MASTERS THESIS

STOCK RETURNS BEHAVIOUR AND THE PRICING OF VOLATILITY IN AFRICA'S EQUITY MARKETS

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SUBMITTED BY:

ONTHATILE TINY OGOTSENG

STUDENT No. 1499780

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SUPERVISOR: DR. ODONGO KODONGO

ABSTRACT

This Paper empirically investigates the behavior of Africa's stock price volatility over time in ten African equity markets. It also attempts to establish the existence of a relationship between volatility and expected returns in the chosen equity markets. The effect of volatility on the stock prices is also investigated, together with establishing variations in the stock return volatility risk premia. Lastly, an investigation of whether volatility is transmitted from international markets to African markets is also undertaken. The sample period starts from November 1998 until December 2016.

The preliminary empirical results show a mixed finding in the mean-variance tradeoff theory. Based on the GARCH-type models, the empirical results show that volatility of stock returns show the characteristics of volatility clustering, leptokurtic distribution and leverage effects over time for all the Africa equity markets. A weak relationship between volatility and expected returns is also found in all the African equity markets studied.

The results also showed that as volatility increases, the returns correspondingly decrease by a factor of the coefficient for most of the equity markets. These results negate the theory of a positive risk premium on stock indices. It was also observed that stock return volatility risk premia have variations over time. The study also established that there was volatility transmission from the international markets into Africa equity markets.

Keywords: Volatilty, GARCH-type models, Risk Premia, Volatility transmission, Africa Equity markets, EGARCH, GARCH-in-Mean.

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To My Father who art in Heaven, whom without His mercy and grace I could not exist.

I extend my special appreciation to my loving husband, my best friend and the dearest father to my son, without whom I would not know how to love and to be loved.

I thank mostly, my Supervisor Dr. Odongo Kodongo for his unwavering support his calmness, far-reaching wisdom and his patience with me throughout my journey of growth.

I acknowledge my current employer, Botswana Motor Vehicle Accident Fund, for giving me the opportunity to challenge myself more and to grow my professional path. The Best Employer indeed!

I dedicate this Paper to my amazing son, for making me a mother and to make me experience real love and all the glories of life.

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CHAPTER 1: INTRODUCTION

1.1 The Emergence of African Stock markets

The multi-year sovereign debt crisis and prolonged sluggish growth of the European economies has presented Africa with an opportunity to be recognized as the next frontier for investors. Africa's positive growth projections and its surging economy have had more investors attracted to it over the recent years. In the 2011 *Africa Attractiveness Survey*, Ernst & Young (EY) indicated that the perceptions about Africa among investors have become more distinctly positive over the long-term horizon. In its subsequent survey of 2015, EY stated that it believed that Africa now has the potential to bring about a future that would have been unimaginable a generation ago.

To harness these growth prospects, Africa's stock markets have been key in availing receptive avenues as the first points of contact with investors. Investors now confidently participate in the African financial markets, specifically, the equity market with assurance and security from the existing Stock Exchange structures.

Favorable to Stock Exchanges, is also their known power to enable businesses to raise investment capital for expansions, far better than other asset classes. Alagidede (2011) deposed that part of the expansion in financial flows in emerging markets has been brought about by the growth of equity funds dedicated to investing in publicly listed securities in developing countries. Ojah and Kodongo (2015) pointed out that Stock Exchanges provide a platform for corporations to access external capital through debt and equity issuances (primary markets) and

for holders of the issued ownership certificates to trade them in a secondary market (liquidity provision).

Hence, Stock Exchanges also give investors the opportunity to directly invest in large corporations whilst also playing a regulatory role in ensuring that they (investors) are not exploited. Inevitably, their role extends and spills over to promoting growth within an economy by boosting economic development and raising standards of living. Singh and Hamid (1992) have, in their study, observed that through equity, the corporate sector is able to contribute to the economic development in developing countries. Empirical evidence also suggests that movements in equity prices are fundamental in explaining aggregate investment behavior (Barro, 1990). The results from the study undertaken by Yartey and Adjasi (2007) showed that stock markets have contributed to the financing of the growth of large corporations in certain African countries.

The importance of a stock market particularly in transitioning economies, a status enjoyed predominantly by most African countries, cannot be overstated. However, Singh (1999) made a statement in his study about "Africa countries' promotion of stock market capitalism being a costly irrelevance which they can ill-afford." He recommended focus to be shifted to the banking industry, although noting in the same breadth that Africa's banking systems are bedeviled by state ownership which more or less caters for multi-national firms. He further noted that the inept, corrupt and political mismanagement of the banking system are inappropriate characteristics that blanket the banking system.

His arguments have since been challenged in detail by Ojah and Odongo (2011), who hold that the recommendation for the extinction of stock markets in Africa merely for the pursuit and

advancement of a banking system is not a strong enough basis. They highlight that Singh's (1999) observation that bank-based capital markets such as Germany and Japan are superior to stock-based ones, ignores the reality that these cited countries also have public equity markets. To that end, it is a legitimate locus, to recognize that the banking system and the public equity markets co-exist and they assist each other to equally play a role in providing external capital to firms.

In fact, Levine (2002) concluded in his cross-country study of differentiation growth effect of financial market-type, that there is no evidence of such differentiation. To that end, he contends that it is an unnecessary and biased exercise to sequence the financial market types within a given economy. Cho (1986) pointed out that since equity finance does not experience adverse selection to the same extent as debt finance, the credit market needs to be supported by well-functioning equity markets.

However, some of the shortfalls observed by Singh (1999) in Africa equity markets are a reality that requires practical solutions. Alagidede (2009) argued that the risk perception and institutional underdevelopment remain obstacles to the development of Africa's emerging equity markets. He recommended lessening of political and economic policy risk, and / or reducing existing barriers to movement of financial resources in order to deepen and foster integration of Africa's capital markets.

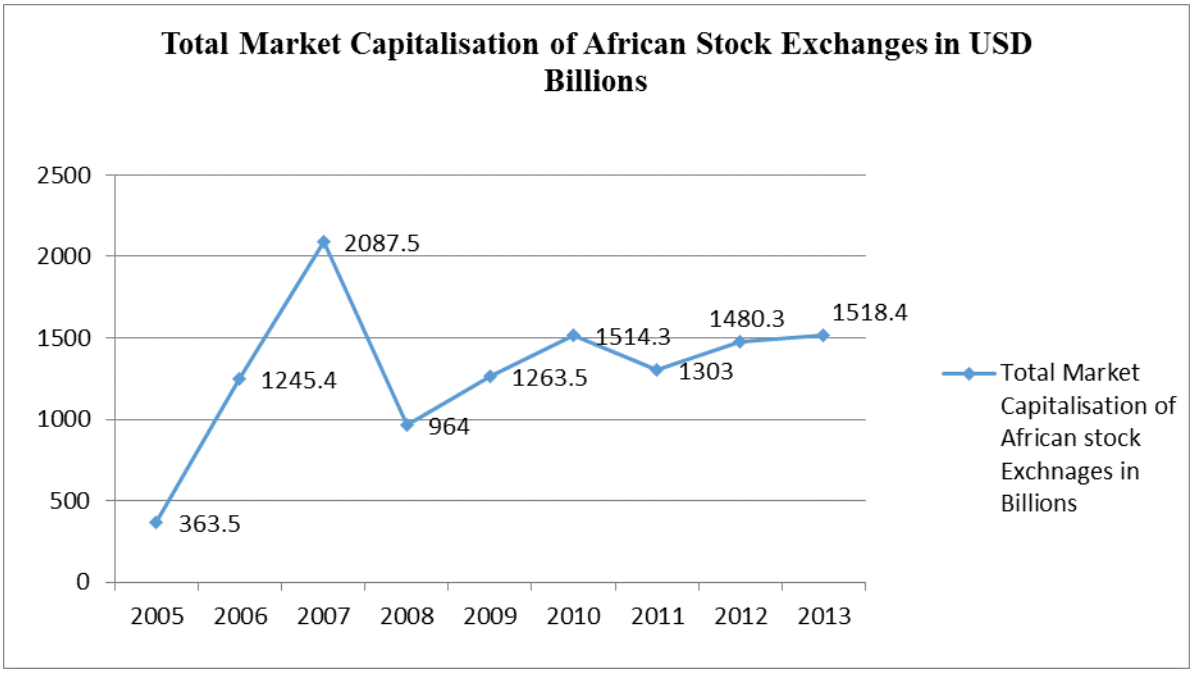
Adrianaivo and Yartey (2010) reiterated the assertion made by Alagidede (2009), citing that Africa stock markets suffer infrastructural bottlenecks, highlighting that slow trading, clearing and settlement systems hamper information production and activity turnover.

Despite the differing opinions on the relevance of equity markets in Africa, it is common cause that African markets have been experiencing an influx of investors and as a result have grown over the past decades. De Santis (1997) observes that foreign investors have shown an increasing interest in equities from developing countries. The number of active securities exchanges in Africa has since increased from seven (Egypt, Morocco, Tunisia, South Africa, Zimbabwe, Kenya, and Nigeria) in 1989 to twenty-nine, representing thirty-eight nations in 2016. In-depth Report of 2013, a publication of Applied Capital Markets Ltd, ACM-Insight, found that African frontier equity markets currently exceed their European and American counterparts by market capitalization in the Russell Frontier Index (RFI), having posted 14.5 per cent. The RFI represents investable frontier equity market and its segments and it is constructed using float-adjusted market capitalization weights.

Senbet and Otchere (2008) showed that the returns (after controlling for risk) on African markets are similar to those realized in Latin America and Asia, even when the results are converted into US Dollars. This represents unexploited opportunities for both local and international investors.

The size of African Stock Exchanges by market capitalization continues to grow, with an average annual growth of 38.8% recorded between the years 2005 and 2013.**Figure 1** distinctively discloses the trend of market capitalization of African Stock Exchanges between years 2005 and 2013.

Figure 1:



Source: *Various African Securities Exchanges and Applied Capital Markets Limited (ACM)*

From **Figure 1**, there is an outlier observed in 2007 where the total market capitalization of African Stock Markets increased by 67.6% from USD 1245.4 billion recorded in 2006 to USD 2087.5 billion. The significant increase in the total market capitalization of the African Stock Exchange can be attributable to the implementation of the financial reforms that were popularly introduced to improve efficiencies in the African stock markets. These reforms included positive legislative and policy changes, infrastructural and institutional improvements. Following the implementation of these reforms, a number of the African stock exchanges went through a remarkable transition and recorded attractive results. A notable increase was observed in Botswana's market capitalization which rose steadily from 23.1% of the Gross Domestic Product (GDP) in 2001 to 53.8% of the GDP in 2007. Nigeria also recorded a rise in its market capitalization from 12.2% of the GDP in 2001 to 51.9% in 2007.Egypt too grew its market

capitalization in 2007, attaining a peak of 106.8% of the GDP when compared to 24.9% attained in 2001. Tunisia, Namibia, Kenya and Ghana also experienced steady increases during this period.

However, in 2008, there is an observed decline in the total market capitalization of the African stock exchanges. The plummeting was attributable to the global financial crisis which originated from the United States of America.

1.2 Brief Background on Selected African Stock Exchanges

A summary of the Stock Exchanges selected for this study is indicated in *Table 1*. The study will be based on data from the stock returns of the primary indices of each respective Stock Exchange, derived from their monthly stock prices. The data sample will be selected from ten (10) African countries whose combined market capitalization is 90% of the total market capitalization for Africa equity markets.

Further, the geographical location of the selected countries is across Africa hence diverse. It represents North Africa (Egypt, Morocco and Tunisia), East Africa (Kenya) and West Africa (Ghana and Nigeria) and Southern Africa (Botswana, Malawi, Mauritius and South Africa). This selection will provide a representative sample and will accurately proxy for African Stock markets.

***Table* 1** shows a list of the African countries, their respective number of listings, market capitalization and turnover in 2014.

STOCK EXCHANGE	LOCATION	FOUNDED	NO. OF LISTINGS	MARKET CAP. (USD Billion)	Turnover ratio (%)
Botswana Stock Exchange**	Botswana	1989	35	4.4	5.2
Bourse de Tunis**	Tunisia	1969	56	9.32	9.5
Bourse de Valores De Cabo Verde	Cape Verde	2005	0	81 422 105.88	4.56
Bourse Régionale des ValeursMobilièresSA (BRVM)	Cote d'Ivoire	1998	39	11.7	2.4
Casablanca Stock Exchange**	Morocco	1929	81	53.44	5.7
Dar-es-Salaam Stock Exchange	Tanzania	1998	17	12.8	5.1
Ghana Stock Exchange**	Ghana	1990	37	20.11	537.59
Johannesburg Stock Exchange**	South Africa	1887	402	1150.5	35.2
Lusaka Stock Exchange	Zambia	1994	16		
Malawi Stock Exchange**	Malawi	1995	14	15.74	1.7
Nairobi Securities Exchange**	Kenya	1954	64	25.57	9.27
Stock Exchange of Mauritius**	Mauritius	1988	88		
The Egyptian Stock Exchange**	Egypt	1883	833	70,029,947,721.25	38
The Namibian Stock Exchange**	Namibia	1992		148.48	1.32
The Nigerian Stock Exchange	Nigeria	1960	223	61.72	11.65
Uganda Securities Exchange	Uganda	2013	3	9,492.00	0.18
Zimbabwe Stock Exchange	Zimbabwe	1948	64	4.33	10.47

***Source**: African Securities Exchanges Association (ASEA) 2014 Annual & Statistics Report*

* Turnover Ratio (%) = value traded of listed securities/market capitalization (%)
**Countries selected for purposes of this study.

