Journal of Economic and Financial Sciences
ISSN: (Online) 2312-2803, (Print) 1995-7076

Dynamic volatility behaviour of stock markets in southern Africa

Authors:
Tafirei Mashamba[1]
Rabson Magweva[2]

Affiliations:
[1]School of Accounting, Economics and Finance, University of KwaZulu-Natal, Durban, South Africa

[2]Department of Banking and Finance, Great Zimbabwe University, Masvingo, Zimbabwe

Corresponding author:
Tafirei Mashamba,
cfamashamba@gmail.com

Dates:
Received: 13 July 2017
Accepted: 24 Oct. 2017
Published: 18 Mar. 2019

How to cite this article:
Mashamba, T. & Magweva, R., 2019, 'Dynamic volatility behaviour of stock markets in southern Africa', *Journal of Economic and Financial Sciences* 12(1), a396. https://doi.org/10.4102/jef.v12i1.396

Orientation: The behaviour of stock market return volatility and implications thereof in Southern African Development Committee (SADC).

Research purpose: The main aim of this study was to examine leverage effects and volatility persistence in selected southern African stock markets.

Motivation for the study: To examine the volatility of stock markets in SADC which has implications on investment risk.

Research approach, design and method: The study adopted exponential generalised autoregressive conditional heteroscedasticity (1.1) model using generalised error distribution and Student's *t*-distribution.

Main findings: Leverage effects were evidenced in Namibia and South Africa. Other nations reflected mixed results depending on the error distribution assumed. Volatility persistence was noted in all nations save for Malawi.

Practical/managerial implications: Investors in Namibia and South Africa are encouraged to include leverage effects in portfolio optimisation and value-at-risk computations. Firms raising funds in these nations should be prepared to incur a risk premium as compensation to creditors for assuming high risk. As such raising capital in such nations is expected to be expensive and difficult coupled by market illiquidity, other things being equal. Except for Malawi, firms operating in other SADC nations are encouraged to hedge their operations as the level of stock market volatility is persistent and notable.

Contribution/value-add: The study focused on countries that are excluded from recent studies using current models of volatility. A comparison is therefore possible at country level and using two different error distribution assumptions which concretise the results.

Introduction

Understanding and monitoring the dynamic behaviour of risk in capital markets is very crucial in the current era where the markets are becoming highly integrated, connected and volatile. The speed of integration is accentuated mostly by the de-regulation of financial markets and milestone developments in information technology. At this pace of globalisation and integration, contagion effects, whether positive or negative, are unavoidable. With such an exposure to external influences, it is high time that financial market participants fully understand the risk they are getting themselves into when investing in stock markets. Therefore, examining the risk or volatility dynamics of asset return aids financial market participants in pricing assets (mostly derivatives), risk management, flexing capital structure and portfolio selection decision. Markets that are very volatile make the availability of long-term capital very difficult and expensive and render financial assets unattractive subsequently eroding investor confidence (Islam 2013; Treasury 2004). In addition, the detection of volatility behaviour provides an insight for a better way to design an appropriate investment strategy (Emenike 2010).

The purpose of this study is to examine the volatility features of selected southern African stock markets so as to assert the level of volatility persistence and assess the impact of return shocks or news on future volatility on the markets. Southern African nations are in dire need of long-term capital investments in areas such as energy, transport and health systems. Although investment opportunities are rife, risk or volatility, information asymmetry and lack of transparency are also highly pronounced. Thus, it is of interest to conduct an empirical investigation on stock market volatility behaviour so that the capital market and monetary authorities will factor in such features when structuring policies, costing projects and soliciting for funds.

Stylised facts

Aspects of volatility examined in this study are volatility persistence and leverage effects. Persistence in volatility refers to the degree to which future stock market volatility is a function of current volatility. Variables that exhibit significant volatility persistence actually means that once a shock is introduced into the market, it takes time to die out. In other words, it has a long memory. In the case where persistence is very low, the effect of a shock quickly dies down. Leverage effects refer to the impact of negative conditional variance shocks on future return volatility. Presence of leverage effects indicates that negative news or shocks have a higher impact on future volatility than positive shocks of same magnitude. In other words, future volatility is more sensitive to market downswings than upswings, meaning that there is a negative relationship between current market returns and future volatility. This implies an asymmetric reaction of volatility to past returns, where volatility is rising more rapidly when returns are negative than positive (Aydemir, Gallmeyer & Hollifield 2006; Owidi & Mugo-Waweru 2016). As indicated by Avramov et al. (2007), leverage effects are a result of uninformed traders selling in the downturn and fall in equity value leading to more debt in the capital structure, thus risk to equity holders and the firm (Black 1976; Christie 1982).

