

**UNIVERSITY OF THE WITWATERSRAND  
JOHANNESBURG**



UNIVERSITY OF THE  
WITWATERSRAND,  
JOHANNESBURG

**FACULTY OF COMMERCE, LAW AND MANAGEMENT**

**OIL PRICES, STOCK PRICES AND THE ECONOMY:  
EXAMINING VOLATILITY TRANSMISSION IN DEVELOPING  
AFRICAN COUNTRIES**

Sylvia Lindiwe Sibanyoni  
(320599)

A thesis submitted to the faculty of commerce, law and management, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Management in Finance and Investment.

Supervisor: Prof Kodongo Odongo

Johannesburg, 2019


## Contents

DECLARATION.....	iii
ABSTRACT .....	iv
ACKNOWLEDGEMENTS.....	
LIST OF FIGURES .....	i
LIST OF TABLES .....	ii
CHAPTER 1: INTRODUCTION .....	1
1.1 Background.....	1
1.1.1 The Relationship between Oil price Volatility and the Stock Market .....	2
1.1.2 Oil price Volatility and economic growth.....	2
1.1.3 Oil Transmission Channels through which Oil prices affect the economy.....	3
1.2 Problem statement .....	5
1.3 Research Objectives .....	6
1.4 Research Questions.....	6
1.5 Significance of Study .....	6
1.6 Overview of the chapters.....	6
CHAPTER 2: LITERATURE REVIEW .....	7
THEORETICAL LITERATURE .....	7
The relationship between oil prices and stock price movements .....	7
Stock Market and Macroeconomic Volatility.....	8
EMPIRICAL LITERATURE .....	9
The relationship between Oil prices and Stock prices movements .....	9
Relationship between Oil price and Stock price in Emerging markets .....	13
Developing African countries: Relationship between Oil prices and Stock prices movements.....	15
The Relationship between the Stock market and the Macro economy .....	17
The Stock market volatility and Macro economy .....	19
SUMMARY OF FINDINGS .....	21
CHAPTER 3: METHODOLOGY .....	23
3.1 Introduction.....	23
3.2 Population and Sample .....	23
3.3 Data .....	23
3.3.1 The relationship between oil price volatility and stock price volatility of the selected African countries.....	23
3.3.2 The impact of oil price volatility on macroeconomic performance of the selected African countries.....	25

3.3.3 The transmission channels through which oil price volatility affect the economy of the selected African Countries .....	27
3.3.4 Variables.....	30
CHAPTER 4: DATA ANALYSIS .....	31
4.0 Introduction.....	31
4.1 The relationship between oil price volatility and stock price volatility of the selected African countries.....	31
4.1.1 Unit root test results .....	31
4.1.2 Descriptive statistics.....	33
4.1.3 ARCH effects test results .....	40
4.1.4 Multivariate GARCH model estimation results .....	41
4.2 The impact of oil price volatility on macroeconomic performance of the selected African countries .....	48
4.2.1 Estimating the volatility of oil prices .....	48
4.2.2 GARCH (1, 1) model estimation results for Brent crude price returns .....	48
4.2.3 Panel Unit root test results .....	50
4.2.4 The impact of oil price volatility on macroeconomic performance of selected African countries .....	51
4.3 The transmission channels through which oil prices and stock prices' relationship affect the economy in selected African countries.....	54
4.3.1 Vector Autoregression-based Johansen cointegration test results .....	54
4.3.2 Vector Error Correction Model (VECM) results.....	56
4.3.3 Impulse responses.....	58
4.3.4 Variance decomposition.....	60
4.3.5 Transmission channels through which oil price volatility affects economic growth of the selected African countries.....	61
4.3.6 Pairwise Granger Causality or Block Exogeneity tests .....	63
CHAPTER 5: SUMMARY, CONCLUSION AND POLICY RECOMMENDATION .....	64
5.1 Introduction.....	64
5.2 Summary of main findings and Conclusion.....	64
5.3 Policy implications.....	65
5.4 Priorities going forward.....	66
5.5 Further research.....	66
BIBLIOGRAPHY.....	67

## DECLARATION

I the undersigned, hereby declare that this thesis submitted to the University of the Witwatersrand for examination in consideration for the Master of Management in Finance and Investment award, is my own unaided work. This work has never been submitted for before for any degree or examination in any other University. I have taken reasonable care to ensure that the work is original to the best of my knowledge and has not been taken from other sources except where sources have been acknowledged and cited within text.

