887	303	951.3**

Note. (Nairobi Stock Exchange, 2017).
*, **, ***, Reference year 2017, 2016, 2015 respectively.

and transaction costs. On the other hand, indirect financial integration attributes that the return on an investment in one country is indirectly associated to the return on investments in other countries (Lumenga-Neso, 2001). The literature exhibits three financial indicators that exemplify the level of financial market integration. First, price-based indicators, which examine the co-movement between asset prices (Fauziah, 2018), integration based on law of one price – see for example Adam et al. (2002). Secondly, quantity-based indicators which are statistical data that quantify determinants of demand and supply of investment opportunities and capture the importance and size of financial connections between countries. Thirdly, regulatory and institutional measures, which include laws and regulations, trigger the barriers across different financial markets (Perera and Wickramanayake, 2012). Some scholars use changes in returns dispersion to test the law of one price, for instance Solnik and Roulet (2000), Baele et al. (2004), Byström (2006), and Eiling and Gerard (2007). These studies show highly correlated returns move together on the up or the downside, while lower correlations depict divergence in returns.

This study adapts the price-based measures that capture disparities in assets prices across different national markets and the regulatory measures' indicators that analyse the price co-movements of different stock indices from the mentioned countries besides uncovering the rules and restrictions that hinder the allocation of financial resources across these countries. In addition, volatilities in stock market returns across the markets are compared to measure their impact in the chosen markets.

OVERVIEW OF THE EAST AFRICAN STOCK MARKETS

East African stock markets are facing some challenges that are slowing down the integration of these markets.

Political turmoil and underdevelopment in information exchange systems are some of those challenges to be overcome. The depth of the different markets in East Africa is measured by their market capitalisation and listings (Ncube and Mingiri, 2015). The upcoming part gives an insight in the development of the East African stock markets.

East African stock markets capitalisation

East African stock markets are not as striking as some stock markets in Northern and Southern Africa. Kenya has, by far, an expansive and the most advanced bond market in the region, comprising about 67% of the total outstanding government bonds in issue (African Financial Markets Initiative, 2016). Furthermore, according to Allen et al. (2011), East African markets are deemed the most illiquid markets in Africa as they hold less than 1% value in stock traded on their stock markets in relation to their GDP (Allen et al., 2011: 5). However, more support to integrate the East African Area (EAA) capital markets in order to improve their investment features is coming from the East African Securities Regulatory Authorities (EASRA). This body comprised of capital market regulators, working on legislation that will enable companies in Kenya, Uganda, Tanzania and Rwanda to float bonds within the region (African Financial Markets Initiative, 2016). Some efforts are being done to facilitate regional integration among the East African countries, which comprise of eliminating restrictions on cross-border trade and free movement of capital and services across borders (World Bank, 2014). This is, of course, a chance for EAA to integrate its stock market activities in the global market. Kenya has the oldest and most pronounced stock exchange market in East Africa compared to the other capital markets in Uganda, Tanzania and Rwanda as shown in Table 1. This Table clearly shows that Kenya has the oldest stock exchange
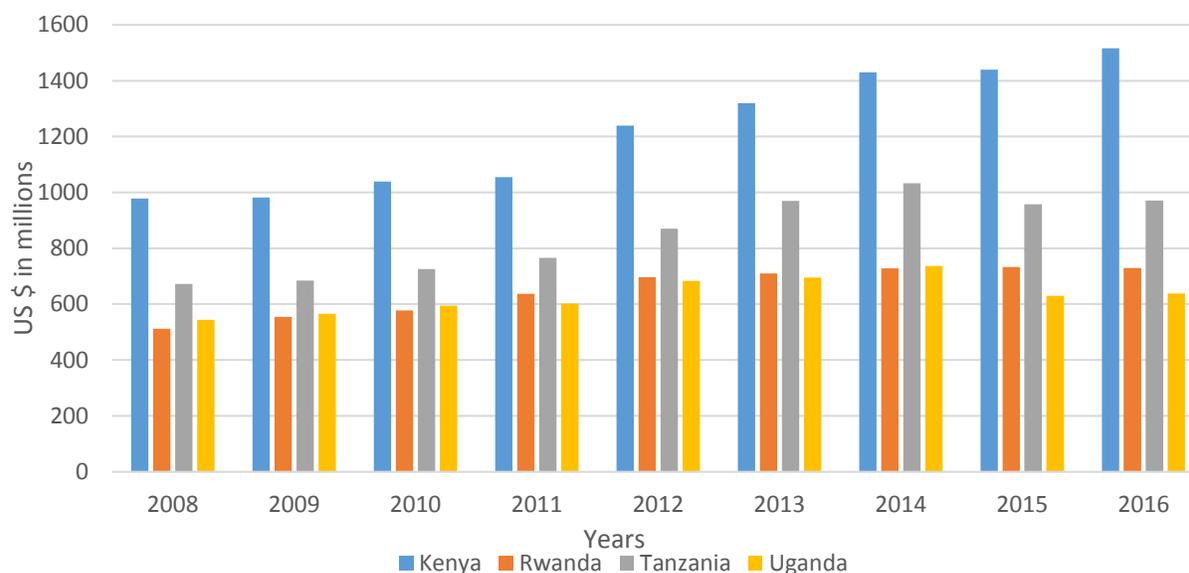
Figure 1. GDP per capita in US$, 2017.
Source: Author's own representation with IMF data, 2017.