Understanding these two volatility features assists in risk management, value-at-risk (VAR) calculation, hedging strategies formulation and portfolio selection decisions. Engle (2004) noted that the presence of leverage effects (if not accounted) leads to significant underestimation of VAR. Therefore, modelling volatility improves the usefulness of measuring the intrinsic value of securities, and in the process, it becomes easy for a firm to raise funds in the market (Emenike 2010; Rodríguez 2010). On the same note, the presence of leverage effects results in more returns demanded by stock market investors as a compensation for uncertainty or risk. Its absence is a signal to investors not to expect any compensation for holding stocks that are highly leveraged (high debt levels in the capital structure). Nevertheless, literature on stock market volatility behaviour in southern African stock exchanges is scant, hence the need to carry out an empirical study on the same. Contrary to most studies which examined volatility behaviour of single stock market (Emenike 2010; Niyitegeka & Tewari 2013; Oskooe & Shamsavari 2011; Wan, Cheng & Yang 2014), this study looked at five Southern African Development Committee (SADC) nations, thereby providing room for an in-depth comparison. Understanding dynamics of stock return volatility will guide security exchange authorities like Committee of SADC Stock Exchanges (COSSE) in developing measures that would dampen price volatility, thereby increasing stock market stability and soundness.

Recent developments on the stock markets under study

The stock markets under study, namely Zimbabwe, South Africa, Zambia, Malawi and Namibia, are members of the African Securities Exchanges Association (ASEA) and COSSE. ASEA is a continental institution propagated to promote sustainable development of African capital markets and to facilitate an increase in market access at the regional level, promoting linkages among African exchanges (ASEA 2015). COSSE is a formal organisation of securities exchanges of SADC that was set up in 1997. It has 10 members, namely the exchanges of Botswana, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. It forms part of SADC structures as it has a formal status under the SADC Finance and Investment Protocol. The objectives of the COSSE among others include the following: increasing market liquidity; promoting the development of efficient, fair and transparent securities markets within the SADC region; and encouraging the transfer of securities markets' intellectual capital and technical expertise among the member countries of COSSE.

Johannesburg Stock Exchange (JSE) in South Africa is the largest exchange on the continent in terms of capitalisation. It is fully automated and trades in bonds, shares and derivatives. Such a development goes a long way in hedging risks and promoting market efficiency since the price of the financial assets is approximately its fundamental value. In 2003, it established the Alternative Exchange platform for small-to-medium companies to list on a regulated exchange (ASEA 2015). JSE participants are assured of an integrated market that encompasses listing, trading, clearing and settlement across all products, overseen by advanced market surveillance. The exchange is unique in its ability to conduct equity market surveillance and supervision to individual client level on a real-time basis. For five consecutive years, the JSE has been ranked first for 'Regulation of Securities Exchanges' by the World Economic Forum Global Competitiveness Survey, up to and including the 2014–2015 report. Such a robust framework promotes market efficiency and transparency, which subsequently leads to large trading volumes and highly liquid exchange, other things remaining constant.

Namibia Stock Exchange (NSE) was launched in 1992 and is the second largest exchange in Africa by capitalisation, although it is still about to set up a Centralised Securities Depository (CSD), formalise bond and derivative trading, and demutualise. Namibia is a member of the Southern African Customs Union (SACU) which is a 'monetary union' using rand as their trading currency. Such integration is likely to promote and enhance 'spill-over' effects among member states. Namibia had peaceful elections during 2014 and continues to be a stable investor friendly destination. The enhancement of the governance landscape has positively positioned Namibia on the African investment scene and resulted in the deepening of the Namibian capital markets as it opens its market to a larger international investing pool.

The Lusaka Stock Exchange (LUSE) began operations in February 1994. Its formation was directly linked to the economic reforms and liberalisation of the Zambian economy that began in 1991, a key feature of which was the privatisation of state-owned enterprises. The stock market trades in equity and

debt instruments. The equity market has two tiers – the listed or main board, and the quoted or second tier market (ASEA 2015).

Malawi Stock Exchange is generally marred with chronic economic challenges and domestic government borrowings which stifle capital market performance. Malawi stock exchange, which is thinly traded, is still to adopt the CSD system. In December 2014, the exchange held a second financial literacy week under the theme 'Building a Financially Literate Nation' in the capital city, Lilongwe. In order to stimulate activity on the market, the Stock Exchange continues to hold sensitisation workshops throughout the country on stock investment and listing opportunities on the Exchange. Despite such general economic challenges such as high inflation and interest rates, increased domestic government borrowing coupled with the food uncertainty, the market continues to attract foreign portfolio investors. Liquidity remains a challenge as investors maintain a hold strategy coupled with marginal floats in some counters.

The now Zimbabwe Stock Exchange (ZSE) is one of the oldest exchanges in Africa and is a member of the following associations: ASEA, SADC, COSSE and the Sustainable Stock Exchange initiative (SSE). The securities commonly traded on the bourse include common stock, preferred stock and convertible debt instruments. Short selling is permitted but prior authority is sought from the ZSE Ltd. Margin trading is not practised on the exchange. Trading on the exchange was once suspended by the Central Bank in November 2008 and re-opened on 19 February 2009 when all the indices were rebased to 100 after the adoption of the multi-currency system. Since the introduction of multi-currency regime in Zimbabwe in 2009 February, the ZSE underwent a notable development phase to enhance investor confidence and market efficiency. Punctuating the phase includes demutualisation, automated trading and dematerialisation of securities (CSD). This process is expected to improve investor confidence, and it brings more transparency and efficiency compared to the paper form which was punctuated by forgery, certificates loss, mutilation and theft.