Signed:  \_\_\_\_\_

Student number: 320599

Date: 31-03-2020

## ABSTRACT

The dependency of stock prices on the oil price volatility has been found to be more prevalent in emerging market net-oil importing countries. Most African countries are net-oil importer and the effect of the oil price volatility has significant impact on their economies. To answer the objectives of this study, this research employs the diagonal BEKK GARCH model, GMM model and the VECM over data from selected African countries from July 2003 – November 2019. The results from the diagonal BEKK Model suggests a co-movement between oil price volatility and stock price volatility does not appear to be directly linked to geography or economic relations between the sample countries due to financial globalization and integration. There is evidence of increased volatility during and after the 2007/08 crisis financial, with volatility more pronounced in the aftermath of the crisis. In examining the effects of the oil price volatility on the economic growth, the GMM results show that oil price and stock prices volatility have negative impacts on the economic growth. The empirical findings from the VECM suggest that a significant negative long run relationship between oil price volatility and economic growth exists. Furthermore, the results also indicate that oil price volatility is transmitted to the economy through the exchange rates, real interest rates, consumer price indices (rate of inflation) and the volatility of stock market returns. Finally, the pairwise Granger causality test indicate a uni-directional cause and effect that runs from oil price volatility to economic growth through stock price volatility.

Key Words: Oil price volatility, stock price volatility, economic growth, diagonal BEKK GARCH, GMM, VECM, transmission channels, developing African countries

## ACKNOWLEDGEMENTS

I thank God the almighty and my guardian angels for the guidance and support throughout my studies. The challenges faced would have been unbearable without you.

I thank my mother (Elsie “Mmantsarane” Sibanyoni) for being by my side and allowing me to follow my dreams without question or doubt. The support you have given me during my studies is invaluable. You have always been a Rockstar in my life, my pillar of strength, my peace and motivator. I will always treasure the love you give to me.

To my friend Nomvula Masilela, my buddy and provider of best friend things. Thank you for the spa days I did not know I needed, for the place to sleep when attending classes, endless gifts I received during school/work stress and much more. Mostly for loving me and being such a blessing in my life. A sister for life 😊

This thesis would have never been possible without the assistance, guidance and dedication of my Supervisor Prof. Kodongo Odongo. I appreciate all the long hours taken to work on this thesis and driving it to the standard it is. The best supervisor I could ask for.

## LIST OF FIGURES

<i>Figure 1: Stock indices and commodity price time series graphs .....</i>	<i>36</i>
<i>Figure 2: Stock indices and commodity price return series graphs.....</i>	<i>37</i>
<i>Figure 3: Evidence of volatility clustering and excess kurtosis in stock index and commodity price return series .....</i>	<i>39</i>
<i>Figure 4: Conditional variance of the Multivariate Diagonal BEKK (1, 1) model .....</i>	<i>46</i>
<i>Figure 5: Conditional correlations of the Multivariate Diagonal BEKK (1, 1) model.....</i>	<i>47</i>
<i>Figure 6: Impulse responses for economic growth (LGDPG) and Brentcrude price volatility (BPVOL) .....</i>	<i>60</i>