in East Africa founded in 1954, followed by Dar-es-Salaam founded in 1996. In addition, the biggest market capitalisation[1] of around US$18.8 billion is the Nairobi Securities Exchange (NSE) of Kenya, followed by Tanzania at US$11 billion, Rwanda at just under US$2 billion and Uganda a value of US$7 billion (Nairobi Stock Exchange, 2017).

Table 1 also illustrates that South African JSE can be used as a performance benchmark for the African stock markets as it is the oldest stock market in Africa with an outstanding market capitalisation of US$ 951.3 billion (World Bank, 2016).

Features of the East African region and stock markets

East African countries are stated in Table 1. However, the countries of interest in this paper are Kenya, Rwanda, Tanzania, and Uganda due to data availability. These aforementioned countries have a total population of approximately 147 million people (International Monetary Fund, 2017). Tanzania has the highest population of around 49 million followed by Kenya with a population of around 45 million people. Tanzania ranks third with a population of around 41 million and the least population rate is in Rwanda with 12 million people. The population

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[1] "Market capitalisation or market cap is the market value of a company's issued share capital or the number of shares issued times the current price of those shares on the stock market."

in East African countries matters because of GDP per capita (Vossos, 2019). The GDP level of these countries is illustrated in Figure 1. This Figure shows a positive trend in population over the years from the year 2008 until 2016. The highest trend in GDP can be seen in Kenya, between the year 2012 and 2016 where a gradual increase from US $1239 mio to US $516 mio in GDP is noticed.

Restricted securities operations in the East African Area

Table 2 illustrates the restrictions in operations in the East African region. This table demonstrates how the markets in East Africa are yet to align their securities operations in the region to make it easier for investors to enter these markets (African Securities Exchanges Association, 2014). Local purchase by non-residents of collective investment schemes (mutual funds) is allowed in all the markets but the other security operations still need alignment. The next chapter illustrates the theoretical background of the existing literature in this area. Various scholars have researched on stock market integration concluding different results on how integrated the stock markets are.

THEORETICAL BACKGROUND OF EXISTING LITERATURE

According to Kapinguria et al. (2014), financial or stock market integration prevails in three dimensions: nationally

Table 2. Securities Operations that are Restricted in East African Community.