Table 2 below depicts the infrastructural and institutional indicators for the African Stock Exchanges

	Market Regulator	Govt. Law	Clearing & Settlement	Settlement Cycle	Foreign Participation	International Custodian	Exchange Control	Trading System
Botswana Stock Exchange**	√	√	Manual	5	√	√	None	Manual
Bourse de Tunis**	√	√	Manual	5	√	√	None	Electronic
Bourse Régionale des ValeursMobilièresSA (BRVM)	√	√	Manual	5	√	√	None	Electronic
Casablanca Stock Exchange**	√	None	Manual	4	√	√	None	Electronic
Dar-es-Salaam Stock Exchange	√	√	Manual	5	√	√	None	Manual
Ghana Stock Exchange**	√	√	Manual	5	√	√	None	Manual
Johannesburg Stock Exchange**	√	√	Electronic	5	√	√	None	Electronic
Lusaka Stock Exchange	√	√	Electronic	3	√	√	None	Manual
Malawi Stock Exchange**	√	√	Manual	7	None	None	None	Manual
Nairobi Securities Exchange**	√	√	Electronic	5	√	√	None	Manual
Stock Exchange of Mauritius**	√	√	Electronic	3	√	√	None	Electronic
The Egyptian Stock Exchange**	√	None	Manual	4	√	√	None	Electronic
The Namibian Stock Exchange	None	None	Manual	5	None	None	None	Electronic
The Nigerian Stock Exchange**	√	√	Electronic	3	√	√	None	Electronic
Uganda Securities Exchange	√	None	Manual	5	√	None	√	Manual
Zimbabwe Stock Exchange	√	√	Manual	7	None	√	None	Manual

***Source**: African Securities Exchanges Association (ASEA) Annual & Statistics Reports*

***** √ denotes the presence of the related indicator
**Countries selected for the study

A brief description of the stock indices used by the respective Stock exchange is given below. The list and representation of the symbol for each Stock Exchange is shown in the Index of Acronyms and Abbreviations in the last pages for ease of reference.

1.2.1 Botswana Stock Exchange (BSE)

BSE was established in June 1989 in Botswana. As at the end of 2015, its equity turnover was US$ 3,032 and the total number of trading on the bourse was 12,730. In the same period, it recorded a market capitalization of US$ 421,099 and a total of 32 listed companies. BSE has three stock indices: the Domestic Company Index (BSE DCI); the Foreign Company Index (BSE FCI), incorporating companies which are dual listed on the BSE and another stock exchange; and the All Company Index, which is a weighted average of the DCI and FCI. For this study, the Domestic Company Index will be used to examine the stock return volatility. The FCI cannot be used as it was only introduced in 2004, hence there is no historical data to match the selected start period for this research work.

1.2.2 Bourse de Tunis (Tunisia)

Bourse de Tunis was established in 1969.The bourse has three (3) indices; TUNINDEX, Sector indices and TUNINDEX 20. The TUNINDEX which is a broad market return index, weighted by the free float adjusted market capitalization will be used in this study.

1.2.3 Casablanca Stock Exchange (Morocco)

Founded in 1929, Casablanca Stock Exchange is one of the oldest bourses (exchanges) on the continent. It is Africa's third largest Bourse after Johannesburg Stock Exchange (South Africa) and Nigerian Stock Exchange in Lagos.In 2015; it recorded an equity turnover of US$ 20, 488, with 130 trades. The Stock exchange which was established in 1929, recorded a total market capitalization of US$ 45,763,178,295 in 2015, and had a total of 75 equity-listed companies. The Casablanca Stock Exchange has two (2) indices; MASI Float and FTSE CSE Morocco 15 Index. MASI Float is a broad-based index comprising all shares and will be used as a proxy of the Casablanca Stock Exchange in this study.

1.2.4 Ghana Stock Exchange (GSE)

The Ghana Stock Exchange recorded a total market capitalization of US$15,030,755,263 as at the end of 20115. It had 39 listed companies and had a total of 26,937 trades during the same period. The bourse which was launched in 1990 recorded a turnover of US$ 65,167,532 in 2015. GSE has two (2) indices; GSE Composite Index (GSE-CI) and GSE Financial Stocks Index (GSE-FSI). The GSE Composite Index (GSE-CI) is calculated based on the volume weighted average closing price of all listed stocks. All ordinary shares listed on GSE are included in the GSE-CI at total market capitalization, with the exception of those of listed companies which have shares listed on other markets. This study will use it as a proxy for the stock returns of GSE.

1.2.5 Johannesburg Stock Exchange (South Africa)

Johannesburg Stock Exchange is one of the oldest bourses in Africa, having been established in 1887. In 2015, its total market capitalization was US$756,836,503,648 and had 395 listed companies on its equity market. It recorded a turnover of US$392,615,437,362 and had 61,894,253 trades in the same period. The JSE uses multiple indices. However, the FTSE/JSE Africa All-Share will be used as a market proxy when examining return volatility as it is a market capitalization-weighted index. Companies included in this index make up the top 99% of the total pre free-float market capitalization of all listed companies on the Johannesburg Stock Exchange.

1.2.6 Malawi Stock Exchange (MSE)

In 2015, Malawi Stock Exchange had a total market capitalization of US$9 362 932 with a total of 14 listed companies. Its number of trades during the same year was 1 220 and it recorded a turnover of US$410 717.56. Out of the three (indices) used in the Malawi Stock Exchange (Malawi All Share Index (MASI), Domestic Share Index (DSI) and Foreign Share Index (FSI)), this study will use MASI as a proxy as it is a market capitalization index and measures the performance of the entire market.

1.2.7 Nairobi Securities Exchange (Kenya)

Nairobi securities Exchange was established in 1954. It recorded a market capitalization of US$20 billion, with a total of 63 listed companies in 2015. Its turnover was US$2,045 and it had 406,634 trades during the same period. The NSE 20-Share Index (NSE-20) will be used as a market proxy when examining return volatility for NSE as its members represent 80% of the stock exchange's overall market capitalization. It is a price weight index and the members are selected based on a weighted market performance for a 12 month period as follows: Market Capitalization 40%, Shares Traded 30%, Number of deals 20%, and Turnover 10% and the Index is updated at the end of day only.

1.2.8 Stock Exchange of Mauritius (SEM)

The bourse which was launched in 1988 operates two markets; the Official Market and the Development & Enterprise Market (DEM). In 2015, there were 95 companies listed on the Official Market with a market capitalization of about US$ 7 billion. Its turnover was US$533,129,718 and it recorded 71,978 trades in the same year. The DEM which was launched in August 2016 has 43 listed companies valued at US$1.2 billion. For purposes of the study, the Official Market will be used by reason of the availability of data. The SEM-10 Index will be used as a market proxy when examining return volatility as its tracks the performance of the ten largest eligible stocks of the Official Market in terms of market capitalization, investibility criteria and liquidity.

1.2.9 The Egyptian Stock Exchange (EGX)

The Egyptian Stock Exchange is the oldest Stock exchange in Africa, having been established in 1883. It had a market capitalization of US$55,733 billion in 2015, with 252 listed companies. Its turnover was US$20,488 billion and it had recorded 4,871 trades in the same year. EGX has six (6) indices; EGX 30, EGX 70, EGX 100, Dow Jones EGX and Egypt Titans 2, S&P/EGX ESG and EGX 20. The EGX 30 which is the free float market capitalization weighted index is the main index and will proxy the stock returns of EGX for purposes of this study.

1.2.10 Nigerian Stock Exchange (NGSE)

Nigerian Stock Exchange was established in 1960. In 2015, it recorded a total market capitalization of US$49,456,969,735 and it had 184 listed companies. In the same year, it recorded a turnover of US$3,931,503,298 and had 917,946 trades. NGSE 2 has multiple stock price indices such as the NGSE 30 and Sector Indices. It also has an All Shares Index which includes all listings. The All Share Index which is value-weighted will be used to examine volatility as it has been maintained by NGSE 2 since 1984

1.3 Volatility of Stock Markets

Jefferies & Smith (2005) in their study observed that although many of the African markets performed well in terms of returns for investors, they are generally characterized by high levels of volatility. Stock market volatility is a common phrase that speaks to the fluctuations in stock prices and, by extension, stock returns. It is known that stock returns have a tendency to go up

one day, down the other and then up again on the third or fourth day. This fluctuation is known as the stock market volatility.

Uyaebo, Atoi and Usman (2015) stated that conceptually, equity market volatility measures the degree of variation of the current equity price from its average past values, which is synonymous with the risk level of the market.

Different authors have interpreted volatility in stock prices in different ways. Hameed and Ashraf (2006) pointed out that increased volatility is seen as indicating a rise in financial risk, which can affect investor's assets and wealth. Poon and Granger (2003), argue that volatility is not the same as risk, but when it is interpreted as uncertainty (risk), it becomes a key input to many investment decisions and portfolio creations. They state that volatility is an important variable in the pricing of securities. Substantial research that focuses on the source of volatility and whether it is explainable by fundamental or non-fundamental factors has also been undertaken in the past.

Despite the various opinions and findings, volatility remains an important issue in the stock market and though it can be dramatic, it is the one that keeps the game alive as it generates market returns and brings investors experience. In the traditional sense, volatility is the variability or the level of dispersion of stock returns from its mean. It is examined through different statistical measures, conventionally the standard deviation. The standard deviation tells how intimately the price of a stock is grouped around its mean or a moving average (MA). This is also a measure of the investment risk. The smaller the standard deviation is, the lesser the dispersion of returns and the lower the risk of the investment (Hampton, 2011).

The standard deviation method does have its critics who negate it on the basis of its lack of accuracy due to the complexity of its result analysis. It is also said to assume normality of returns when in fact, returns are leptokurtosis i.e. exhibit fat tails. Aparicio and Estrada (1997) argue that from a theoretical point of view, the normality of stock returns is questionable if information does not arrive linearly to the market, and even if it does, investors do not react linearly to its arrival. So the normality assumption leads to under-estimation of risk. It is also said to be highly sensitive to outliers in the returns data (Ley, 2013).

Chege, Othieno & Kodongo (2016) highlight that while the assumption of normally distributed asset returns allows for simple variance and covariance techniques to be employed for measuring risk, some recent studies have shown that volatility is not constant but varies with time. The traditional asset pricing models have also been faulted because they are premised on the static volatility in the distribution of asset returns.

Some previous studies show that there is a significantly inverse relationship between volatility and market performance (Crestmont, 2011*)*.As the stock market rises, volatility tends to decline and increases as the stock market falls. However, Poon and Taylor (1992) established an insignificant positive relationship between expected stock returns and expected volatility in the UK stock market, using ARCH models and daily, weekly, monthly data in the period from January 1965 through to December 1989.

Also open for further studies, is the question of equity premium (the expected return of a stock minus the risk-free rate) on the backdrop of a Stock market that is highly volatile. The empirical findings of De Santis and Imrohoroglu (1994), do not suggest that there was a positive and

significant reward-to-risk relationship in emerging financial markets. They also found no relationship between expected stock returns and conditional variance or standard deviation. These findings seem to contradict the standard implications of asset pricing theories which suggest that there is a risk premium built into equity returns.

1.3 Volatility of Stock Markets in Africa

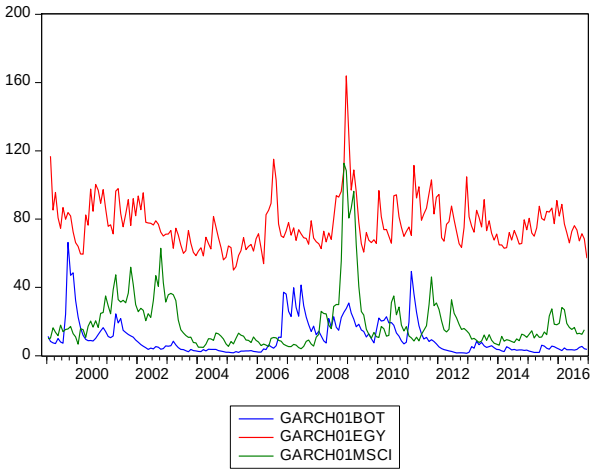
De Santis and Imrohoroglu (1997) have shown that emerging markets have higher conditional volatility. However, part of this high volatility in emerging markets can be attributed to important macroeconomic factors specific to emerging markets like political, social and economic events. Studies on African emerging stock markets (Senbet and Otchere, 2008), hold the same contention that there are risk factors that are beyond the control of the African stock markets, which largely stem from instabilities in the economic and political systems.