## LIST OF TABLES

<i>Table 1: Variables and definitions</i> .....	30
<i>Table 2: Unit root test results for the original stock indices and commodity price series</i> .....	32
<i>Table 3: Descriptive statistics for the stock indices and commodity price return series</i> .....	35
<i>Table 4: Conditional Heteroscedasticity 'ARCH-effects' test results</i> .....	40
<i>Table 5: Multivariate Diagonal BEKK (1, 1) model estimation results</i> .....	42
<i>Table 6: Univariate GARCH (1, 1) model estimation results for Brent crude prices returns</i> .....	48
<i>Table 7: ARCH-LM test for the residuals of the fitted GARCH (1, 1) model</i> .....	49
<i>Table 8: Panel Unit root test results</i> .....	50
<i>Table 9: Panel GMM estimation results</i> .....	52
<i>Table 10: Unrestricted Cointegration Rank Test (Trace)</i> .....	54
<i>Table 11: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)</i> .....	55
<i>Table 12: The estimated cointegration relationship of the estimated VECM</i> .....	56
<i>Table 13: The error correction mechanism and short-run relations between Economic growth (LGDP) and Brent crude price volatility (BPVOL)</i> .....	56
<i>Table 14: Impulse responses of economic growth (LGDP) to Brentcrude price volatility (BPVOL) shocks</i> .....	58
<i>Table 15: Impulse responses of Brentcrude price volatility (BPVOL) to shocks from economic growth (LGDP)</i> .....	59
<i>Table 16: Variance decomposition results for Economic growth (LGDP) in selected African countries</i> .....	61
<i>Table 17: Pairwise Granger Causality or Block Exogeneity tests results</i> .....	63



## CHAPTER 1: INTRODUCTION

### 1.1 Background

For several decades, oil has been one of the most used commodities throughout the world. The global demand for oil continues to grow with an increase in growth rate of 1.3% recorded for the year 2018. The oil market is crucial in the world economy due to the role of oil in various economic sectors especially by the Transport, Residential, Industry, Services, Fishery etc. as per the IEA (2018) statistics.

According to World Economic Outlook Update (January 2019), difficult external conditions have impacted the emerging and developing economies amid trade tensions, rising US interest rates, dollar appreciation, capital outflows, and volatile oil prices.

Unclear global geopolitical risks, production restrictions and industrial demand changes give rise to an uncertain outlook on oil prices. Many African countries have shown that they are vulnerable and have high exposure to global commodity prices' fluctuations (The African economic outlook 2019).

The extent of the usage of oil in various economic sectors makes oil a significant input in the aggregate output growth of any given country (Suleiman, 2013). This then raises the need to understand the relationship between the oil price volatility and the stock market as well as the impact that the oil price volatility has on the macroeconomy of the African countries, as African countries are the most vulnerable to oil price volatility. This further raises the fundamental question: *What are the transmission channels through which oil price volatility affect the economy of developing African countries?* Understanding the channels that oil price volatility affects the economy will help policy makers in African counties to better forecast and prevent the impact of oil price volatility as well as take measures to mitigate the cost of oil price volatility.

### 1.1.1 The Relationship between Oil price Volatility and the Stock Market

A number of studies have examined the relationship between oil prices and stock prices. Different findings are presented by various studies. Other studies suggest that there is a negative relationship between the oil price volatility and stock market, such as findings presented by (Asteriou & Bashmakova, 2013).

However, there are other contrasting studies that suggest that oil prices have a positive relationship with the stock market (A. Dutta, Nikkinen, & Rothovius, 2017; Guesmi & Fattoum, 2014; Silvapulle, Smyth, Zhang, & Fenech, 2017).

While other studies show that high oil prices results in lower stock market returns for oil importing countries, whereas higher oil prices result in higher stock market returns for oil exporting countries as presented by Stavros Degiannakis and Vipin (2018), this is as supported by (Nasir, Naidoo, Shahbaz, & Amoo, 2018).

Silvapulle et al. (2017) argues that there is a positive and significant impact of the oil price on the stock market prices more especially after the global financial crises. The researchers suggest that there is a behaviour change between the oil and stock price in the long run as the previous studies found a negative relationship between oil and stock market. The changing relationship between oil and stock prices supports the earlier findings presented by (Miller & Ratti, 2009).