Securities operations	Kenya	Rwanda	Tanzania	Uganda
Foreign shares purchase by residents	Open	Open	No	Open
Local purchase by non-residents of shares	Open	Open	No	No
Participation of residents in IPO's in foreign capital markets	Open	Open	No	Open
Local sale by non-residents of foreign shares	Open	Open	No	Open
Foreign sale of shares by residents	Open	Open	No	Open
Local purchase of bonds and other debt instruments by non-residents	Open	Open	No	No
Local purchase by non-residents of collective investment schemes (mutual funds)	Open	Open	Open	Open
Foreign purchase / sale of money market instruments (debt securities)	Open	No	Open	Open

Source: African Securities Exchange Association (ASEA) Year Book Annual Report (2014).

(in a given country), regionally (in a particular region e.g. in the African region) and globally (combining different regions and countries together). Vertical integration exists between domestic markets and international financial markets (e.g. African and European markets), while horizontal integration occurs among domestic stock market segments (e.g. integration among different African markets) (Kapinguria et al., 2014). This study focuses on horizontal integration among the East African region stock markets. This is because they share the same geographical region. However, JSE is used as a performance benchmark for the African region as it is one of the pronounced stock market in Africa.

Using samples of five African stock markets with monthly data ranging from February 2000 to September 2008, Ncube and Mingiri (2015) found out that South Africa was the best performing stock market compared to Botswana, Namibia, Mauritius and Nigeria. Despite contagion risk that may arise due to stock market integration, researchers like Bracker (1999), Stulz (1999), Irving (2005), and Alagidede (2009), have proven the edge of integrated markets. These researchers imply that integrated capital markets strengthens competition, lowers the cost of information sharing among the members and enhances innovation across different institutions, thereby providing a wider range of investment products for potential international investors in the market (Yabara, 2012).

On the other hand, other researchers' findings show that highly segmented markets have an inflated level of risk, which inevitably affects the local cost of capital; affecting business financing and, hence, economic growth. The results also crystalize how the world stock markets are progressively becoming integrated (Bekaert, 1995; Bekaert and Harvey, 1995; Kim and Singal, 2000).

Some studies show that developing stock markets are less correlated with developed stock markets which may propose remarkable diversification advantages for international investors (Bekaert and Harvey, 1995; Yeoh et al., 2010; Neaime, 2012). Despite the fact that African financial markets are fast growing and becoming more significant for investors, there is still less in relation to the degree of integration and volatility of African markets with the global financial markets. Researchers like Umutlu et al. (2010) and Ali et al. (2011) have focused on the level of stock market development in emerging markets, while others like Yu et al. (2010), have studied the level of integration between different markets in Asia on a regional basis.

Various empirical research apply the co integration analysis approach to check for integration among different markets. Serletis and King (1997) and Bley (2009) explore capital market integration in European markets. Manning (2002), Yu et al. (2010) Wang and Huyghebaert (2003) exert this approach to investigate the integration in Asian capital markets. They only vary from each other in the countries used and the time period implemented in their analysis. Nonetheless, less has been said about integration and volatility in stock returns in African stock markets, especially in the East African Area.

DATA AND METHODOLOGY

The data for analysis used in this study comprises of weekly (Friday's) closing price indices of four East African countries: Kenya, Tanzania, Rwanda, and Uganda and South Africa as a benchmark for the African market. If Friday is a holiday, then Thursday's closing price is used. The period used is from 17th January 2008 to 31st March 2017 with 479 observations as generated by Eviews software. The data used is displayed in Table 3. Data on stock market indices was taken from www.tradingeconomics.com all the data sets are in local currencies and illustrated in Table 3. The missing values were catered for by interpolation.

To determine the weekly returns and volatility of stock returns, the Box Jenkins Model is implemented. The weekly stock log returns for these selected East African stock indices are calculated as follows:

$$\ln(P_t / P_{t-1}) = \text{Index Return} \tag{1}$$

The natural log difference approach is used to calculate the stock returns, where P_t and P_{t-1} are the current and previous day closing prices respectively.