This study will however provide more focus on the analysis of stock return volatility in the selected equity markets.

Figure 2 presents the volatility of the selected African Stock Exchanges against the world markets which are proxied by the MSCI World Index.

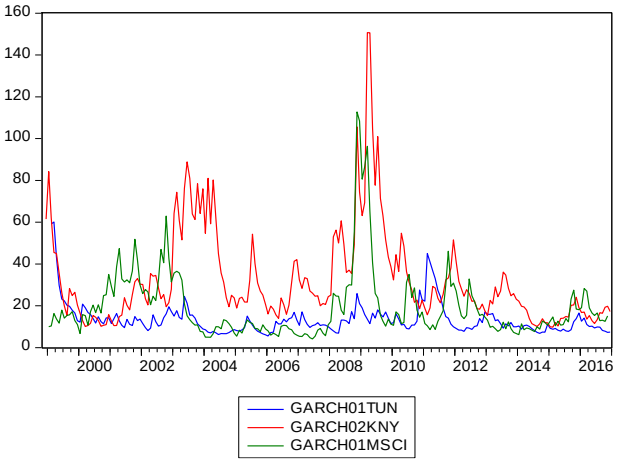
Volatility for Botswana &Egypt

Benchmarked against MSCI World Index



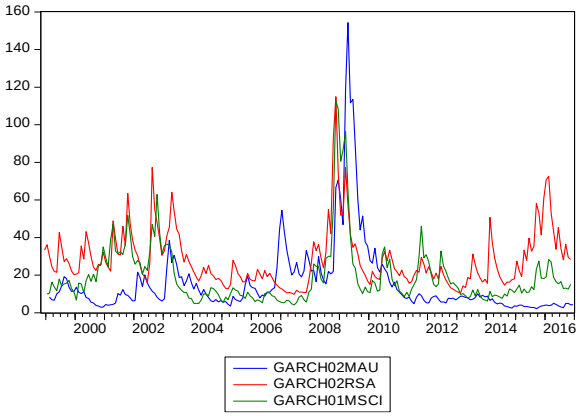
Volatility for Tunisia & Kenya

Benchmarked against MSCI World Index



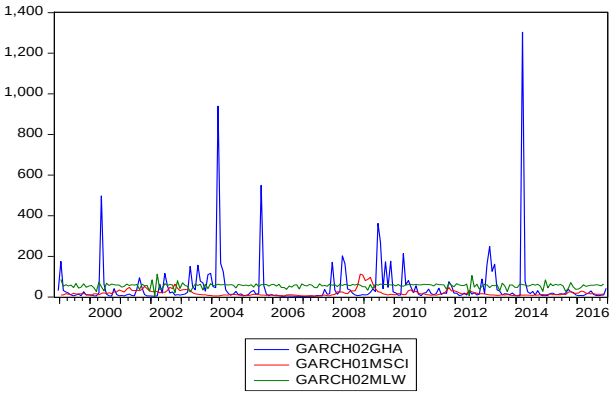
Volatility for Mauritius & South Africa

Benchmarked against MSCI World Index



Volatility for Ghana and Malawi

Benchmarked against MSCI World Index



Volatility for Morocco & Nigeria

Benchmarked against MSCI World Index

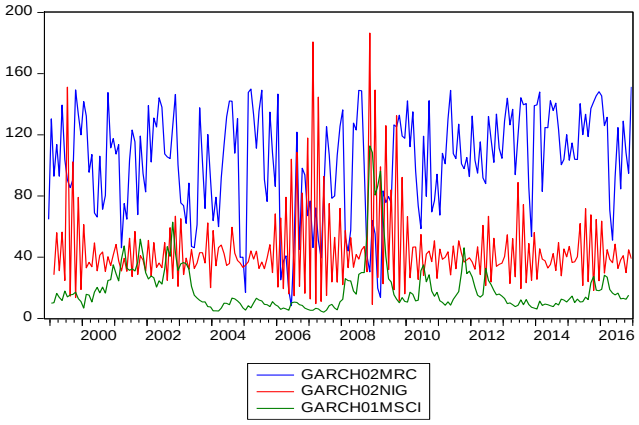


Fig.2:**The pairing of countries is merely for presentation purpose

Figure 2 illustrates the development of volatility in the ten Africa stock indices against MSCI World Index as a benchmark. The graphs illustrate that there were larger and upward fluctuations for all the indices during 2008 when compared to the previous periods between 2002 and 2006. From 2002 until 2006, almost all Africa equity markets followed the MSCI World Index well, save for Ghana which displayed extreme deviations. Although the volatility patterns for most Africa equity markets showed to follow the MSCI World Index, Egypt, Kenya, Morocco and Nigeria had higher volatility. This may in a lot of these countries, save for Kenya, be ascribed the unstable political and social landscape of each of the countries.

The equity markets were generally stable from 2002 and through to the other years until 2008 when the world was hard-hit by the economic crisis. It is quite clear from the graphs that the 2008 financial crisis significantly affected volatility in almost all the selected equity markets. Mauritius had the highest increase in its volatility than any of the selected equity markets. However, following the crisis, the equity markets appear to stabilize and they reverted to their

pre-2008 fluctuations. An inference that the economic crisis has a significant impact on the volatility can therefore be drawn.

1.4 MOTIVATION FOR THE STUDY

Empirical studies present varying results on the pricing of volatility in the stock markets in general. Poon and Taylor (1992) observed a weak relationship between risk and reward in advanced markets whilst De Santis and Imrohoroglu (1994) reported a stronger risk-reward relationship in emerging markets. Although a commonly known feature of the African stock markets is their exhibition of higher volatility than more developed economies (De Santis and Imrohoroglu, 1994), it is not clear whether volatility is priced in these stock markets because there have not been direct, relevant examination and comparative studies on the pricing of volatility in the African stock markets. This study intends to close this research gap by examining the return volatility and the pricing of equity in the selected Stock Exchanges and providing a comparative analysis to that extent.

Within the African context, there have been scarce comprehensive studies on the relationship between stock returns and stock volatility. This is despite the even more compelling reason to understand and study the phenomenon given that the African equity markets are famously known to have high stock return volatility. It is therefore imperative to examine and study this phenomenon with a view to finding out its benefits and challenges, if any, within the African equity market. Most of the studies done thus far, are confined to the examination of one or not more than five (5) specific stock exchanges in one study

This study will therefore contribute to the existing literature of stock return and volatility in African stock markets by using techniques for time series data to examine the behavior of stock returns and volatility and pricing of equity. Monthly stock prices (adjusted closing prices) from the period 1998:11 to 2016:12 will be used in the research, to investigate the pricing of volatility within the African equity returns while also investigating the variation of volatility in the stock returns over time. The study will also seek to establish the transmission or lack thereof from international markets (world market, proxied by MSCI World portfolio) to African stock markets.

Ten African countries, each providing for its equity markets have been selected for this study. The countries are also one way or the other directly or indirectly linked by fairly close business ties. The countries also provide a representative perspective as they are geographically located in various and diverse parts of Africa (southern Africa, east-Africa, north-Africa and west-Africa). The choice of the equity markets is also made on the basis of data availability and the diversity found in these stock exchanges will obviate biasness and enhance the integrity of the findings of this study.

The selected period of the data of 1998:11 to 2016:12 is adequate for the findings of this study to support the hypotheses. The chosen period pinnacles the periods of upturns and downturns in the global financial markets which inevitably impact on volatility in the stock exchanges. The selected period precedes, includes and covers the post-events for some of the major global events in the financial markets. These include the collapse of the economic bubble for dot.com or the

technology bubble in 2000, the rise in terrorist attacks from 2001 to the Iraqi War in 2003, the Middle-East unrests, the crash of the major stock exchanges which have a transmission relationship with the African Stock Exchanges such as the stock market downturn of 2002, the Chinese stock bubble of 2007, US bear market of 2007-2009. Other events which occurred during the selected period also include the global financial crises of 2007-2008, European Sovereign debt of 2010, the 2015-2016 Chinese stock market crash and the aftermath of the United Kingdom European Union membership Referendum.

Similar to other continents, the volatility of African stock markets can be ascribed to both exogenous and endogenous factors. Besides the global financial market events, Africa has had her own fair share of major internal developments and challenges. The selected period covers major political and financial shocks (positive and negative) on the financial markets. These include the prolonged political instability in Zimbabwe, post-apartheid South Africa, the Arab Spring which started in 2011, with political uprisings witnessed in certain North African countries such as Tunisia, Libya. There was also the mushrooming of trade ties between most African countries and other emerging economies like China and India, which brought about remarkable records of growth for Africa, albeit the subsequent shut-down which brought the show to an end when it caused export orders to plummet hence impacting on the price of oil, minerals and other raw materials.

The data will therefore fully capture some of the economic events and also encompass the latest economic challenges faced by African stock markets. It will also investigate the pricing of volatility and its effect on the stock returns. The hypothesis that investors are rewarded with

higher returns for taking higher market risk will also be tested (De Santis and İmrohoroğlu, 1997).

1.5 STATEMENT OF THE PROBLEM

The value of a stock and its resultant patterns observed over time remain one of the primary factors that influence investors' decisions to invest or disinvest in a stock. It is therefore necessary for investors and other stock-related professionals to understand the impact of various factors that influence a stock price. Volatility is known to be a function of a stock price hence significantly influencing the valuation of stocks. This study is therefore undertaken to earn a more comprehensive understanding on the impact of volatility on stock valuation. The problem statement is therefore cast as follows;

'Africa's equity investors need to know the extent of the factors that influence the value of stocks which they seek to invest in so that they can make appropriate investment decisions.'

1.6 OBJECTIVES OF THE STUDY

This study aims to contribute to the literature of African equity markets by examining the volatility of the return series of these markets. It will further investigate the pricing of volatility and establish whether or not it is eventually factored in the investor's rate of return (i.e. whether there is a relationship between volatility and investor's rate of return) within the African context.

Given the rate of growth of Stock Exchanges in the African markets, it is important to note the role of stock return volatility and how it is impounded in investors' required rate of return. The scope of this Paper will be restricted to these issues. The objectives of this study are as follows;

- To establish the behavior of Africa's stock price volatility over time;
- To determine whether there is a relationship between volatility and expected returns in Africa's stock markets;
- To establish the effect of volatility on the stock prices in Africa stock markets;
- To establish the variations, if any, in the stock return volatility risk premia;
- To determine whether volatility is transmitted from international markets to African markets.

The study will therefore focus its attention on the following key questions;

1. What is the behavior of Africa's stock return volatility over time?
2. Is there a relationship between expected returns and volatility in Africa's stock markets?
3. Is volatility (conditional standard deviation) priced in the Africa's equity returns?
4. Are there variations in stock return volatility risk premia over time?
5. Is there volatility transmission from international market to the African markets?

In order to appropriately answer these questions, it is necessary to consider a broad spectrum of the relevant literature regarding stock markets, which exists in both the international, regional and local arena.

CHAPTER 2: OVERVIEW OF THE LITERATURE

2.1 Behaviour of Stock Return Volatility

The behavior of stock returns is an extensively researched subject in the study of equity markets. There have been countless and inconclusive debates and vast literature exist around it. The developments in the modern finance theories such as the efficient market and the random walk have shaped up the discussions on the behavior of stock returns.

By implication, the random walk theory contends that the market is information -efficient, hence the current prices fully reflect the available information. Therefore there are no prospects for any investor to realize abnormal gains (Fama, 1970). Under this theorem, current stock prices are viewed as the best approximation of the intrinsic value of a stock. Critics of the Fama model however, argue that markets require heterogeneity (psychological and behavioural elements) so that future returns can be predicted. Consensus on these theories remains elusive and will continue to be as long as the inherent differences and limitations in the parametric and non-parametric tests that are used to test them remain.

Albeit its restrictive assumptions, Smith & Jefferies (2002) used the conventional technique of autocorrelation (also known as serial correlation) to establish the behavior of stock returns in some Africa stock exchanges. They observed a linear dependence on the stock returns for most of the stock exchanges selected for the study, save for South Africa. Their results for these selected countries; Botswana, Egypt, Kenya, Mauritius, Morocco, Nigeria and Zimbabwe negated the random walk theorem.