Varied findings are also presented in the African context, some studies show that oil prices have a negative relationship with the stock market (A. Dutta et al., 2017; Goodness, 2015) .While other studies show that there is a positive relationship between oil prices and stock market (Kamel Si, Benhabib, & Maliki, 2016; Zaki, Elgammal, & Hussainey). Moreover, some studies indicate that the relationship of oil prices and stock prices depends whether a country is an oil importer or exporter (The African economic outlook ,2019).

### 1.1.2 Oil price Volatility and economic growth

In recent findings Van Eyden, Difeto, Gupta, and Wohar (2019) indicate that oil price volatility negatively affects aggregate economic activity and growth. Therefore, it may be the volatility in the oil price leading to changes in economic output.

According to Basher, Wadud & Ahmed (2013), the oil price uncertainty has a significant influence on the overall changes in output level. The researchers show that there is a significant fall of output levels following an increase in oil prices, which indicate an adverse demand shock.

A number of studies suggest that oil price increases have negative effect on the oil importing countries' macroeconomic growth by increasing inflation, unemployment and devaluing financial markets (Sauter & Awerbuch, 2003). However, Berument, Ceylan, and Dogan (2010) found that oil price increases had no statistically significant effect on the output growth of the oil importing countries in the MENA region.

Berument et al. (2010) also show that in the MENA countries, oil price increase has a positive and statistically significant effect on the output growth of the oil exporters. In support of Berument et al. (2010) , Akinlo and Apanisile (2015); (Foudeh, 2017; Mukhtarov, Aliyev, & Zeynalov, 2020) present findings that suggests that for oil exporting countries, oil price volatility has a positive impact on the economic growth.

However, different results are presented by the findings from Omojolaibi and Egwaikhide (2013), who analysed the relationship between oil prices and the macroeconomic variables and found that oil price volatility has significant influence on the gross investment rather than fiscal deficit, real GDP and money supply.

Varied views are presented by researchers on the impact of oil price volatility on the economic performance. Moreover, only a few studies have examined this relationship for Africa, this study aims to impart more knowledge on the impact of oil price volatility on the economic growth of the developing African countries.

### 1.1.3 Oil Transmission Channels through which Oil prices affect the economy

Various transmission channels exist through which oil prices may impact on the economic activity. Transmission channel is a tool that is capable of transferring actions and effects of a factor or series of factors over another or others within a country or from one country to the other.

First the classical supply side effect channel, whereby crude oil is considered a basic input in production. A rise in oil prices leads to an increase in the firms cost of production by changing the domestic capital and labour inputs and reducing capacity utilisation. Consequently, an increase in production costs leads to reduction in the growth of output and productivity (Brown and Yücel (2002) .

The second transmission channel is the income transfer effect, which is the transfer of wealth between oil importing and oil exporting countries. A rise in oil prices compromises the terms of trade of an oil importing country, where the wealth transfer from the oil importing country to an oil exporting country, which leads to a decrease in the purchasing power of firms and households of oil importing countries, and thus reduced consumption and growth Darby (1982).

Thirdly, Pierce, Enzler, Fand & Gordon (1974) discusses the real balance effect transmission channel. According to the real balance effect, a rise in oil prices will lead to increased money demand. When monetary authorities fail to increase the money supply to meet the increased money demand, the interest rates will rise and slow down economic growth. The real balance channel suggests that with a given money supply, oil price increases causes higher inflation which reduces the amount of real balances. Lower real balances produce recessions, then increased interest rates leading to depressed investment spending, reduced aggregate demand and an associated fall in output.

Finally, a rise in oil prices may negatively impact on consumption, investment and stock prices. Consumption is affected through the positive link with disposable income, investment is affected by increasing firm's costs.

Maina (2015) empirically investigated the channels through which oil price shocks affects Kenya's economic activity. The study focused on real exchange rate, inflation, money supply, real GDP growth and international price of crude oil. The study identified that real exchange rate and the money supply are the most important sources of disturbances in Kenya's economic activity following an oil price shock.