Literature review

Studies carried out examining the impact of current return shocks on future stock markets volatility reached divergent conclusions. Oskooe and Shamsavari (2011) studying the Iranian stock market rejected the asymmetric volatility hypothesis indicating that good and bad news (current shocks) of the same magnitude had similar impact on the future volatility levels on Iran stock exchange. These findings agree with the results obtained by Bahadur (2008) using the Nepalese stock market data; Jayasuriya, Shambora and Rossiter (2009) analysing mature and emerging markets; Cheng, Jahn-Pavar and Rothman (2010) considering stock markets in the Middle East and North Africa; and Niyitegeka and Tewari (2013) analysing South African stock exchange. Such results drive home the point that positive shocks and negative shocks both have the same effect on future volatility (Ndwiga & Muriu 2016). The absence of leverage effects can be attributed to price limits restrictions, call over market systems and the absence of overreaction (under-reaction) to bad news and under-reaction (overreaction) to good news.

In contrast to the above findings, Cermeño and Suleman (2014) examining Latin America stock markets noted significant evidence indicating that negative shocks to these markets increase volatility of stock returns to a greater extent than positive shocks (thus attesting to the presence of leverage effect). The same conclusions were made by Coffie (2015) after modelling and forecasting conditional variance on Ghana implying that negative shocks or news lead to higher next period variance than positive news of the same size. These findings concur with the findings made by Ortiz and Arjona (2001) who noted the existence of asymmetric effects in Argentina, Brazil, Venezuela, Mexico, Chile and Colombia over a 5-year period. The returns in these countries were all heteroscedastic, asymmetric, skewed and leptokurtic thus supporting the existence of special features in financial returns. Similar conclusions were made by Abdalla and Winker (2012) having studied stock market volatility in Sudan and Egypt.

On the extreme end of the spectrum, Coffie (2015) empirically investigating the stocks listed in Nigeria evidenced the existence of reverse volatility asymmetry meaning that positive news has greater effect on volatility than negative news of the same magnitude. This concurs with the results obtained by Wan et al. (2014) examining the stocks listed in China. This indicates the existence of positive correlation between current return and future volatility of stock returns. Emenike and Aleke (2012) looking at Nigeria stock exchange for the period 1996–2011 noted the existence of reverse volatility asymmetry indicating that positive news produces higher volatility in the immediate future than negative news of the same magnitude in Nigeria. Further studies by Ogum, Beer and Nouyrigat (2005) established that Nairobi Stock Exchange is characterised by positive and significant asymmetric volatility signifying that positive shocks upsurge volatility more than negative shocks of similar scale in Kenya. Other authors who asserted the existence of reverse volatility asymmetry and volatility persistence include Saleem (2007), Emenike (2010) and Aliyu (2011).

Given the parallel views and empirical findings from previous studies, it becomes crucial to examine the behaviour of volatility in equities listed southern Africa where the need for long-term capital investment is dire and risk disposition significant. This will aid a lot in assessing and hedging risk positions of investors and management thereof.

Data and methodology

The data used in this study were obtained from Bloomberg database. Some SADC stock exchanges had few observations warranting their exclusion from the study. For example, Botswana was dropped from the study because the available

TABLE 1: Indices used and data range.

Index used	Market represented	Period (data range)
Johannesburg all share index	South Africa	Jan 2000 to Dec 2015
Malawi all share index	Malawi	Jan 2000 to Dec 2015
Namibia overall index	Namibia	Jan 2000 to Sept 2009
Lusaka all share index	Zambia	Jan 2000 to Dec 2015
Zimbabwe industrial index	Zimbabwe	Feb 2009 to Dec 2015

Source: Researcher's design based on Bloomberg data.

data covered only 5 years. Mozambique and Swaziland were dropped because of significant non-trading. The study made use of daily index returns over the period January 2000 to December 2015, save for Malawi and Zambia where weekly data were used (because of absence of daily data). The study made use of stock market indices as indicated in Table 1.

Market price indices were transformed to daily returns using Equation 1 below (Ndwiga & Muriu 2016):

$$R_t = log\left(PI_t \Big/ PI_{t-1} \right) \qquad \text{[Eqn 1]}$$

where R_t is the index return, PI_t is the price index at time period t, and PI_{t-1} is the price index at time period t–1 or simply one period lagged equity price indices.

As asserted by Niyitegeka and Tewari (2013), many financial econometrics models use variance and standard deviation as a measure of uncertainty or risk. In most of these models such as autoregressive moving averages (ARMA), variance is assumed to be constant through time (homoscedasticity). Empirical evidence, however, has rejected this homoscedasticity assumption. Tripathy and Gil-Alana (2010) contend that stock market return volatility tends to be time varying, and volatility tends to appear in clusters indicating that large shocks are followed by large shocks and small shocks followed by small shocks in either sign. A technical term given to this phenomenon is autoregressive conditional heteroscedasticity (ARCH) or simply the ARCH effect. In short, financial asset returns tend to be not normally distributed, auto-correlated in variance and exhibit variance which is clustered, asymmetric and changes with time (Emenike 2010). In analysing financial asset risk, it must be noted that the existence of these features makes conditional variance models more suitable. Models put forward to represent the evolution of volatility in financial returns are expected to exhibit the above properties usually observed in financial returns.