Theory and empirical studies have found some common characteristics, referred to as ‘stylised facts’, among the behavior of stock returns over time. These characteristics include excess volatility, heavy tails, leverage effects and volatility clustering. Stock return volatility has therefore developed into an interest area for researchers, culminating in many of its observations across equity markets in the world. Also intriguing to researchers, is one of the stylized facts of stock returns known as ‘volatility clustering’. Volatility clustering is the phenomenon that in the time series of stock returns, large changes tend to be followed by large changes of both sign and the same is true for small changes which tend to be followed by small changes over time. De Santis and Imrohoroglu (1997) observed that volatility clustering in emerging markets was similar to most developed markets, and the volatility showed high levels of persistence. Their study analyzed the dynamic behavior of stock returns and volatility in numerous emerging markets to detect the stock return volatility changing over time.

Mecagni and Sourial (1999) have examined the behavior of stock returns in the Egyptian Stock Exchange (EGX), and the relationship between returns and conditional volatility. GARCH (p,q)-M models were used to estimate for the four best known daily indices. The findings indicated the tendency for returns to exhibit volatility clustering and a significant positive association between risk and returns.

Ushad (2009) studied the volatility of stock returns in Stock Exchange of Mauritius (SME) using a standard GARCH model on daily SEMDEX returns from 1998 to 2006. The results showed

that the return series are leptokurtic, indicating a higher peak and a thicker tail than a normal distribution. However, there are limited studies on the risk-return relationship in SME.

Mandimika and Chinzara (2011) observed that in South Africa, volatility at aggregate industry and sector level was also generally persistent and there was significant evidence of asymmetry and leverage effects. Typically, rising stock prices were accompanied by declining volatility, and vice versa.

Emenike and Aleke (2012) examined the volatility of Nigerian Stock Exchange return series for evidence of asymmetric effects by estimating GARCH (1, 1), EGARCH and GJR- GARCH models. Their results showed evidence of volatility clustering and volatility persistence in Nigeria. The estimates from asymmetric models also indicated that the Nigerian equity market is asymmetric in that the stock returns and conditional volatility are negatively correlated.

Chege, Othieno and Kodongo, (2016) state that the returns on equities listed on the Nairobi Securities Exchange (NSE), have exhibited a great deal of volatility in the recent past. Their examination of the monthly returns showed evidence of volatility clustering in monthly returns, during 2002/2003 and 2008/2009 and the weekly returns plot indicated clustering in 2003 and 2007.These results are consistent with the inference that investors require larger risk premia on equities if they anticipate greater price volatility in future.

In their comparison of conditional volatility reaction to market shocks and volatility persistence alongside the asymmetric properties, Uyaebo, Atoi and Usman (2015) observed that volatility of

Nigeria and Kenya stock returns react to market shock faster than other countries included in the study, which were the US, Germany, South Africa and China..

2.2 Relationship between Expected Stock Returns and Volatility/Pricing of Volatility

The principle of risk-return tradeoff is one of the basic tenets of finance. It is based on the hypothesis that potential returns rise as risk increases. This positive relationship is assumed by the traditional asset pricing theories such as the capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965). Baillie and DeGennaro(1990) stated that most asset pricing models hypothesize a relationship between a stock portfolio's expected returns and volatility.

The hypothesis guides investment decisions and evaluation of performance of investment portfolios hence important for the investors. In support of this hypothesis, French, Schwert and Stambaugh (1987) documented that unexpected stock market returns are negatively related to the unexpected change in the volatility of stock returns. They argue that evidence of a positive relationship between expected risk premia and volatility can therefore be inferred from their finding of this negative relationship.

However, there have been recent empirical findings that challenge the risk-return tradeoff principle. Poon and Taylor (1992) have observed a weak relationship between risk and reward in advanced markets. Their study examined the relationship between the stock returns and volatility in the UK context using daily, weekly, fortnightly and monthly returns on the Financial All

Share Index. Using monthly variances and ARCH models, they showed that expected returns have a positive, though not statistically significant, relationship with expected volatility. Evidence for a negative relationship was also found when the volatility expectations were measured by the standard deviation.

Many other similar studies report that such a positive relationship is weak and almost non-existent in the US stock market (Baillie and DeGennaro, 1990; Theodossiou and Lee, 1995).De Santis and Imrohoroglu (1997) reported no evidence of risk premium for Asian countries included in their analysis. However, they observed a stronger risk-reward relationship in emerging markets.

The findings of De Santis and Imrohoroglu (1997), seemingly support the hypothesis of positive association of equity risk premium with return volatility. However, they found that exposure of emerging markets to high country-specific risk did not appear to be rewarded with high expected returns, hence negating the two measures of risk(conditional variance and conditional standard deviations) which assume that country-specific risk, should be priced.

Léon (2007) found a positive but insignificant relationship between stock market return and volatility, and established that return volatility changes over the business cycles where it becomes higher during booms. Bekaert and Wu (2000) claimed that ‘it appears that volatility in equity markets is asymmetric: returns and conditional volatility are negatively correlated’. Their findings substantially mirror the findings of Whitelaw (2000) that there is a negative correlation between stock market returns and stock market volatility.

Li, Yang, Hsiao and Chang (2005) also examined the nexus between expected stock returns and volatility for the largest international stock markets during the period 1980:01 to 2001:12. Using parametric E-GARCH-M models, their findings were analogous with most previous studies for advanced markets, showing a positive but statistically insignificant relationship during the sample period for the majority of the markets. However, when using a flexible semi-parametric specification of conditional variance, they found evidence of a significant negative relationship between expected returns and volatility in fifty percent of the sample.

Glosten, Jagannathan, and Runkle (1993) argue that across time, there is no theoretical agreement about the relationship between returns and volatility within a given period of time. They contend further that either a positive or a negative relationship between current stock returns and current volatility is probable.

The finding of an insignificant relationship between stock returns and stock volatility is mystifying, particularly for the enthusiasts of the risk-return trade off theory. Poterba and Summers (1986) indicated that though a significant impact of volatility on the stock prices can take place only if shocks to volatility persist over a long period of time, it is well documented that stock market volatility is persistent. Baillie and DeGennaro (1990), Theodossiou and Lee (1995) and Choudhry (1996), have challenged the appropriateness of using the conditional variance (as modeled by a parametric GARCH process) to proxy for risk and attribute the finding of the weak relationship to the lack of a proper measure of risk in the studies.

Hameed and Ashraf (2006) have also contributed to the literature by pointing out that the rise in the financial risk is evidenced by increased volatility. Poon and Granger (2003), draw a distinction between volatility and risk. They assert that volatility is not the same as risk, but when it is interpreted as uncertainty (risk), it becomes a key input to many investment decisions and portfolio creations.

There has also been much research on modeling and forecasting the volatility of financial returns, although few theoretical models explain how volatility comes to exist in the first place. Roll (1984) shows that volatility is affected by market microstructure. Glosten and Milgrom (1985) show that at least one source of volatility can be explained by the liquidity provision process. Baker, Bradley, and Wurgler (2011) have since argued that this empirical evidence of a weak positive nexus between stock returns and conditional variance disrupts the fundamental principle in finance that risk is compensated with higher expected return.

The literature on the volatility of stock returns in Africa is scarce. However, there have been a few studies undertaken around stock returns in Africa. While testing for the daily return series of the Botswana Stock Market, now BSE, Mollah (2007) found that the empirical results reject the null hypothesis of random walk model for the daily return series of BSE for the period of 1989-2005 and evidenced serial correlation of return series, which clearly indicate predictability and volatility of security prices of Botswana market. Mobarek (2008) observed significant volatility and persistence of both the permanent and transitory component of volatility from nonlinear model GARCH (1, 1), and Component GARCH (time varying volatility) when examining the time- series behavior of stock return in BSE.

Until recently, there have been limited studies on the risk-return relationship within the South African Stock Exchange, which is the largest and most liquid bourse in Africa. The 2015 PWC Africa Capital Markets Watch publication stated that as at 31 December 2015, African exchanges had a market capitalization of about US$1 trillion, with just 23% of this value residing on exchanges outside of South Africa. Chinzara and Aziakpono (2009) have documented that volatilities of the aggregate and four main sectors of the South African stock market is inherently asymmetric.

Bonga (2014) investigated the time-series behavior of stock returns for Zimbabwe Stock market. He found that in most cases, higher average returns appear to be associated with a higher level of volatility. The evidence from his study showed that the Industrial Stock Market has significant results whilst the Mining Stock Market shows a different behavior when testing the relationship between stock returns and unexpected volatility.

Studies on the relationship between stock returns and stock volatility within the African equity market seem to corroborate each other's findings. At least in so far as the theory of risk-return tradeoff is known to be, coupled with the inference that investors require larger risk premia on equities if they anticipate greater price volatility in future, the observations made in the studies of African equity markets mostly sustain this principle. The similarities in these findings of the studies of the various African stock markets invite an academic interest on whether these similar results indicate a possible influential relationship between African equity markets.

2.3 Volatility Transmission from International Markets

The question of whether there is volatility transmission from international markets to Africa's equity markets is also paramount in this study. The concept of volatility transmission or spillovers deals with how information is transmitted from the stock market to the foreign exchange market and vice versa. Over the years, the world has witnessed how various financial crises originating in a particular jurisdiction can potentially extend to all the other geographical areas. This signals the effects of globalization and the interrelation that exists within the financial markets. It seems almost obvious that information generated in one market can spread out to affect other markets.

The unprecedented ripple effects of the weak global financial market in Africa give further evidence to the existing inter-reliance between Africa and the global markets. Currently, African economies are also in the same wave of the struggle to recover since the 2008 financial crises, just like other global economies. In 2015, the world economy recorded flat growth across a number of regions, including Africa, resulting from the decline in the aggregate demand, lower commodity prices and the increase in financial market volatility in major economies.

Several studies have been undertaken by different researchers examining the existence of volatility transmission in different economies. With a foreign exchange perspective, the studies examine volatility transmission through financial markets. The findings from these researches will assist investors to adopt investment strategies that call for vigilance when examining information in the stock market and in the foreign exchange market.

The study of volatility spillovers between the Indian stock and foreign exchange markets (Mishra, Swain and Mahotra, 2007), showed that there exists a bi-directional volatility spillover between the Indian stock market and the foreign exchange market with the exception of S&P CNX NIFTY and S&P CNX 500. This is evidence of information transmission between the two markets. They concluded that the observation of significant bi-directional volatility spillover suggest that there is an information flow (transmission) between these two markets and both these markets are integrated with each other.

Abbas, Khan and Shah (2013) established that volatility transmission is present between friendly countries of different regions with economic links. They also found some evidence of transmission of volatility between countries which are on unfriendly terms when investigating the presence of volatility transmission between some Asian region equity markets and developed equity markets.

Emenike (2014) examined volatility transmission between stock and foreign exchange markets from January 1996 to March 2013. He observed a bi-directional shock transmission between stock and foreign exchange markets. A unidirectional volatility transmission from the foreign exchange market to the stock market was also detected, suggesting that information flow in the foreign exchange market impact the stock market and vice versa. This in turn can provide insight into investor behavior.

The integration of stock markets within Africa is a topic of interest that can further be examined as a number of lobby groups advocating for pan-African exchanges. Alagidede (2008) observed that African stock markets are not well integrated with each other. He, however found weak

stochastic trends between African markets and the rest of the world, indicating that Africa's markets tend to respond to local rather than global information. He concluded that these weak trends present an opportunity to diversify or hedge portfolio into African markets, although there is still need for reform in some areas to foster for the integration of African stock exchanges.

The papers (Humavindu &Floros, 2006; Neidhardt, 2009; Piesse &Hearn, 2005) estimated the volatility spillover effects between the Namibian Stock Exchange and the Johannesburg Stock Exchange. Humavindu & Floros (2006) analysed the integration and volatility spillovers on the Namibian and South African stock markets. They found that the two markets exhibit very low correlations, while there is no evidence of linear relationship between the markets. Furthermore, their analysis shows evidence of no spillover effects. Their results suggested that NSX is an attractive risk diversification tool for regional portfolio diversification in Southern Africa.

CHAPTER 3: DATA & RESEARCH METHODOLOGY

3.1 DATA

The research will be undertaken using the historical monthly stock returns of the main indices from the selected African equity markets. Monthly stock returns have been selected primarily because they are less approximately normally distributed. Although the assumption of normality exists, it is less when compared to daily stock returns (Fama,1970) Chege, Othieno& Kodongo (2016) stated that monthly returns appear to have better ability to reveal volatility clustering. The monthly frequency is the most popular in the stock volatility literature. (See; Poon and Taylor, 1992; Choudhry, 1996; Tah, 2013). Compared to daily stock returns and weekly stock returns, monthly returns are also fast to compute and easier to model. It is also easier to identify changes in the trends when using monthly returns.

In his studies, (Fama, 1970), made the assertion that the usefulness of the model for stock prices depends on how well it describes the relationships between average returns and risk. His view is that if the model fulfils this criterion, then the small observed departures from normality in monthly returns can be tolerated, at least until better models come along.