Table 3. Summary of stock market data.

Country	Index	Source	Beginning date
Kenya	NSE 20	www.tradingeconomics.com	29th July 2010
Tanzania	DSE All Share	www.tradingeconomics.com	7th January 2008
Rwanda	RSE All Share	www.tradingeconomics.com	11th January 2013
Uganda	USE All Share	www.tradingeconomics.com	7th January 2008
South Africa	JSE	www.tradingeconomics.com	7th January 2008

Source: Author's own presentation.

Unit root test

The primary step in estimating the property of a time series is by conducting a unit root test. The most popular way is by using an Augmented Dickey Fuller (ADF) test. According to Arltová and Fedorová (2016), there are different models to keep in mind before running an ADF test. The three regression models are:
First, there is no constant and no trend:

$$\Delta y_t = \gamma y_{t-1} + v_t \tag{2}$$

Second, there is a constant, but no trend:

$$\Delta y_t = \alpha + \gamma y_{t-1} + v_t \tag{3}$$

Lastly, there is a constant and a trend:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \lambda_t + v_t \tag{4}$$

The dissimilarity among the three regressions is the existence of the deterministic elements, α and λ_t. Equation 2 is a pure random walk model, Equation 3 adds an intercept or a drift term and Equation 4 includes both a drift and a linear time trend. Before performing a co integration test, one has to make sure that the series are non-stationary and thus integrated of order 1. This study implements the Augmented Dickey Fuller test on the series as this seems to be the standard measure used by most scholars to perform unit root tests. The data is differenced to confirm the series order. Phillips-Peron concept is used for lag selection. The ADF test is as follows:

$$\Delta y_t = \alpha + \delta y_{t-1} + \gamma t + \sum_{i=1}^{n} \beta_i \, \Delta y_{t-1} + \mathcal{E}_t \tag{5}$$

Where alpha (α) is a constant and gamma (γt) is a time trend, which assumes that y_t will be quadratic, t is linear, and n is the final amount of lag order of the autoregressive process. The lags i.e. Δy_{t-1} are the estimators of the β_i that have t – distributions. The unit root test is performed under the hypothesis $\delta = 0$ against the alternative hypothesis of $\delta < 0$. If we reject the null hypothesis, this means that the series is stationary and if the null is not rejected, this indicates that the series is non-stationary. In the ADF test, the negative number under t-statistic is taken into consideration and the more negative it is, the stronger the rejection of the null hypothesis.

Granger causality test

Granger causality is a circumstance in which a one time series variable consistently and predictably changes before another variable (Studenmund, 2006: 431). Granger causality is essential as it enables examination of which variable precedes the other, as this is important for forecasting purposes. Granger proposed that, to check whether A Granger-caused Y, one should run:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_p Y_{t-p} + \alpha_1 A_{t-1} + \alpha_p A_{t-p} + \epsilon_t \tag{6}$$

and test the null hypothesis that the coefficients of the lagged As (the αs) are equal to zero. If we reject this null hypothesis using the F-Test, then we prove that A Granger causes Y. The application of this test means running two Granger tests, one in each direction, testing for Granger causality in both directions by testing the null hypothesis that the coefficients of the lagged Ys (αs) are equal to zero (Studenmund, 2006).

$$Y_t = \beta_0 + \beta_1 A_{t-1} + \beta_p A_{t-p} + \alpha_1 Y_{t-1} + \alpha_p Y_{t-p} + \epsilon_t \tag{7}$$

If the F-test is significant for Equation 6 and not for Equation 7, then we can conclude that A Granger causes Y. Chapter 5 introduces the results of the descriptive analysis with the unit root test results and the correlation test results.