Given that stock returns are non-normally distributed and often exhibit the above stated stylised features, ARMA models may not appropriately capture stock volatility. A number of models have been developed that are especially suited to estimate the conditional volatility of financial returns, and the most well-known and frequently applied models for this volatility are the conditional heteroscedastic models. Such models have been constructed to represent dynamics of stock return volatility in an attempt to forecast it. These are ARCH model introduced by Engle (1982) and the generalised ARCH (GARCH) model propounded by Bollerslev (1986). Coffie (2015) in concordance with Nelson (1991) and Glosten, Jagannathan and Runkle (1993) concluded that the standard symmetrical ARCH or GARCH models can model three important characteristics of financial time series, namely leptokurtosis, skewness and volatility clustering, but is unable to capture the dynamics of a fourth important feature of financial time series, the leverage effect. The standard ARCH or GARCH models cannot model leverage effect because they model the conditional variance as a function of absolute past values of disturbance term.

In order to capture the asymmetric effect in modelling the stock returns volatility, the threshold generalised autoregressive conditional heteroscedasticity (TGARCH) propounded by Zakoian (1994), the exponential generalised autoregressive conditional heteroscedasticity (EGARCH) by Nelson (1991) can be used as noted by Islam (2013). For better results, it is crucial to compare the results obtained under the different return distribution setting such as the Student's t and the generalised error distribution (GED) as adopted in this study. Thus, if the conditional variance does not follow the normal distribution, the standard GARCH model could not explain the entire leptokurtosis in the sample data, and it is better to use the non-normal distributions, such as Student's t, normal-lognormal distribution GARCH models, to capture higher conditional moments.

Discussing three asymmetric GARCH extensions (namely EGARCH, Glosten-Jagannathan-Runkle-GARCH [GJR-GARCH] and TGARCH), Villar (2010) asserted that if the objective of the researcher is to estimate the underlying volatilities of returns, any of the three models give the same answer. This study adopted the EGARCH model as used in researches done by Banumathy and Azhagaiah (2015) and Coffie (2015) which is stipulated in Equation 2:

$$log\left(\sigma_t^2\right) = \alpha_0 + \beta_1 log\left(\sigma_{t-1}^2\right) + \alpha_1 \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \lambda_1 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \qquad \text{[Eqn 2]}$$

where $\left(\sigma_t^2\right)$ is the variance at time t, ε is the disturbance term, and α and β are empirical parameters determined by maximum likelihood estimation.

As commented by Su (2010), the α parameter represents a magnitude effect or the symmetric effect of the model, the 'GARCH' effect. The parameter β measures the persistence in conditional volatility after a shock in the market. The persistence of shocks to the volatility is captured by β under the EGARCH, but on other models it will be captured using different parameters. When β is relatively large, then volatility takes a long time to die out following a shock in the market.

The presence of asymmetric leverage effect is tested by the hypothesis that $\lambda_1 = 0$. The shock is symmetric if, $\lambda_1 = 0$ as such a positive return shock has the same effect on volatility as the

TABLE 2: Descriptive statistics.

Statistical measure	Malawi	Namibia	South Africa	Zambia	Zimbabwe
Mean	0.000762	0.000192	0.000196	0.000466	3.52E-05
Median	0.000000	0.000000	0.000312	0.000000	-7.86E-05
Maximum	0.147452	0.050873	0.029680	0.464576	0.105225
Minimum	-0.260459	-0.095883	-0.034519	-0.046713	-0.082677
Standard deviation	0.009509	0.009425	0.005372	0.009978	0.006447
Skewness	-7.403076	-0.750375	-0.180202	32.36355	0.506985
Kurtosis	307.5982	12.71533	6.536204	1493.254	74.44077
Jarque-Bera	8276936.	6080.257	2105.245	2.92E+08	363079.7
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1.627057	0.290163	0.782460	1.467918	0.060131
Sum Sq. Dev.	0.193060	0.134042	0.115386	0.313211	0.070909
Observations	2136	1510	3999	3147	1707

Source: Researcher's design based on Bloomberg data.

negative return shock of the same magnitude. In the case where $\lambda_1 < 0$, positive return shocks generate less volatility than negative return shocks of the same magnitude. In contrast, if $\lambda_1 > 0$, positive return shocks generate more volatility than negative return shocks (reverse volatility asymmetry). The advantage of using the logarithmic construction on the EGARCH model is that the conditional variance will be positive always, so there will be no need to impose a restriction of non-negative coefficients. It is imperative to note that the EGARCH model can be estimated using any distribution including Gaussian (normal distribution), Student's *t* and GED.

Empirical results

Following the above methodology utilising E-views 7 statistical package, the results obtained are discussed hereunder.