The stock returns will be obtained by converting the stock price indices to stock returns to eliminate non-stationarity of the data. The period of study will be from November 1998 to December 2016. The indices chosen for the equity markets are the main indices of each stock market, constructed as weighted-average indices hence are well-diversified as they account for more than 90% of total capitalization of Africa equity markets. The indices are therefore

representative of each stock market by overall market capitalization. Data will be sourced directly from the Stock exchanges or from financial databases such as Bloomberg, World Federation of Exchanges and Africa Markets.com and Yahoo Finance. Eviews 8 will be used to obtain the results.

3.2 ECONOMIC METHODOLOGY

The monthly index values will be computed to monthly returns of each series as follows:

$$\ln(P_t) - \ln(P_{t-1}) \qquad (1)$$

where P_t is the index value at time t and P_{t-1} is the index value at time $t-1$.

The logarithm of the index return is used for structural reasons such as normalization, i.e. measuring all variables in a comparative metric for ease of evaluation of relationships (Brooks, 2014). It simplifies cumbersome calculations since exponents can then be added or subtracted. Logarithms also help to rescale the data to overcome statistical problems of heteroscedasticity. It also provides equality when returns are small.

In modeling the data, an AR(p) is fitted to the return series and the residuals examined for structural defects. If the error term is independently and identically distributed, ut~iid (0, σ_t^2), it is a 'white noise' and if there are shocks in the market, their values always revert to the mean.

However, if there is evidence against iid, then the assumptions of linearity will be relaxed and the options for alternative techniques for modeling the time series increase (Mills, 1996).

After fitting the AR (p) model to the stock returns, the optimal Autoregressive Integrated Moving Average (ARIMA) models were obtained for each of the selected country based on the minimum Akaike Information Criterion (AIC) value. The AIC is based on the information theory and it gives relative estimates of the information lost when a given model is used to represent the process that generates the data. The ARIMA model selection for each of the country yielded the following results;

Table 3

Sample Country	Model Estimation
Botswana	AR(1)
Egypt	AR(1 to2) MA(1 to3)
Ghana	C
Kenya	C
Mauritius	AR (1 to 2) MA(1 to 3)
Malawi	AR(1) MA(1)
Morocco	C
Tunisia	AR(1 to 2) MA(1 to 3)
Nigeria	AR(1 to 2) MA(1 to 3)
South Africa	C

**C is the random walk

**** The actual results together with the diagnostics are provided as Appendix A at the end of the Report.**

All the selected countries follow the low order autoregressive process, with the highest order autoregressive process observed at AR (2) for Egypt, Mauritius, Tunisia and Nigeria.

The specific models and processes that will be used to determine each of the objectives identified for this study are discussed comprehensively below.

3.2.1 Behaviour of Stock returns volatility over time

In determining the dynamic behavior of stock returns volatility across time, the GARCH-type model which is a widely-documented model of time-varying volatility, will be estimated. The conditional standard deviations will be extracted and plotted over time, followed by the interpretation of the time-varying characteristics.

From the historical perspective, GARCH (Generalized ARCH) was introduced by Bollerslev (1986) and Taylor (1986). It comes from the family of ARCH-models hence it describes how the variance of the errors evolve. In contrast to the preposition of the Classical Linear Regression Model (CLRM), it does not assume that the variance is constant (Brooks, 2014). It therefore recognizes that it is unlikely and almost impractical for financial time series to have a constant variance over time. Compared to the linear structural (and time series) models, the GARCH model can capture and explain a number of stylized features of asset returns such as leverage effects volatility asymmetry) and volatility clustering, which are efficiently parameterizing by this model.

GARCH is considered to be a better model than ARCH as it is more parsimonious and avoids overfitting (Brooks, 2014). Often, it is sufficient as it incorporates much of the information that a much larger ARCH model with large numbers of lags would contain. It is also less likely to breach the non-negativity constraints.

In addition, the choice for the GARCH-type model is synchronized with conclusions from previous related studies, which have equally employed it: the premise in most financial models is that investors are rewarded for taking additional risk through higher returns as premised in most financial models (Brooks, 2014). As a result, the return of an asset is allowed to be partly determined by its risk and therefore, in the mean equation of the GARCH model there is reference to variance. Poon and Taylor (1992) observed that the GARCH-type models are common in empirical studies of stock market volatility as they can be used to model the volatility in financial series analysis. They are widely used to model mean reversion in conditional volatility.

The GARCH (1,1) process consists of two equations, the mean equation and the variance equation of the time series, which two equations are then solved to model the financial data. In order to construct the mean equation, the rate of return at time t, is modelled by using y_t, as a function of a constant mean, μ, and conditional variance, $ln(\sigma^2_{t|t-1})$ with a co-efficient δ:

$$y_t = \mu + \delta\, ln(\sigma^2_{t|t-1}) + \vartheta_t \qquad (2)$$

where $\vartheta_t = \epsilon_{t|t-1}\varepsilon_t$ is the random component of return such that $\epsilon_{t|t-1}$ is positive and $\varepsilon_t$is a

white noise process.

Under the $\mathrm{GARCH}\,(1,1)$ process, the variance equation is constructed by modelling the conditional volatility as:

$$\sigma_{t|t-1}^2 = \omega + \alpha\vartheta_{t-1}^2 + \beta\sigma_{t-1|t-2}^2 \qquad (3)$$

where $\boldsymbol{\vartheta_{t-1}^2}$ is the residual ϑ_t from equation (2).

The parameters of the $\mathrm{GARCH}\,(1,1)$ process must be non-negative ($\omega > 0$, $\alpha \geq 0$ and $\beta \geq 0$) to ensure that $\sigma_{t|t-1}^2$, (known as the conditional variance since it is a one-period ahead estimate for the variance calculated based on the relevant historical data) is positive for all values of the white noise process, ε_t.

If the co-efficient δ, is positive and statistically significant, then the increased risk results in an increase in the mean return (Brooks, 2014). This increased risk is shown by the conditional variance and can be interpreted as a risk premium. The variance is conditional upon changes in the market which occur as news or information gets updated. In that case, the hypothesis that investors are rewarded by higher returns for bearing high volatility therefore holds. However, this hypothesis is rejected if the co-efficient, δ is negative,

The traditional $\mathrm{GARCH}\,(1,1)$ model, however, has a major deficiency in that the non-negativity

constraints may still be violated. It ignores the volatility asymmetry typically observed in practice. In the GARCH (1,1) model, both positive return shocks (when $\vartheta_{t-1} > 0$) and negative return shocks (when $\vartheta_{t-1} < 0$) have an identical impact on the conditional variance, $\sigma_{t|t-1}^2$, since the residual ϑ_{t-1} appears in squared form. The volatility asymmetry phenomenon (known commonly as AVP) is a market dynamic in which market down swings have higher market volatility than market upward swings. It is usually attributable to the leverage effects and volatility feedback. Other attributes can be the perceived risk-reward balance at market levels. The EGARCH model, which is an asymmetric GARCH model, will therefore be used to avert the deficiency identified in GARCH (1, 1).

The exponential GARCH (EGARCH) was proposed by Nelson (1991) to deal with the shortcomings of the GARCH (1, 1) process and some of its extension models such as the GARCH-in-mean.

Brooks (2014) indicates that the E-GARCH process has several advantages over the pure GARCH process. One of the first advantages is that since $log(\sigma_t^2)$ is modelled, σ_t^2 will be positive variance even if the parameters are negative. It is therefore unnecessary to artificially impose non-negativity constraints on the model parameters. Secondly, asymmetries are allowed for under the E-GARCH formulation, because if the relationship between volatility and returns is negative, γ will be negative, hence accounting for leverage effects.

Meng and Rafikova (2006) evaluated the performance of alternative models for predicting stock

price volatility on the Swedish stock market, namely, Random Walk, Moving Average, Exponentially weighted moving average, the GARCH family models and implied volatility in deriving volatility forecast. They found that other models including the GARCH family model made predictions based on past data. They also stated that the E-GARCH (1,1) model performed better than the GARCH (1,1) model for the data they used.

Under the E-GARCH, there are various ways to express the conditional volatility, but for this study, the following specification is chosen:

$$\log(h_t) = \alpha_0 + \sum_{j=1}^{q} \beta_j \log(h_{t-j}) + \sum_{i=1}^{p} \alpha_i \left| \frac{u_{t=i}}{\sqrt{h_{t=i}}} \right| + \sum_{k=1}^{r} \gamma_k \frac{u_{t-k}}{\sqrt{h_{t-k}}} \qquad (4)$$

In the equation γ_k represents leverage effects which accounts for the asymmetry of the model. If $\gamma_k < 0$ it indicates leverage effect exist and if $\gamma_k \neq 0$ impact is asymmetric. The meaning of leverage effect bad news increases volatility. If the asymmetry term is negative, it implies that negative shock has a greater impact on volatility rather than positive shocks of the same magnitude.

Before estimating the EGARCH model, all the data series will be examined to identify their statistical properties and to see if they meet the pre-conditions for the EGARCH model. EGARCH model will then be fitted using an appropriate equation for each stock return.

3.2.2 Establishing the Relationship between Volatility and Expected Returns

A simple approach of correlation has been adopted to establish whether there is a relationship between volatility and expected returns in Africa's stock markets. Correlation is the degree of association between two variables. Pairwise correlation coefficients will be used to show the extent or degree of association between expected stock returns and volatility. In carrying out this examination, the stock returns will be squared and then differenced to proxy for volatility.

The range of values for the correlation coefficient is -1.0 to 1.0. A correlation of -1.0 indicates a perfect negative correlation. This means that as one variable increases in its values, the other variable decreases in its values through an exact linear rule. On the other side, a correlation of 1.0 indicates a perfect positive correlation. As one variable increases in its values, the other variable also increases in its values through an exact linear rule Where the value derived is 0, it indicates that there is no linear relationship, hence no correlation.

3.2.3 Establishing the Pricing of Volatility

To establish whether volatility (conditional standard deviation) is priced in equity returns, an estimation of the GARCH-in Mean will be used. GARCH-in-mean model was developed by Engle, Lilien and Robins (1987), as an extension of the GARCH (1,1) model.

GARCH-in-Mean is premised on the finance theory of risk-return tradeoff. Investors expect risk to be compensated by a higher return. Engle, Lillien and Robins (1987) suggested that the return

of a security is partly determined by its risk. They suggested the ARCH-M specification. A GARCH-M model will therefore be;

$$y_t = \mu + \delta\sigma_{t-1} + \vartheta_t \quad , \quad \vartheta_t \sim N(0, \sigma_t^2) \qquad (5)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1\vartheta_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad (6)$$

The co-efficient δ, can be interpreted as a sort of risk premium.

Nam, Pyun and Arize (2002) used asymmetric GARCH-M model for US market indices during 1926-1997 and found that negative returns on average reverted more quickly to the long term average that the positive returns.

Nguyen (2005) studied the dynamic behaviours of conditional volatility around stock market liberalization for emerging markets, using a bivariate conditional GARCH-in-mean model. His results showed that conditional volatility measures tended to be predictable and persisted over time.

In investigating the stochastic behavior of monthly stock market returns for the Nairobi Stock Exchange (of Kenya) and Lusaka Stock Exchange (of Zambia) for the period February 1997 to October 2012, Tah (2013) used the GARCH-in-mean. He observed a negative and significant relationship between conditional mean and variance for Lusaka Stock Exchange and an insignificant relationship between expected returns and conditional variance for Nairobi Stock Exchange.

3.2.4 Establishing Variations in Stock return Risk Premia

To establish the variations in stock return volatility risk premia, the rolling coefficient approach will be applied. The Fama-French five-factor model, which is the extension of the three-factor model, will be estimated with an additional variable in the form of conditional volatility of the returns. These factors are known to define the returns of stocks hence it is crucially important to have them in the estimated model.

In 1993, Fama and French developed the three- factor asset pricing model as a result of increasing empirical evidence that the Capital Asset Pricing Model performed poorly in explaining realised returns. It is however, an extension of the CAPM model which has the market factor, and augments it by the two factors identified by Fama and French being size effect and the book-to equity effect.

Bundoo (2006) used the Fama-French three-factor model under the assumption that the two additional factors proxy other risk factors that are omitted by CAPM, it is assumed that these two additional factors proxy for other. His study provided some empirical evidence in an emerging market, the Stock Exchange of Mauritius, and evidenced that the size and the book-to-equity effects are international in character.

Faff (2001) employed Australian data over the period 1991 to 1999 to examine the power of the Fama French three-factor model. He observed strong support for the Fama and French three factor model. However, he found a significant negative rather than the expected positive,

premium, to small size stocks. His results appeared to be consistent with other recent evidence of a reversal of the size effect.

The five-factor model is the expansion of Fama and French original three-factor model established in 1993. They have now added two more factors to the model. The original three-factor model consisted of market risk, size and value. It was designed to capture the relationship between average return and size, with the finding that in the period 1963-1990, stocks with a small market capitalisation earn higher returns than stocks with a large market capitalization. The value effect captured the relationship between average returns and price rations, showed that there was superior performance of stocks with a low price to book compared with stocks with a high price to book (Fama and French (1993)).