The vector autoregressive (VAR) time series model

The Vector Auto regressive (VAR) Model is one of the most successful, flexible, and easy to use models for the analysis of multivariate time series. It is a natural extension of the univariate autoregressive model to dynamic multivariate time series. The VAR Model has proven to be especially useful for describing the dynamic behaviour of economic and financial time series and for forecasting. It often provides superior forecasts to those from univariate time series models and elaborate theory-based simultaneous equations models. Forecasts from VAR models are quite flexible because they can be made conditional on the potential future paths of specified variables in the model (Canova, 1995).

To illustrate the mechanism, this study used two lags (k=2) of each variable. Schwartz (SIC) and Akaike (AIC) Information Criterion using 2 lags in the general VAR model determined the lag length. JSE is the independent variable and the East African stock market indices are the dependent variables. The estimates of the parameters of the equation is given below in Table 4 with data series spanning from 2008 to 2017.

The output of the JSE VAR effect on the East African Market is to be interpreted in the old fashion. Of course, with several lags of the same variable, each estimated coefficient will not be statistically significant, possibly because of multicollinearity. However, collectively, they may be significant based on the standard F test. In addition, Figure 2 shows the impulse response in the given markets.

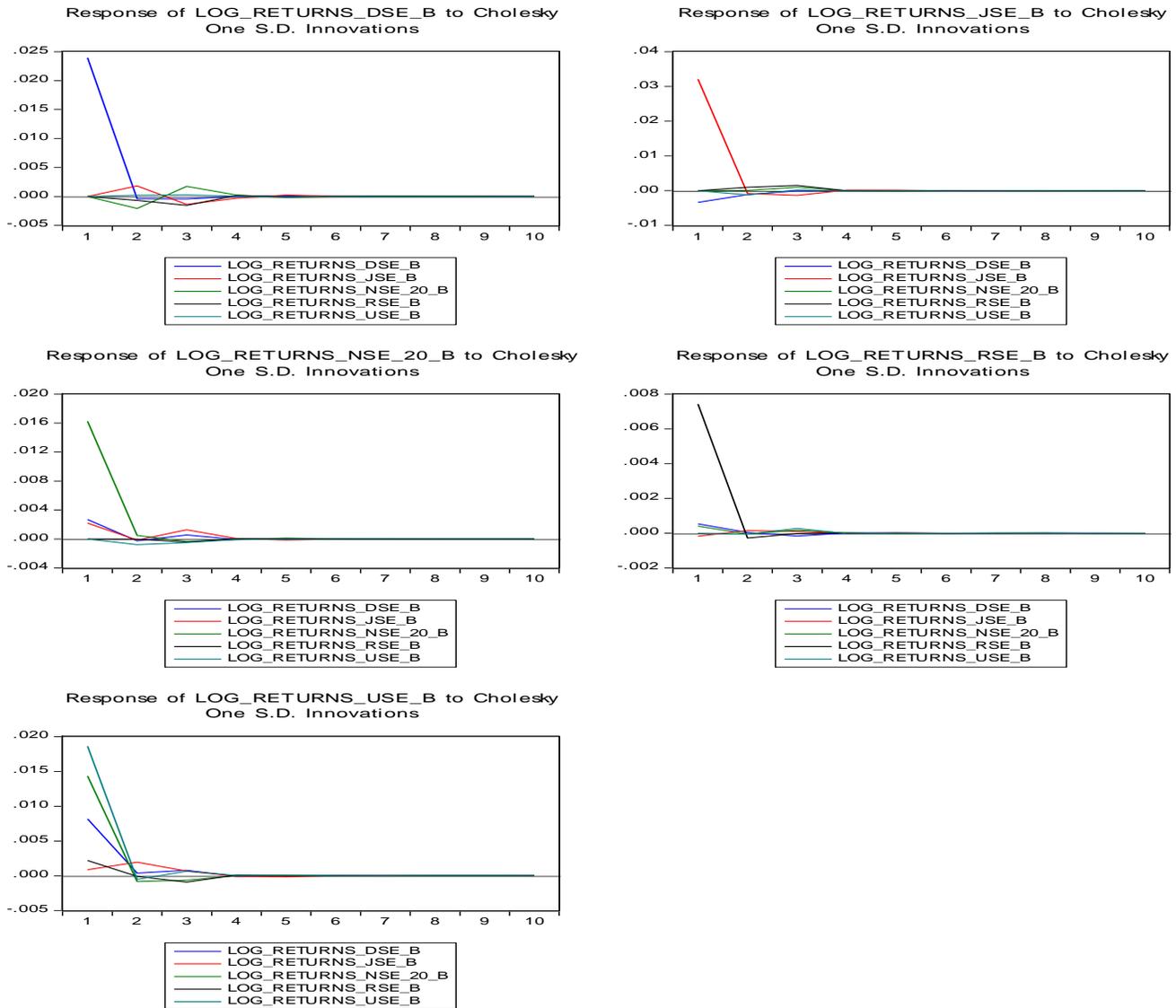This confirms the low impact of changes or shocks from the