Descriptive statistics

In order to lay bare the nature and distributional features of the selected SADC stock markets, the researchers computed the mean return, standard deviation, 3rd and 4th moments of distribution and Jarque-Bera (using individual samples) as presented in Table 2. The Jarque-Bera statistic measures whether the variable is normally distributed or not. Looking at the *p*-value for the Jarque-Bera statistic (which is zero for all variables), we can safely reject the null hypothesis. This indicates that the variables are not normally distributed. Portfolio managers and investors are therefore encouraged to be careful when applying concepts and tests that assume normality. Such concepts include the modern portfolio theory, efficient market hypothesis and traditional finance framework.

Excess kurtosis (above 3) evidenced in all the markets under consideration suggests that big shocks of either sign are more likely to be noted. Positive skewness noted in Zimbabwe and Namibia implies that the return distribution has a long right tail implying that large positive movements in stock prices are not usually matched by equally large negative movements. The reverse can be said for Malawi, Zambia and South Africa returns which are negatively skewed. Honouring the Jarque-Bera test statistic and the corresponding *p*-values, it can be safely concluded that all the markets under study do not follow a normal distribution. The variation in the returns observed in these markets can be attributed to differences in economic and financial development which is of notable difference among the markets under study. Such variations in return can also be a function of nation specific or individual attributes such as foreign direct inflows and brown field investments which are significant in all other nations save Zimbabwe. On a positive note, small standard deviations (which is an absolute measure of risk) noted in all the markets under study indicates that risk is generally low. This can be attributed to the fact that the SADC region is generally stable politically and financial sector wise. Capital inflows into the region were promoted by the global financial crisis which negatively affected developed nations who in turn courted the SADC economies in an attempt to diversify risks.

TABLE 3: Stationarity of market returns.

Country	ADF CV at 1%	*t*-statistic	Decision
Malawi	-3.43	-15.75	Stationary in levels
Namibia	-3.43	-43.03	Stationary in levels
South Africa	-3.43	-60.85	Stationary in levels
Zambia	-3.43	-59.03	Stationary in levels
Zimbabwe	-3.43	-8.40	Stationary in levels

Source: Researchers' own computation based on Bloomberg data.
ADF, Augmented Dickey Fuller; CV, critical values.

Stationarity test results

A stationary variable gives us the green light to use stochastic models in analysing the dynamic behaviour of returns volatility over time. A unit root test examines whether a time series variable is stationary or non-stationary using an autoregressive model approach. To verify the order of integration and avoid spurious regression (in the conditional mean equation), the study adopted the common Augmented Dickey Fuller (ADF) test. The results of the ADF unit root test are presented in Table 3.

As clearly presented, all the stock markets returns were stationary in levels (integrated of order zero) implying no need for any transformation before the variables are used for model estimation.

Testing for autoregressive conditional heteroscedasticity and generalised autoregressive conditional heteroscedasticity effects

Prior to estimating an ARCH or GARCH model, it is essential to check whether there are significant ARCH effects in the error terms (Brooks 2008). If no ARCH effects manifest in the residuals, then an ARCH model is pointless and mis-specified according to Zivot and Wang (2006). What legitimises the use of ARCH family models is the presence of autocorrelation of variance or heteroscedasticity, excess kurtosis and skewness, which are prevalent in developing nations as argued by Kim (2003) and Ng (2000) and also in developed nations as concluded by Kim and Kon (1994). The Lagrange multiplier test statistic given by TR^2, where R is the sample multiple correlation coefficient computed from the regression of εt^2 on a constant and T is the sample size, was adopted in this study. The results from the heteroscedasticity test are shown in Table 4.

The results in Table 4 indicate that markets under study exhibit 'ARCH' effects. This gives us the green light to estimate a GARCH model which is appropriate only if such effects exist.

Exponential generalised autoregressive conditional heteroscedasticity test results

Estimation of EGARCH (1.1) in this study using E-views 7 resulted in the following results in Tables 5 and 6 assuming GED and Student's *t*-distribution, respectively. It must be emphasised that persistence in volatility is denoted by the parameter β and the parameter λ signifies the leverage effect.

Considering the GED distribution, all the markets under consideration indicated significant presence of GARCH effects meaning previous variance plays an important role in determining today's variance. Leverage effects (negative shocks or variance having larger impact on future returns volatility than positive news of the same effect) were noted in the stock markets of Namibia, Zambia and South Africa. The stock markets of Zimbabwe and Malawi evidenced the presence of reverse asymmetry (in which case positive shocks on stock returns have larger impact on future volatility than negative shocks of the same size). Similar findings were obtained by Kalu and Friday (2012) looking at Nigeria market and Wan et al. (2014) examining Chinese stock markets. Looking at volatility persistence in the stock markets, all the markets indicated long memory (significant persistence) except for Malawi indicating that shocks quickly die out (short memory).

Using the Student's *t*-distribution (Table 6), the GARCH effects were significant in all markets save for Zambia. Leverage effects were noted in Namibia and South Africa, whereas Zambia, Malawi and Zimbabwe indicated the absence of asymmetric volatility indicating that both positive and negative shocks on stock market returns have the same impact on future return volatility. Similar results of same effect were also noted by Cheng et al. (2010) analysing stock markets in the Middle East.

Malawi and Zambia indicated the absence of volatility persistence as their β_1 values were not that close to unity. Such a result is contrary to the results obtained by Niyitegeka and Tewari (2013) who noted the existence of volatility persistence on South African stock markets and Emenike (2010) analysing volatility behaviour in Nigeria.