The three-factors are computed as follows;

$$R_{it} - R_{Ft} = a_i + b_i\,(R_{Mt} - R_{Ft}) + s_i\,SMB_t + h_i HML_t + \varepsilon_{ti} \qquad (7)$$

where R_{it} = return on security o portfolio *i* for period *t*, R_{Ft}= the risk-free return, R_{Mt}= return on the value-weight (VW) market portfolio, SMB_t= return on a diversified portfolio of small stocks minus the return on a diversified portfolio of big stock, HML_t= difference between the returns on a diversified portfolio of high and low B/M stocks, and ε_{ti} is zero mean residual.

Fama and French (1993) posit that treating the parameters in (7) as true values rather than estimates, if the factor exposures b_i , s_i and h_i capture all variation in expected returns, the intercept a_i =0 for all securities and portfolios *i*.

Fama and French (2015) have now added in their five-factor model, profitability (stocks with a high operating profitability perform better) and an investment factor (stocks of companies with the high total asset growth have below average returns).

$$R_{it} - R_{Ft} = a_i + b_i (R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t \varepsilon_{ti} \quad (8)$$

where RMW_t = difference between the returns on diversified portfolios of stocks with robust and weak profitability, and CMA_t= difference between the returns on diversified portfolios of the stocks of low and high investment firms (conservative and aggressive). If the exposures to the five factors b_i , s_i, h_i, r_i and c_i capture all variation in expected returns, the intercept a_i in (8) =0 for all securities and portfolios *i*.

According to Adrian and Rosenberg (2008), intertemporal models predict that financial asset risk premia are not only due to covariation of returns with the market return, but also covariation with the state variables that govern market volatility. They formed pricing factors that reflect shocks to systematic volatility at different times by modeling the log-volatility of the market portfolio as the sum of a short- and a long-run volatility component. Their study found that prices of risk are negative and significant for both volatility components, indicating that investors require

compensation in order to hold assets that depreciate when volatility rises, even if the volatility shocks have little persistence.

The five-factor model will therefore be adopted for purposes of this study, to test whether volatility is priced in equity returns. The five factors were collected from the Fama/French database. The Fama/French Global Factors was used as there are no constructions specific to Africa.

The concept of rolling estimation is premised on the fact that coefficients may change over time due to various factors such as the evolution of the economy and changes in policy. They can, therefore not be observed through one glance. In order to obtain the rolling coefficients, the sample for a given window is rolled through using the number of observations for the estimation. One observation is advanced at a time and then repeated. The coefficients against time are then estimated. In essence, multiple regression with different overlapping (or non-overlapping) window of values at a time are run in order to obtain the rolling estimates. The rolling estimates are a combination of true coefficients and the residual term.

3.2.5 Establishing Volatility Transmission

To establish whether there is volatility transmission from one market to the other within the African region, the EGARCH model will be applied. EGARCH has been comprehensively discussed in other previous discussions of this study.

CHAPTER 4: PRESENTATION OF EMPIRICAL RESULTS

The summary statistics of the monthly return series for the sample period is reported in **Table 4** below. The mean return is the first expected return on an investment and shows the middle value in a distribution. From the summary statistics, Egypt has the highest mean return (1.2690) with the lowest mean occurring in Kenya at (-1.353). Kenya also has the highest standard deviation (22.91). The results of Kenya seemingly indicate that the risk/return tradeoff as known in finance theory may not be true in all instances. Much as investors expect higher returns for assuming more risk, higher risk may also be indicative of higher potential losses. The wide gap between the maximum and minimum returns gives support to the high variability of price change in the African equity markets. Some of the selected countries exhibit high standard deviations (Ghana (14.73), Egypt (9.34) and Malawi (7.88) and this can infer that investors should expect to be compensated higher for assuming more risk. The reverse will be true for Botswana and Tunisia which exhibit the lowest standard deviations of 3.64 and 3.81 respectively.

The kurtosis of all the selected countries exceeds the normal distribution threshold of 3, with South Africa recording a marginal excess at 3.04. Ghana and Kenya exhibit the fattest tails than all the other countries. Kurtosis coefficients which are less than or greater than 3 suggest flatness and peakedness. The returns in Africa therefore exhibit fatter tails than in a normal distribution. In terms of the skewness, 30% of the sample countries are positively skewed while the remaining 70% of the sample countries are negatively skewed. Positive or negative skewness indicate asymmetry in the series.. Negative skewness implies that the distribution has a long left tail and a

deviation from normality.The assumption of normality is rejected under the Jacque-Bera test for all the sampled countries.

Table 4

Descriptive statistics (dlog*100)

Sample	Botswana	Tunisia	Morocco	Ghana	South Africa	Malawi	Kenya	Mauritius	Egypt	Nigeria
Obs.	216	216	216	216	216	216	216	216	216	216
Mean (μ)	1.0695	0.8320	0.2276	0.3532	0.8829	0.5952	-1.353	0.6395	1.2690	0.7155
Maximum	19.78	19.17	19.95	20.10	13.13	29.14	16.02	15.38	31.19	32.99
Minimum	-10.70	-14.26	-15.69	-197.30	-15.03	-51.08	-326.24	-20.56	-40.33	-36.58
St. dev (σ)	3.64	3.81	5.01	14.73	3.81	7.88	22.91	4.16	9.34	6.93
Skewness (S)	0.76	0.50	0.02	-11.26	-0.22	-2.01	-13.28	-0.29	-0.13	-0.37
Kurtosis (K)	7.75	6.82	4.21	151.8	3.04	16.79	188.87	4.21	4.98	8.67
JB	224.07	140.43	13.11	203839	1.83	1856.8	317277	241.14	35.95	294.4

Table 5 reports the results of the estimates after fitting the EGARCH model to the stock returns of the respective equity markets selected for this study. The variance equation shows the conditional variance as a function of past conditional variances and past innovations. The relevant coefficients are statistically significant at 5%.

Various studies show that there is a significantly inverse relationship between volatility and market performance. As the stock market rises (stock returns increase), volatility tends to decline. When the stock market declines (stock returns drop), volatility increases.

From the results of the exponential GARCH model, there are positive coefficients which indicate that asymmetric volatility is present in Botswana, Egypt, Morocco, Ghana, Mauritius, South Africa, Tunisia and Kenya. Evidence of significant and positive asymmetric volatility, suggests that positive shocks increase volatility more than negative shocks of an equal magnitude. There is, however, no evidence of asymmetric volatility in Malawi and Nigeria. This means that a negative innovation has a higher impact on volatility than positive innovation. The significance of negative shocks persistence or volatility asymmetry indicates that investors are more prone to negative news in comparison to the positive news, hence implying that volatility spill over is asymmetric.

Table 5: Results for the fitted EGARCH Model: AR(1), EGARCH (1,1) Model

Variable	Botswana	Egypt	Malawi	Morocco	Tunisia	Mauritius	South Africa	Kenya	Nigeria	Ghana
C	1.094 (0.356)	1.404 (0.837)	1.399 (1.153)	-1.656 (0.658)	0.824 (0.287)	0.041 (0.349)	0.985 (0.336)	-0.326 (0.356)	1.295 (0.639)	0.448 (0.206)
AR(1)	0.565 (0.065)	0.609 (0.159)	0.909 (0.077)	0.909 (0.077)	-0141 (0.035)	1.431 (0.563)			-0.114 (0.093)	
AR(2)		-0.688 (0.136)			-0.944 (0.029)	-0.479 (0.502)			0.807 (0.075)	
MA(1)		-0.433 (0.163)	-0.823 (0.085)		0.246 (0.073)	-1.198 (0.567)			0.205 (0.102)	
MA(2)		0.577 (0.144)			0.959 (0.037)	0.287 (0.400)			-0.742 (0.121)	
MA(3)		0.265 (0.087)			0.0642 (0.074)	-0.011 (0.138)			0.026 (0.062)	
				Variance Equation						
C(2)				4.989 (1.455)			0.255 (0.289)	-0.11 (0.148)		0.279 (0.210)
C(3)	-1.188 (0.053)			-1.407 (0.161)			0.257 (0.169)	0.364 (0.091)		1.354 (0.143)
C(4)	0.429 (0.069)		5.784 (0.531)	0.040 (0.091)			-0.178 (0.074)	0.002 (0.0394)		0.186 (0.102)
C(5)	0.065 (0.045)		-0.321 (0.089)	0.007 (0.317)			0.855 (0.104)	0.946 (0.0423)		0.562 (0.073)
C(6)	0.938 (0.022)		0.074 (0.079)							
C(7)		1.492 (1.666)	-0.402 (0.137)		0.228 (0.196)	-0.224 (0.088)			6.682 (0.215)	
C(8)		0.045 (0.126)			0.285 (0.106)	0.429 (0.108)			0.383 (0.071)	
C(9)		-0.117 (0.092)			-0.31 (0.053)	-0.0400 (0.048)			-0.0059 (0.0321)	
C(10)		0.647 (0.391)			0.821 (0.092)	0.956 (0.138)			-0.897 (0.021)	
R-squared	0.262	0.105	0.044	-0.477	0.046	0.081	-0.0003	-0.006	0.067	-0.019
Adjusted R-squared	0.258	0.084	0.035	-0.477	0.0227	0.059	-0.0003	-0.006	0.045	-0.019
S.E of Regression	3.142	8.97	7.751	12.339	3.775	4.035	5.298	5.665	6.786	5.914
Durbin Watson	2.04	1.94	1.93	1.123	1.999	2.02	2.04	1.568	1.92	0.885
Akaike Info Criteria	4.849	7.27	6.925	7.648	5.437	5.285	6.117	6.178	6.539	5.844
Schwartz Criterion	4.943	7.42	7.035	7.726	5.594	5.441	6.195	6.256	6.696	5.922
Hannan Quin Criterion	4.887	7.33	6.969	7.679	5.5	5.348	6.149	6.209	6.603	5.876

****The values in the parenthesis represent the standard errors (S.E).**

Table 6 reports the pair wise correlation coefficient estimations of stock returns and volatility for the period 1998:11 to 2016:12 for the selected equity markets. Correlation numerically measures the degree of association or the strength of the relationship between expected returns and volatility.

There is evidence of positive correlation between expected returns and volatility in Botswana, Egypt, Morocco, Nigeria, South Africa and Tunisia. However, Ghana, Kenya, Mauritius and Malawi recorded a negative correlation. Negative correlation means that there is a degree of association between expected returns and volatility in these countries, although the relationship is negative.

Tunisia has the highest positive correlation at 0.381, followed by Botswana at 0.192. A weak positive correlation is observed in Nigeria at 0.0095 and Egypt at 0.079. For negative correlation, Ghana has the highest negative correlation at -0.091 whilst Malawi has the weakest negative correlation at -0.329. There is also no perfect correlation observed in all the selected equity markets. Further, for all the selected countries, there is no evidence of zero correlation (i.e where r=0). Zero correlation will mean that the expected returns and volatility are not associated.

Therefore, all African equity markets show evidence of a relationship between expected returns and volatility. This therefore means that expected returns and volatility vary together. However, there is no evidence of perfect positive correlation and perfect negative correlation for all the selected countries. Perfect correlation of either sign is the highest degree of association or absolute association between the variables being considered. However, it must be highlighted that although there is evidence of correlation, it does not translate into causality.