Figure 2. The impulse response pattern of the log returns in each market.
Source: Author's own representation.

Interpretation of VAR model results

From Table 4, the coefficient of LOG_RETURNS_DSE_B at period one is 0.038 on the average. This implies that a 1% increase in the log returns of the JSE will have 0.038% negative marginal contributory on the Dar-es-Salaam stock index return. This further confirms the degree of independence in the respective stock markets with respect to return (Demirhan and Atyb, 2013). The relation is also found to be not significant as $p < 0.05$. At lag two, the contributory impact is also negative and insignificant.

Due to the idea of infinite memory of a variable and the persistence of random shocks, current values are chiefly affected by their past values over time. JSE negatively influences its period one and two past values by 0.02 and 0.03% respectively, and not significant ($p < 0.05$). The NSE 20 Index for Kenya estimate shows a

positive contributory impact of 0.058 and 0.039% and Rwanda stock index (USE) estimates shows a higher positive contributory impact of 0.150 and 0.20% compared to other East African Markets. The Uganda stock Index (USE) shows a negative and positive contributory impact of 0.067 and 0.01%.

The Coefficient of Multiple Determination (R^2) of the JSE regression equation is 0.009351 indicates the percentage of the total variations in the endogenous variable(s) that are explained by the variations in the entire lagged endogenous variable as shown in Table 4. In essence, as expected, the JSE model suggests a very low predictive power. This means the shocks or changes on the JSE stock exchange have less impact on the given East African stock markets. Figure 2 displays the response of the Johannesburg (JSE) stock index return, Uganda stock Index (UGS), Rwanda stock index (RSE), Dar-es-Salaam stock index (DSE) and NSE 20 Index for Kenya (KES) to a one-standard deviation structural innovation. Short-dashed lines show the two-standard-error confidence intervals. The discussion of the impulse response functions (IRFs)

Table 4. VAR Model parameters.

LOG_RETURNS_JSE_B	
LOG_RETURNS_DSE_B(-1)	-0.038802
	(0.06601)
	[-0.58780]
LOG_RETURNS_DSE_B(-2)	-0.020579
	(0.06588)
	[-0.31236]
LOG_RETURNS_JSE_B(-1)	-0.027825
	(0.04700)
	[-0.59206]
LOG_RETURNS_JSE_B(-2)	-0.039523
	(0.04716)
	[-0.83804]
LOG_RETURNS_NSE_20_B(-1)	0.058752
	(0.11506)
	[0.51063]
LOG_RETURNS_NSE_20_B(-2)	0.039480
	(0.11492)
	[0.34355]
LOG_RETURNS_RSE_B(-1)	0.150233
	(0.20247)
	[0.74201]
LOG_RETURNS_RSE_B(-2)	0.202995
	(0.20267)
LOG_RETURNS_USE_B(-1)	-0.067134
	(0.08002)
LOG_RETURNS_USE_B(-2)	0.010273
	(0.07982)
	[0.12870]
C	0.003713
	(0.00153)
	[2.42186]
R-squared	0.009351
Adj. R-squared	-0.011908
Sum sq. resids	0.484734
S.E. equation	0.032252
F-statistic	0.439868
Log likelihood	966.8301
Akaike AIC	-4.007673
Schwarz SC	-3.911567
Mean dependent	0.003337
S.D. dependent	0.032062