TABLE 4: Autoregressive conditional heteroscedasticity effects.

Stock market	TR^2	*p*-value	Decision
Zimbabwe	37.92	0.00	ARCH effects are present
South Africa	172.83	0.00	ARCH effects are present
Zambia	9.73	0.03	ARCH effects are present
Malawi	18.56	0.01	ARCH effects are present
Namibia	5.87	0.04	ARCH effects are present

Source: Researchers' own computation based on Bloomberg data.
ARCH, autoregressive conditional heteroscedasticity.

TABLE 5: Exponential generalised autoregressive conditional heteroscedasticity results assuming generalised error distribution.

Parameter and respective *p*-value	Namibia	Zambia	Malawi	South Africa	Zimbabwe
α_0	-0.3360	-1.0000	-3.9070	-0.3011	-0.1659
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
α_1	0.0929	0.2558	0.2960	0.1426	0.0672
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
λ_1	-0.1193	-0.0782	0.1427	-0.0900	0.0090
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
β_1	0.9712	0.9248	0.6860	0.9824	0.9896
p-value	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Researchers' own computation based on Bloomberg data.

TABLE 6: Exponential generalised autoregressive conditional heteroscedasticity results assuming Student's *t*-distribution.

Parameter and respective *p*-value	Namibia	Zambia	Malawi	South Africa	Zimbabwe
α_0	-0.3130	-2.3180	-2.5876	-0.2813	-0.2148
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
α_1	0.1068	2.2040	0.3070	0.1311	0.0943
p-value	0.0000	0.1300	0.0390	0.0000	0.0000
λ_1	-0.1079	-0.7060	0.2330	-0.0940	-0.0050
p-value	0.0000	0.1300	0.3940	0.0000	0.6400
β_1	0.9750	0.7730	0.8080	0.9840	0.9870
p-value	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Researchers' own computation based on Bloomberg data.

Discussion of findings

The differences in volatility features among the markets under study are attributable to different approaches towards macro-economic stability (in both monetary and fiscal policy), tax and foreign investment policies which are not fully harmonised, lack of depth and liquidity in the stock markets and disparities in trading, clearing and settlement procedures and infrastructure. The lack of co-movement and integration among the stock markets and economies is evidenced by varied volatility behaviour.

Consistent results were obtained on the presence of leverage effects in Namibia and South Africa indicating that negative shocks on the markets will result in greater impact on future return volatility than positive shocks of the same magnitude. Similar results were also obtained by Coffie (2015),

Cermeño and Suleman (2014). Such results are acute opposite of the results obtained by Saleem (2007) and Aliyu (2011) who noted the existence of reverse asymmetry volatility. This implies that market participants overreact to negative news or shocks and under-react to positive news. Investors interested in these stock markets are encouraged to take into account leverage effects in their estimation of VAR. Firms intending to raise capital in Namibia and South Africa should be prepared to pay a risk premium as the suppliers of capital are exposed to significant uncertainty or risk. Investors interested in these markets are recommended to go beyond portfolio optimisation and consider these stylised features (skewness, excess kurtosis and leverage effects) in their decision-making process. All other stock markets indicated divergent results depending on the distribution type assumed. Findings from this study are in disharmony to such authors who noted the absence of asymmetric effects such as Oskooe and Shamsaravi (2011) examining Iran stock market and Niyitegeka and Tewari (2013) analysing South African stock markets.

Volatility asymmetry evidenced in South Africa can be attributed to a wave of few large managed divestures of local listed companies by foreign parents, shaking an investor confidence already bruised from political fallout in late 2015. As already noted, South Africa and Namibia are members of the SACU which is likely to promote transmission of economic performance among member states. Volatility asymmetry noted in the mentioned nations is also attributable to the trading activities of uninformed and informed agents in South Africa and Namibia (Avramov et al. 2007). In the former case, uninformed traders sell when stock prices fall, leading to an increase in stock returns volatility, whereas informed investors sell after stock price rises, which leads to a decline in volatility. Advancement in information technology promotes the use and abuse of data among investors. Information overload might promote overreaction especially to negative news which results in volatility asymmetry.

Malawi is the only market where volatility shocks quickly die out (absence of significant volatility persistence). This sweetener to investors promotes investor confidence, reduces the cost of capital and makes capital easily available, other things being equal. As a result of insignificant volatility persistence in Malawi, the cost of providing liquidity is likely to be small, thereby promoting the liquidity of the whole market. The remaining four markets indicated significant volatility persistence implying that shocks on the stock market take time to decay, thereby making volatility prediction possible. Persisting volatility makes investors more averse to holding stocks because of uncertainty, which in turn demands a higher risk premium to insure against the increased uncertainty. A greater risk premium results in a higher cost of capital, which subsequently leads to less private investment (Emenike 2010). Volatility persistence is attributable to market inefficiencies where investors take time to fully and correctly impound information into prices. A large body of investors in such markets means that their beliefs, forecasts and assets evaluation methods also vary greatly. This lack of consensus promotes 'noise' in the market, thereby promoting volatility persistence as diverse analysts (including necromancers) incorporate news into asset prices.