Table 6: RESULTS FOR THE COVARIANCE CORRELATION OF STOCK RETURNS AND VOLATILITY

Covariance Correlation	BOT	EGY	GHA	KNY	MAU	MLW	MRC	NIG	SAFR	TUN
BOT	13.23459									
	1.000000									
BOT2	**30.96801**									
	0.192352									
EGY	-0.098835	87.05109								
	-0.002912	1.000000								
EGY2	0.081743	**171.8851**								
	9.76E-05	**0.079994**								
GHA	-0.332349	1.597905	33.90173							
	-0.015690	0.029414	1.000000							
GHA2	-10.26718	151.6567	**-58.61476**							
	-0.025377	0.146158	**-0.090520**							
KNY	-1.375226	14.00584	1.102534	31.09358						
	-0.067793	0.269207	0.033958	1.000000						
KNY2	19.97694	-1.732422	-12.83193	**-108.6484**						
	0.062656	-0.002119	-0.025146	**-0.222319**						
MAU	1.327770	10.48983	0.269263	10.46239	17.32003					
	0.087699	0.270151	0.011112	0.450839	1.000000					
MAU2	13.45217	-15.03476	10.07337	-95.92362	**-26.44518**					
	0.071517	-0.031166	0.033461	-0.332707	**-0.122898**					
MLW	1.434353	7.881546	2.194018	0.455913	-0.454832	62.00122				
	0.050073	0.107281	0.047855	0.010384	-0.013880	1.000000				
MLW2	-19.78318	48.81476	-62.92923	25.05051	131.8399	**-894.7908**				

	-0.015783	0.015185	-0.031369	0.013039	0.091945	**-0.329819**				
MRC	0.028792	9.352632	-0.092438	4.923742	5.121376	5.614892	25.12790			
	0.001579	0.199972	-0.003167	0.176150	0.245490	0.142254	1.000000			

Covariance **Correlation**	**BOT**	**EGY**	**GHA**	**KNY**	**MAU**	**MLW**	**MRC**	**NIG**	**SAFR**	**TUN**
MRC2	1.804046	70.04928	7.037075	25.02371	14.63955	-0.132165	1.841219			
	0.008427	0.127591	0.020539	0.076264	0.059780	-0.000285	**0.006242**			
NIG	2.373525	9.831934	5.374254	9.123359	8.505287	8.057189	8.360898	48.07325		
	0.094099	0.151985	0.133124	0.235976	0.294756	0.147581	0.240560	1.000000		
NIG2	-30.75865	234.8701	87.99145	43.10027	137.6848	-24.05194	-159.2430	11.90722		
	-0.046950	0.139787	0.083918	0.042921	0.183713	-0.016962	-0.176404	**0.009536**		
SAFR	-0.345016	6.652477	-2.991426	7.401837	5.534120	7.798582	8.577590	9.358756	27.97377	
	-0.017931	0.134810	-0.097139	0.250974	0.251419	0.187258	0.323528	0.255206	1.000000	
SAFR2	0.520105	-15.55252	-14.51389	-1.754295	0.836288	-1.293795	-15.67916	63.11760	27.22683	
	0.002635	-0.030721	-0.045941	-0.005798	0.003703	-0.003028	-0.057646	0.167773	**0.094874**	
TUN	1.133363	7.078166	-0.516835	2.215098	1.275284	2.280647	0.600931	-2.369620	0.294756	14.53870
	0.081705	0.198962	-0.023280	0.104183	0.080366	0.075962	0.031440	-0.089632	0.014616	1.000000
TUN2	-3.276665	88.58516	12.08335	21.05985	11.22857	23.57375	18.61157	-11.71590	-26.13728	74.46746
	-0.017549	0.184985	0.040433	0.073584	0.052567	0.058330	0.072338	-0.032922	-0.096283	**0.380511**

From **Table 7**, the results show that the coefficient for GARCH (SQRT (GARCH)) in the Mean Equation is negative under the significant level of 5% for Botswana, Egypt, Malawi, Morocco, Tunisia and Nigeria. However, it is positive for South Africa, Mauritius, Kenya and Ghana. Mauritius and Kenya have the highest positive results at 0.0623 and 0.646 respectively. Tunisia has the least negative results (-2.947).

The estimated coefficient (risk premium) of $\sigma 2$ in the mean equation is negative for Botswana, Egypt, Morocco, Tunisia and Nigeria. This gives an indication that the mean of return sequence considerably depends on past innovation and past conditional variance. The conditional variance used as proxy for risk of return is negatively related to the level of return.

The result show that as volatility increases, the returns correspondingly decrease by a factor of the coefficient for the respective equity markets. These results negate the theory of a positive risk premium on stock indices which states that the higher returns are expected for asset with higher level of risk. The null hypothesis that there is no ARCH effect is rejected. However, for Mauritius, South Africa, Kenya and Ghana, the coefficient of the mean equation is positive, hence the conditional variance is positively related to the level of return. As volatility increases, the, the returns correspondingly increase by the factor of the coefficient. The positive results for the mean equation support the risk/return trade off.

TABLE 7 : RESULTS FOR GARCH-IN MEAN MODEL

Variable	Botswana	Egypt	Malawi	Morocco	Tunisia	Mauritius	South Africa	Kenya	Nigeria	Ghana
SQRT(GARCH)	-0.085 (0.206)	-1.055 (0.771)	-1.206 (0.444)	-0.067 (0.011)	-2.947 (2.022)	0.623 (0.209)	0.004 (0.336)	0.646 (0.288)	-2.991 (2.656)	0.098 (0.112)
C	1.108 (0.381)	10.454 (6.627)	8.061 (2.552)	4.213 (1.103)	11.145 (6.979)	-1.278 (0.551)	0.962 (1.618)	-3.491 (1.391)	20.778 (17.581)	0.183 (0.387)
AR(1)	0.589 (0.067)	0.641 (0.034)	0.795 (0.096)		-0.775 (0.337)	1.381 (0.228)			-0.543 (0.402)	
AR(2)		-0.913 (0.027)			-0.427 (0.247)	-0.641 (0.240)			0.390 (0.385)	
MA(1)		-0.539 (0.110)	-0.623 (0.110)		0.844 (0.362)	-1.198 (0.253)			0.594 (0.369)	
MA(2)		0.847 (0.082)			0.427 (0.320)	0.451 (0.253)			-0.288 (0.401)	
MA(3)		0.175 (0.109)			0.032 (0.093)	0.041 (0.106)			0.104 (0.095)	
				Variance Equation						
C(2)										
C(3)				5.060 (0.932)			0.256 (0.295)	-0.152(0.139)		0.307 (0.221)
C(4)	-0.189 (0.057)			-1.165 (0.197)			0.256 (0.170)	0.363 (0.089)		1.331 (0.141)
C(5)	0.445 (0.075)		6.767 (0.513)	-0.355 (0.104)			-0.178 (0.075)	0.057 (0.042)		0.228 (0.101)
C(6)	0.062 (0.047)		-0.309 (0.077)	0.007 (0.193)			0.855 (0.107)	0.958 (0.039)		0.558 (0.078)
C(7)	0.932 (0.025)		0.108 (0.055)							
C(8)		1.0001 (1.053)	-0.652 (0.127)		0.807 (0.469)	-0.281 (0.095)			3.103 (0.929)	
C(9)		0.0523 (0.081)			0.193 (0.141)	0.472 (0.109)			0.185 (0.175)	
C(10)		-0.126 (0.076)			-0.039 (0.064)	0.006 (0.045)			-0.063 (0.095)	
C(11)		0.758 (0.245)			0.622 (0.182)	0.963 (0.029)			0.142 (0.245)	

R-squared	0.258	0.104	0.044	-0.153	0.153	0.067	0.000	0.030	0.062	0.010
Adjusted R-squared	0.251	0.078	0.031	-0.158	0.129	0.040	-0.005	0.025	0.035	0.006
S.E of Regression	3.156	8.999	7.771	12.973	3.564	4.076	5.311	5.576	6.823	5.843
Durbin Watson	2.074	1.942	1.936	1.223	2.057	1.835	2.036	1.635	2.096	0.937
Akaike Info Criteria	4.858	7.263	6.907	7.611	5.429	5.242	6.126	6.151	6.697	5.849
Schwartz Criterion	4.967	7.435	7.033	7.704	5.601	5.415	6.220	6.244	6.870	5.943
Hannan Quin Criterion	4.902	7.332	6.958	7.648	5.499	5.312	6.164	6.189	6.767	5.887

****The values in the parenthesis represent the standard errors (S.E).**

Figure 3 reports a clear and obvious variation in the stock return risk premia for all the selected equity markets. This is represented by the rolling coefficients which show that over time, there are variations in the volatility risk premia of each equity market. There is also a discernible pattern followed by the variations of all the equity markets. This is evidenced by the rolling coefficient which moves in an upward trend, followed by a downward trend and then an upwards trends again. In each rolling coefficient graph, the downward movements are of larger degrees when compared to upward movements.

Figure 3

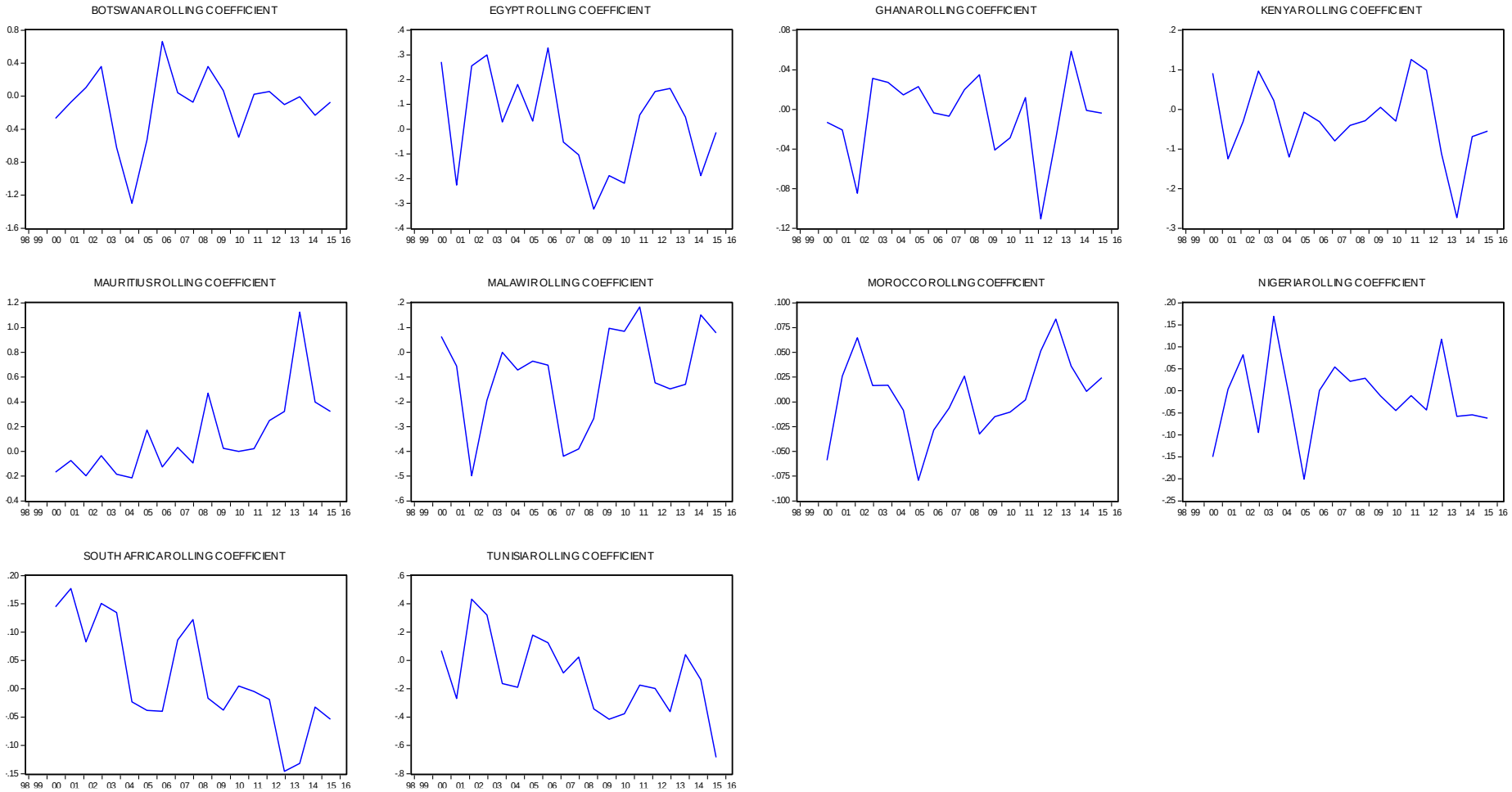

BOTSWANA ROLLING COEFFICIENT
EGYPT ROLLING COEFFICIENT
GHANA ROLLING COEFFICIENT
KENYA ROLLING COEFFICIENT
MAURITIUS ROLLING COEFFICIENT
MALAWI ROLLING COEFFICIENT
MOROCCO ROLLING COEFFICIENT
NIGERIA ROLLING COEFFICIENT
SOUTH AFRICA ROLLING COEFFICIENT
TUNISIA ROLLING COEFFICIENT

Table 8 reports the feedback from the conditional variance to the conditional mean. The main focus in these results is on the estimated parameter in the mean equation. The coefficient is negative and statistically insignificant for Botswana, Egypt, Tunisia and Nigeria. This implies that there is no feedback from the conditional variance to the conditional mean. For Morocco, the negative coefficient it is statistically significant. Positive estimated parameters are observed in Mauritius, South Africa, Kenya and Ghana. In all the positive coefficients, save for Ghana, they are all statistically significant. This implies that there is feedback from the conditional variance to the conditional mean.