Source: Author's calculations.

mainly centres on the responses of each stock index return to their own and other shocks. Given that supply shocks and global demand shocks, as captured by global real economic activity shocks, are treated as contemporaneously exogenous to the other

Table 5. Basic statistics of weekly return for January 2008 to March 2017.

	DSE log returns	JSE log returns	NSE 20 log returns	RSE log returns	USE log returns
Mean	0.002135	0.003453	-0.001519	0.000361	-9.72E-05
Q2	0.003406	0.004812	-0.000459	0.000000	-0.00037
Max.	0.057401	0.117089	0.041358	0.060004	0.073727
Min.	-0.12455	-0.091926	-0.073559	-0.021715	-0.089015
SD	0.023977	0.032147	0.016584	0.007384	0.024872
JB	0.000000	0.000002	0.000000	0.000000	0.000226
SKN	-1.289997	0.368533	-0.563177	2.893796	-0.300454
KT	8.388958	3.892956	5.393900	23.80233	3.693041

Note. Q2= Median. SD=Standard Deviation. JB=Jarque Bera (prob.). SKN= Skewness. KT=Kurtosis.
Source: Author's calculations.

Table 6. Statistical correlation comparison between JSE and the East African Market Indices.

	DSE log returns	JSE log returns	NSE 20 log returns	RSE log returns	USE log returns
DSE log returns	1.000000	-0.102692	0.148881	0.075247	0.327303
JSE log returns	-0.102692	1.000000	0.117823	-0.029169	0.000856
NSE 20 log returns	0.148881	0.117823	1.000000	0.062329	0.615265
RSE log returns	0.075247	-0.029169	0.062329	1.000000	0.143265
USE log returns	0.327303	0.000856	0.615265	0.143265	1.000000

Source: Author's calculations.

variables in the system, it is interesting to analyse how the each index return react to their own shock (Canova, 1995).

DESCRIPTIVE ANALYSIS RESULTS

Summary statistics for the returns series are shown in Table 5. The five indices show in general that there is relatively moderate-to-low volatility. DSE index and JSE index show a higher volatility relative to the other stock market indices with the JSE showing the highest return of 0.117089 and DSE has the lowest return of 0.12455.

Consistent with theoretical market expectation, all the indices have a relatively low mean return with particular exception to NSE 20 Index for Kenya and Uganda stock index (USE), both of which produced a negative mean value implying the long-term depreciation in dividend gains in the markets. The Jarque-Bera statistic confirms that not all of the series are normally distributed which further implies that they have non-symmetric distributions. Negative Skewness for the Dar-es-Salaam stock index (DSE), NSE 20 Index for Kenya (NSE) and Uganda stock index (USE) returns points to a thicker lower tail. The asymmetric tail indicates more negative values on the left. The kurtosis statistics indicate that all the returns series are more peaked than a normal distribution. The correlation test is to essentially test the degree of relation one variable has to the other with a goal of establishing covariance to quantify how strong the returns are related

(Capital Markets Authority, 2010). This implication is displayed in Table 6.

The lowest correlation is experienced between the JSE log return and DSE. This implies that as the return on the JSE rises, DSE return falls by 10% and RSE falls by 2.9%. It would be advisable for Tanzanian and Rwandese investors to invest in JSE as the stock markets are anti-correlated for diversification purposes. The highest positive correlation coefficient is between JSE and NSE 20 Index for Kenya (NSE) hence, when JSE returns rise, NSE returns responds with an 11% increase in log returns.