Firms in Zambia, Zimbabwe, Namibia and South Africa where volatility persistence is significant are likely unable to use their available capital efficiently because of the need to reserve a larger percentage of cash-equivalent investments in order to re-assure lenders and regulators of their stability and soundness as argued by Ndwiga and Muriu (2016). Educational workshops carried out by the stock exchange are likely to be bearing positive results as the participants are likely to be fully equipped when workshop comes to impounding information into prices. Therefore, shocks or effects of news quickly die out as the participants are fully geared up when it comes to analysing information. To add on, lack of liquidity which remains a challenge as investors maintain a hold strategy might be another reason why shocks quickly die out as the participants are incapacitated financially to implement their decisions.

Conclusion and recommendations

This study examined leverage effects and volatility persistence in selected southern African stock markets using EGARCH (1.1) model after noting that the stock market returns were not normally distributed although stationary in levels. Considering GED and Student's *t*-distribution, leverage effects were evidenced in Namibia and South Africa. As such, investors in Namibia and South Africa are encouraged to include leverage effects in portfolio optimisation and value-at-risk computations. Firms raising funds in these nations should be prepared to incur a risk premium as compensation to creditors for assuming high uncertainty or risk. Other nations reflected mixed results depending on the distribution assumed. Volatility persistence was noted in all nations save for Malawi. As such, raising capital in such nations is expected to be expensive and difficult coupled by market illiquidity, other things being equal. Except for Malawi, firms operating in other SADC nations are encouraged to hedge their operations as the level of stock market volatility is persistent and notable.

Acknowledgements

We are very grateful to Dr F. Kwenda, now a research associate, at University of KwaZulu-Natal, who assisted us in obtaining data for the study from Bloomberg database.

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

T.M. contributed to the methodology, data analysis, results, discussion and editing of the manuscript. R.M. contributed to the introduction, literature review, results, discussion, conclusion and recommendations of the study.

References

Abdalla, S.Z.S. & Winker, P., 2012, 'Modelling stock market volatility using univariate GARCH models: Evidence from Sudan and Egypt', *International Journal of Economics and Finance* 4(8), 161–176. https://doi.org/10.5539/ijef.v4n8p161

Aliyu, S.U.R., 2011, 'Does inflation have an impact on stock returns and volatility? Evidence from Nigeria and Ghana', *Applied Financial Economics* 22(6), 427–435. https://doi.org/10.1080/09603107.2011.617691

ASEA year book, 2015, *African securities exchanges association annual report and statistics 2014*, viewed 22 March 2017, from http://www.african-exchanges.org/wpcontent/uploads/2014/10/ASEA Yearbook 2014.pdf.

Avramov, D., Chordia, T., Jostova, G. & Philipov, A., 2007, 'Momentum and credit rating', *The Journal of Finance* 62(5), 2503–2520. https://doi.org/10.1111/j.1540-6261.2007.01282.x

Aydemir, A.C., Gallmeyer, M. & Hollifield, B., 2006, *Financial leverage does not cause the leverage effect*, Working paper no. 263, Society for Economic Dynamics, Edinburgh.

Bahadur, G.C.S., 2008, 'Volatility analysis of Nepalese Stock Market', *Journal of Nepalese Business Studies* 5(1), December 2008, viewed.n.d, from https://ssrn.com/abstract=1565603.

Banumathy, K. & Azhagaiah, R., 2015, 'Modelling stock market volatility: Evidence from India', *Managing Global Transitions* 13(1), 27–42.

Black, F., 1976, 'Studies of stock price volatility changes', *Proceedings of the 1976 meetings of the business and economics statistics section*, American Statistical Association, vol. 27, pp. 399–418.

Bollerslev, T., 1986, 'Generalized autoregressive conditional heteroscedasticity', *Journal of Econometrics* 31(3), 307–327. https://doi.org/10.1016/0304-4076(86)90063-1

Brooks, C., 2008, *Introductory econometrics for finance*, Cambridge University Press, The Edinburgh Building, Cambridge, UK.

Cermeño, R. & Suleman, M.T., 2014, 'Country risk and volatility of stock returns: Panel-GARCH: Evidence for Latin America´s major five', unpublished thesis, Victoria University of Wellington, Wellington.

Cheng, A.R., Jahn-Pavar, M.R. & Rothman, P., 2010, 'An empirical investigation of stock market behaviour in the Middle East and North Africa', *Journal of Empirical Finance* 17, 413–427. https://doi.org/10.1016/j.jempfin.2009.11.002

Chinareasury, H.M., 2004, 'The orange book: Management of risk-principles and concepts', *HM Treasury*, London, viewed 22 March 2017, from http://www.who.int/management/general/risk/managementofrisk.pdf.

Christie, A., 1982, 'The stochastic behaviour of common stock variances: Value, leverage and interest rate effects', *Journal of Financial Economics* 10(4), 407–432. https://doi.org/10.1016/0304-405X(82)90018-6

Coffie, W., 2015, 'Measuring volatility persistence and risk in Southern and East African stock markets', *International Journal of Economics and Business Research* 9(1), 23–36. https://doi.org/10.1504/IJEBR.2015.066009

Emenike, K.O., 2010, *Modelling Stock Returns Volatility In Nigeria Using GARCH Models* (No. 22723), University Library of Munich, Germany.