Table 8: Results for the GARCH-in-Mean (1,1)

Variable	Botswana	Egypt	Malawi	Morocco	Tunisia	Mauritius	South Africa	Kenya	Nigeria	Ghana
					Mean Equation					
SQRT(GARCH)	-0.085 (0.206)	-1.055 (0.771)	-1.206 (0.444)	-0.067 (0.011)	-2.947 (2.022)	0.623 (0.209)	0.004 (0.336)	0.646 (0.288)	-2.991 (2.656)	0.098 (0.112)
C	1.108 (0.381)	10.454 (6.627)	8.061 (2.552)	4.213 (1.103)	11.145 (6.979)	-1.278 (0.551)	0.962 (1.618)	-3.491 (1.391)	20.778 (17.581)	0.183 (0.387)
AR(1)	0.589 (0.067)	0.641 (0.034)	0.795 (0.096)		-0.775 (0.337)	1.381 (0.228)			-0.543 (0.402)	
AR(2)		-0.913 (0.027)			-0.427 (0.247)	-0.641 (0.240)			0.390 (0.385)	
MA(1)		-0.539 (0.110)	-0.623 (0.110)		0.844 (0.362)	-1.198 (0.253)			0.594 (0.369)	
MA(2)		0.847 (0.082)			0.427 (0.320)	0.451 (0.253)			-0.288 (0.401)	
MA(3)		0.175 (0.109)			0.032 (0.093)	0.041 (0.106)			0.104 (0.095)	

CHAPTER 5: CONCLUSION

Overall results from this study provide evidence to show volatility clustering, leptokurtic distribution and leverage effects for the Africa equity markets stock returns data. These results are in line with international evidence of financial data exhibiting the phenomenon of volatility clustering, fat tailed distribution and leverage effects.

Although there is no evidence of evidence of perfect positive correlation and perfect negative correlation for the selected countries, all the African equity markets show evidence of a relationship between expected returns and volatility, albeit a weak one. There is a relationship or a degree of association between expected returns and volatility. However, such relationship is found to be weak.

For Africa equity markets, there are split results on the risk/return trade off. In some jurisdictions, the mean equation supports the theory that volatility is priced, hence investors should anticipate higher returns where they assume higher risk. However, in other equity markets, this theory is not supported.

The stock return volatility risk premia have variations over time in Africa equity markets. Downward variations are on average larger than upward variations.

Volatility is transmitted from international markets to some of the African equity markets, whereas some African equity markets do not evidence such a relationship. Therefore, for

countries where volatility from international markets is transmitted, it means that the equity markets are impacted by the economic disposition of international markets. Most of the African countries whose equity markets are affected by volatility from international markets are those which studies have shown to be information efficient.

Although the results provide inclusive observations, certain characteristic of volatility and expected returns can be estimated. The inclusive results may be attributable to the recording of data in Africa, an area that immensely require improvement, but the observations remain necessary to contribute and probe for more studies in this subject.

INDEX OF ACRONYMS AND ABBREVIATIONS

ARCH	Autoregressive Conditional Heteroskedasticity Model
BSE	Botswana Stock Exchange
DEM	Development & Enterprise Market
EY	Ernst & Young
E-GARCH	Exponential GARCH
GARCH	Generalized Autoregressive Conditional Heteroskedasticity Model/process
JSE	Johannesburg Stock Exchange
MA	Moving Average
NSE 1	Nairobi Securities Exchange
NSE2	Nigeria Stock Exchange
SEM	Stock Exchange of Mauritius
UK	United Kingdom

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APPENDIX A

1. BOTSWANA

LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5) *RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.093661	0.355841	3.073458	0.0021
AR(1)	0.564969	0.064511	8.757733	0.0000
Variance Equation				
C(3)	-0.188226	0.053415	-3.523851	0.0004
C(4)	0.429637	0.069328	6.197170	0.0000
C(5)	0.064747	0.045370	1.427080	0.1536
C(6)	0.938013	0.022467	41.74992	0.0000

R-squared	0.261512	**Mean dependent var**	1.061186
Adjusted R-squared	0.258061	**S.D. dependent var**	3.648017
S.E. of regression	3.142252	**Akaike info criterion**	4.849295
Sum squared resid	2112.982	**Schwarz criterion**	4.943053
Log likelihood	-517.7239	**Hannan-Quinn criter.**	4.887173
Durbin-Watson stat	2.040673		

Inverted AR Roots	.56

2. EGYPT

LOG(GARCH) = C(7) + C(8)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(9) *RESID(-1)/@SQRT(GARCH(-1)) + C(10)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.404057	0.837155	1.677177	0.0935
AR(1)	0.609965	0.158851	3.839861	0.0001
AR(2)	-0.688063	0.136283	-5.048773	0.0000
MA(1)	-0.433086	0.163382	-2.650755	0.0080
MA(2)	0.576972	0.143850	4.010922	0.0001
MA(3)	0.265407	0.087212	3.043231	0.0023
Variance Equation				
C(7)	1.492159	1.665861	0.895728	0.3704
C(8)	0.044646	0.125545	0.355619	0.7221
C(9)	-0.116942	0.091748	-1.274598	0.2025
C(10)	0.646507	0.390978	1.653562	0.0982

R-squared	0.105011	**Mean dependent var**	1.340236
Adjusted R-squared	0.083600	**S.D. dependent var**	9.373718
S.E. of regression	8.973346	**Akaike info criterion**	7.265351
Sum squared resid	16828.88	**Schwarz criterion**	7.422125

Log likelihood	-771.0253	**Hannan-Quinn criter.**	7.328695
Durbin-Watson stat	1.935935		

Inverted AR Roots	.30+.77i	.30-.77i	
Inverted MA Roots	.38+.82i	.38-.82i	-.32

3. GHANA

LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4) *RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.447887	0.206391	2.170091	0.0300
Variance Equation				
C(2)	0.278671	0.210339	1.324867	0.1852
C(3)	1.354062	0.143280	9.450491	0.0000
C(4)	0.185892	0.102010	1.822288	0.0684
C(5)	0.561782	0.073314	7.662718	0.0000

R-squared	-0.018685	**Mean dependent var**	1.247035
Adjusted R-squared	-0.018685	**S.D. dependent var**	5.859858
S.E. of regression	5.914350	**Akaike info criterion**	5.844199
Sum squared resid	7555.579	**Schwarz criterion**	5.922077
Log likelihood	-629.0956	**Hannan-Quinn criter.**	5.875659
Durbin-Watson stat	0.884532		

4. KENYA

LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4) *RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.325696	0.356491	-0.913618	0.3609
Variance Equation				
C(2)	-0.109805	0.148181	-0.741024	0.4587
C(3)	0.364398	0.091422	3.985911	0.0001
C(4)	-0.001876	0.039433	-0.047585	0.9620
C(5)	0.946083	0.042369	22.32975	0.0000

R-squared	-0.006044	**Mean dependent var**	0.112390
Adjusted R-squared	-0.006044	**S.D. dependent var**	5.648127
S.E. of regression	5.665170	**Akaike info criterion**	6.178002
Sum squared resid	6932.336	**Schwarz criterion**	6.255880
Log likelihood	-665.3133	**Hannan-Quinn criter.**	6.209462
Durbin-Watson stat	1.568923		

5. MAURITIUS

LOG(GARCH) = C(7) + C(8)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(9)
*RESID(-1)/@SQRT(GARCH(-1)) + C(10)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.041462	0.348597	0.118938	0.9053
AR(1)	1.431332	0.563305	2.540952	0.0111
AR(2)	-0.478857	0.502122	-0.953667	0.3403
MA(1)	-1.197627	0.566581	-2.113778	0.0345
MA(2)	0.286793	0.400354	0.716349	0.4738
MA(3)	-0.011492	0.137524	-0.083561	0.9334
Variance Equation				
C(7)	-0.224073	0.088100	-2.543390	0.0110
C(8)	0.429682	0.108460	3.961655	0.0001
C(9)	-0.040240	0.047999	-0.838340	0.4018
C(10)	0.955697	0.035948	26.58559	0.0000

R-squared	0.081464	**Mean dependent var**	0.649228
Adjusted R-squared	0.059489	**S.D. dependent var**	4.160798
S.E. of regression	4.035140	**Akaike info criterion**	5.284810
Sum squared resid	3403.012	**Schwarz criterion**	5.441584
Log likelihood	-558.1171	**Hannan-Quinn criter.**	5.348154
Durbin-Watson stat	2.019804		

Inverted AR Roots	.90	.53	
Inverted MA Roots	.89	.26	.05

6. MALAWI

LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.399655	1.152709	1.214230	0.2247
AR(1)	0.908716	0.077216	11.76847	0.0000
MA(1)	-0.822793	0.085458	-9.628089	0.0000
Variance Equation				
C(4)	5.783632	0.531406	10.88365	0.0000
C(5)	-0.320771	0.088648	-3.618495	0.0003
C(6)	0.074099	0.079636	0.930472	0.3521
C(7)	-0.402164	0.136691	-2.942129	0.0033

R-squared	0.044440	**Mean dependent var**	0.586758
Adjusted R-squared	0.035426	**S.D. dependent var**	7.892461
S.E. of regression	7.751403	**Akaike info criterion**	6.924863

Sum squared resid	12737.86	**Schwarz criterion**	7.034605
Log likelihood	-737.4228	**Hannan-Quinn criter.**	6.969204
Durbin-Watson stat	1.929088		
Inverted AR Roots	.91		
Inverted MA Roots	.82		

7. MOROCCO

LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4) *RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-1.656437	0.658222	-2.516531	0.0119
Variance Equation				
C(2)	4.989439	1.455089	3.428957	0.0006
C(3)	-1.047117	0.160917	-6.507180	0.0000
C(4)	0.040372	0.091201	0.442669	0.6580
C(5)	0.006580	0.317498	0.020726	0.9835

R-squared	-0.047771	**Mean dependent var**	0.972289
Adjusted R-squared	-0.047771	**S.D. dependent var**	12.05502
S.E. of regression	12.33959	**Akaike info criterion**	7.648094
Sum squared resid	32889.37	**Schwarz criterion**	7.725972
Log likelihood	-824.8182	**Hannan-Quinn criter.**	7.679554
Durbin-Watson stat	1.123137		

8. TUNISIA

LOG(GARCH) = C(7) + C(8)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(9) *RESID(-1)/@SQRT(GARCH(-1)) + C(10)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.824121	0.286869	2.872811	0.0041
AR(1)	-0.140531	0.034535	-4.069262	0.0000
AR(2)	-0.944099	0.029629	-31.86411	0.0000
MA(1)	0.245510	0.073303	3.349246	0.0008
MA(2)	0.959978	0.037080	25.88947	0.0000
MA(3)	0.064176	0.073543	0.872624	0.3829
Variance Equation				
C(7)	0.227642	0.195935	1.161826	0.2453
C(8)	0.285344	0.105805	2.696878	0.0070
C(9)	-0.031049	0.052831	-0.587708	0.5567
C(10)	0.821321	0.091638	8.962708	0.0000

R-squared	0.045574	**Mean dependent var**	0.811409
Adjusted R-squared	0.022740	**S.D. dependent var**	3.818544
S.E. of regression	3.774877	**Akaike info criterion**	5.436989
Sum squared resid	2978.186	**Schwarz criterion**	5.593763
Log likelihood	-574.4763	**Hannan-Quinn criter.**	5.500333
Durbin-Watson stat	1.999865		

Inverted AR Roots	-.07-.97i	-.07+.97i	
Inverted MA Roots	-.07	-.09+.97i	-.09-.97i

9. NIGERIA

LOG(GARCH) = C(7) + C(8)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(9) *RESID(-1)/@SQRT(GARCH(-1)) + C(10)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.294722	0.639955	2.023147	0.0431
AR(1)	-0.114289	0.092590	-1.234356	0.2171
AR(2)	0.806509	0.074518	10.82302	0.0000
MA(1)	0.205167	0.102352	2.004533	0.0450
MA(2)	-0.742421	0.120877	-6.141979	0.0000
MA(3)	0.025722	0.062244	0.413244	0.6794
	Variance Equation			
C(7)	6.681917	0.215069	31.06876	0.0000
C(8)	0.382745	0.071229	5.373402	0.0000
C(9)	-0.005901	0.032146	-0.183565	0.8544
C(10)	-0.896818	0.020813	-43.08882	0.0000

R-squared	0.067474	**Mean dependent var**	0.791997
Adjusted R-squared	0.045165	**S.D. dependent var**	6.944367
S.E. of regression	6.785735	**Akaike info criterion**	6.539216
Sum squared resid	9623.655	**Schwarz criterion**	6.695990
Log likelihood	-692.9657	**Hannan-Quinn criter.**	6.602560
Durbin-Watson stat	1.920262		

Inverted AR Roots	.84	-.96	
Inverted MA Roots	.75	.04	-.99

10. SOUTH AFRICA

LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.984869	0.336118	2.930128	0.0034
Variance Equation				
C(2)	0.254656	0.288952	0.881309	0.3782
C(3)	0.256538	0.168750	1.520231	0.1285
C(4)	-0.177538	0.074419	-2.385663	0.0170
C(5)	0.855373	0.104117	8.215491	0.0000

R-squared	-0.000372	**Mean dependent var**	0.882936
Adjusted R-squared	-0.000372	**S.D. dependent var**	5.297296
S.E. of regression	5.298281	**Akaike info criterion**	6.117041
Sum squared resid	6035.433	**Schwarz criterion**	6.195173
Log likelihood	-655.6405	**Hannan-Quinn criter.**	6.148607
Durbin-Watson stat	2.036920		