Unit root test results

Two or more nonstationary time series are co-integrated if a linear combination of the variables is stationary. Therefore, the first step in the analysis is to examine each series for the presence of unit roots, to determine if the stock index return series are non-stationary. Non-stationarity is a precondition for co integration; additionally, all the series must be integrated of the same order. For this, the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) tests are applied to the levels and first differences of each series; the null hypothesis is that a series is non-stationary, so rejection of the unit root hypothesis supports stationarity (Canova, 1995). Table 7 displays the unit root results. Unit root tests are

Table 7. Unit root test results.

Order of Integration	Variable	ADF	PP
I(0)	DSE log returns	-22.31734***	-22.31315***
I(0)	JSE log returns	-22.35162***	-22.35784***
I(0)	NSE 20 log returns	-21.35959***	-21.35832***
I(0)	RSE log returns	-22.67347***	-22.68017***
I(0)	USE log returns	-22.41115***	-22.41655***

Note: ADF=Augmented Dickey-Fuller Unit Root Test. PP=Phillip-Perron Unit Root Test
I(0)=integrated at order 0 or variable at level (Author's calculations)
***significant at 1% level, **significant at 5% level & *significant at 10% level

Table 8. VAR Granger causality/block exogeneity wald tests.

Dependent variable: LOG_RETURNS_JSE_B			
Excluded	Chi-sq	df	Prob.
LOG_RETURNS_DSE_B	0.435919	2	0.8042
LOG_RETURNS_NSE_20_B	0.404684	2	0.8168
LOG_RETURNS_RSE_B	1.503983	2	0.4714
LOG_RETURNS_USE_B	0.718852	2	0.6981
All	3.356830	8	0.9100

Note. Chi-sq=Chi square. df=degrees of freedom. Prob.=probability.
Source: Author's calculations.

conducted using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests. All the variables are integrated at order 1(0), in other words stationary at level and hence no need for differencing and co integration.

Granger causality test results

We can test if the endogenous variable can be treated as exogenous. In other words, they are 'truly' endogenous. The chi-square X^2 (Wald) statistics is for the joint significance of each of the other lagged endogenous variables. Prob. is the p-value of that statistics as illustrated in Table 8. According to Table 8 above, all variables in this model are truly endogenous. Given that p>0.05, we accept the null hypothesis of exogeneity (no causality) for all the causality between the log returns of East African markets and JSE. Therefore, it was concluded that the respective returns from East African stock market indices do not Granger-cause JSE market returns.

Conclusions

This paper explores the status quo of the selected East African stock markets in relation to JSE stock index. Hence, the paper investigates the relationship and volatility between these markets and Johannesburg stock market as a performance benchmark for African stock markets. The objective of the paper is to determine if the relationship between the stock markets has an influence on volatility of stock returns in the other markets. In addition, the aim was also to find out if the shocks and changes on JSE stock market have an impact on the given East African stock Exchanges. The study implements Vector Autoregressive Model (VAR), to capture the linear interdependencies among JSE and the East African stock markets. In essence, as expected, the JSE model suggests a very low predictive power. The results in this model show that shocks or changes on the JSE stock exchange have less impact on the given East African stock markets. The less market response behaviour is justified by the impulse response function results. This id because JSE is the performance benchmark in Africa, one would expect the changes from this market to influence the other African markets, but this is not the case here. This could be because of the geographical concentration of the East African stock markets.

The Granger Causality Test results helps us to answer the question whether changes on East African stock markets have an impact on JSE. The results show that the East African markets are not truly endogenous and as such the returns from these stock markets do not Granger-cause JSE market's returns. The low market response among the given markets, show that these markets are independent. Moreover, the low correlations

among the East African stock markets offer diversification opportunities for investors in the given stock markets. It will be interesting to examine, in the future, how East African stock markets are integrated with the rest of world markets to illustrate diversification opportunities for international investors.

There is no potential conflict in this research as this research is fully supported by my employer and this is a good chance for employees to get further studies in this case, a PhD degree.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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