Emenike, K.O. & Aleke, S.F., 2012, 'Modeling asymmetric volatility in the Nigerian stock exchange', *European Journal of Business and Management* 4(12), 52–59.

Engle, R., 2004, 'Risk and volatility: Econometric models and financial practice', *The American Economic Review* 94(3), 405–420. https://doi.org/10.1257/0002828041464597

Engle, R.F., 1982, 'Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation', *Econometrica* 50(4), 987–1007. https://doi.org/10.2307/1912773

Glosten, L.R., Jagannathan, R. & Runkle, D.E., 1993, 'On the relations between the expected value and the volatility of the nominal excess returns on stocks', *Journal of Finance* 48(5), 1779–1801. https://doi.org/10.1111/j.1540-6261.1993.tb05128.x

Islam, M., 2013, 'Estimating volatility of stock index returns by using symmetric GARCH models', *Middle East Journal of Scientific Research* 18(7), 991–999.

Jayasuriya, S., Shambora, W. & Rossiter, R., 2009, 'Asymmetric volatility in emerging and mature markets', *Journal of Emerging Market Finance* 8(1), 25–43. https://doi.org/10.1177/097265270900800102

Kim, D. & Kon, S.J., 1994, 'Alternative models for the conditional heteroscedasticity of stock returns', The Journal of Business 67(4), 563–598. https://doi.org/10.1086/296647

Kim, S.J., 2003, 'The spillover effects of US and Japanese public information news in advanced AsiaPacific stock markets', *Pacific-Basin Finance Journal* 11(5), 611–630.

Ndwiga, D. & Muriu, P.W., 2016, 'Stock returns and volatility in an emerging equity market. Evidence from Kenya', *European Scientific Journal* 12(4), 79–98.

Nelson, D.B., 1991, 'Conditional heteroscedasticity in asset returns: A new approach', *Econometrica* 59(2), 347–370. https://doi.org/10.2307/2938260

Ng, A., 2000, 'Volatility spillover effects from Japan and the US to the Pacific-Basin', *Journal of International Money and Finance,* 19(2), 207–233. https://doi.org/10.1016/S0261-5606(00)00006-1

Niyitegeka, O. & Tewar, D.D., 2013, 'Volatility clustering at the Johannesburg stock exchange: Investigation and analysis', *Mediterranean Journal of Social Sciences* 4(14), 621–626. https://doi.org/10.5901/mjss.2013.v4n14p621

Ogum, G., Beer, F. & Nouyrigat, G., 2005, 'Emerging equity market volatility: An empirical investigation of markets in Kenya and Nigeria', *Journal of African Business* 6(1–2), 139–154. https://doi.org/10.1300/J156v06n01_08

Ortiz, E. & Arjona, E., 2001, 'Heteroscedastic behaviour of the Latin American emerging stock markets', *International Review of Financial Analysis* 10(3), 287–305. https://doi.org/10.1016/S1057-5219(01)00057-6

Oskooe, S.A.P. & Shamsavari, A., 2011, 'Asymmetric effects in emerging stock markets-The case of Iran stock market', *International Journal of Economics and Finance* 3(6), 16–24. https://doi.org/10.5539/ijef.v3n6p16

Owidi, O.H. & Mugo-Waweru, F., 2016, 'Analysis of asymmetric and persistence in stock return volatility in the Nairobi securities exchange market phases', *Journal of Finance and Economics* 4(3), 63–73.

Rodríguez, M., 2010, 'Volatility models with Leverage effect', unpublished thesis, Universidad Carlos iii de Madridm, Spain.

Saleem, K., 2007, 'Modeling time varying volatility and asymmetry of Karachi Stock Exchange (KSE)', *International Journal of Economic Perspectives* 1(1), 1–14. https://doi.org/10.2139/ssrn.964898

Su, C., 2010, 'Application of EGARCH model to estimate financial volatility of daily returns: The empirical case of China', unpublished thesis, University of Gothenburg.

Tripathy, T. & Gil-Alana, L., 2010, 'Suitability of volatility models for forecasting stock market returns: A study on the Indian National Stock Exchange', *American Journal of Applied Sciences* 7(11), https://doi.org/10.3844/ajassp.2010.1487.1494

Villar, M.R., 2010, 'Volatility models with leverage effect', Doctoral thesis, Universidad Carlos III De Madrid.

Wan, D., Cheng, K. & Yang, X., 2014, 'The reverse volatility asymmetry in Chinese financial market', *Applied Financial Economics* 24(24), 1555–1575. https://doi.org/10.1080/09603107.2013.818208

Zakoian, J.M., 1994, 'Threshold heteroscedasticity models', *Journal of Economic Dynamics and Control* 18(5), 931–955. https://doi.org/10.1016/0165-1889(94)90039-6

Zivot, E. & Wang, J., 2006, *Modeling financial time series with S-PLUS*, 2nd edn., Springer-Verlag.