## 1.2 Problem statement

Developing countries tend to have high vulnerability to oil price volatility than developed countries. Many African countries are vulnerable and have high exposure to global commodity prices' fluctuations (The African economic outlook 2019). There is a need to better understand the relationship between oil prices and stock markets for the African continent, this will benefit African countries to better prevent and understand oil price shocks and financial crises by employing various economic and financial measures (Gourène & Mendy, 2018).

Maghyereh (2004) argues that the emerging markets have an inefficient stock market transmission of the oil market shocks. Africa's stock markets are characterised as being excessively volatile, highly illiquid and operating within underdeveloped institutional environments. This has resulted in African stock markets receiving little attention due to underdevelopment and illiquidity (Bundoo, 2017). However, according to Allen, Otchere, & Senbet (2011), several African stock markets have shown considerable improvement, rapid growth and liberalisation.

Varying results have been presented by various studies on the relationship between the oil price volatility and stock markets in developing African countries such as those presented by (A. Dutta et al., 2017; Gourène & Mendy, 2018; Gupta & Modise, 2013). This study has undertaken to better understand the relationship between oil price volatility and the stock market of the selected developing African countries.

The recovery of Brent crude oil prices from 27.45 US Dollars in February 2016 to 74.34 US Dollars in October 2018, has improved the economy of African oil exporters especially of Algeria, Angola, Chad, Congo, Gabon, Libya, and Nigeria. The increase in Brent crude oil prices has however increased inflation in African oil importing countries. Many African countries subsidise energy and this has substantially increased the fiscal burden on their economies (The African economic outlook 2019).

A number of studies suggest that oil price increases have negative effect on the oil importing countries' macroeconomic growth by increasing inflation, unemployment and devaluing financial markets (Sauter & Awerbuch, 2003) . According to Wakeford (2006), a positive oil price shock has caused rising inflation and interest rates, as well as slowing economic growth in South Africa.

In a recent study, Van Eyden et al. (2019) argues that oil price volatility may be leading changes in economic output.

### 1.3 Research Objectives

The objectives of this study are to:

- Examine the relationship between oil price volatility and the stock price volatility of the selected African countries,
- Examine the impact of oil price volatility on macroeconomic performance of the selected African countries.
- Identify the transmission channels through which oil price volatility affects the economy of the selected African countries.

### 1.4 Research Questions

The following research questions are intended to be answered by this study:

1. What is the relationship between oil price volatility and stock prices of the selected African countries?
2. What is the impact of oil price volatility on macroeconomic performance of the selected African countries?
3. What are the transmission channels through which oil price volatility affect the economy of the selected African countries?

### 1.5 Significance of Study

- The results of this study will help policy makers enhance economic growth through monetary policy reforms amid oil market volatility.
- This study will also help policy makers adopt policies and strategies for maintaining safe and stable economic system amid oil market volatility.

### 1.6 Overview of the chapters

To achieve the objectives of this research, the rest of the study is organised as follows; Chapter one (1) the current chapter which focuses on introduction and research objectives. Chapter two (2) is on theoretical and empirical literature from previous researchers on the research topic. Chapter three (3) is on research methodology, this chapter will explain the research methodology used in answering the research questions and research objectives. Chapter four (4) is on data analysis and interpretation of results. Finally, Chapter five (5) is on summary, conclusion and recommendations. Chapter five (5) summarises the empirical results for this research and draws conclusion from the results obtained, as well as suggestion for policy makers and further research for researchers on this topic.

## CHAPTER 2: LITERATURE REVIEW

### THEORETICAL LITERATURE

The relationship between oil prices and stock price movements

According to Basher & Sadorsky (2006) oil price volatility may affect stock prices directly through future cash flows or indirectly through the interest rates that discount the future cash flows. The effects of external supply side shocks are obtained by the oil and commodity prices. Rising oil prices will lead to energy and production cost increases which reduces the firm's future cash flows and thus the stock market returns (Anderson & Subbaraman, 1996).

Based on the economic relationship Oil prices can affect expected future cash flows and discount rates, as like labour and capital oil is a real resource which is an important part of the firm's production costs. Changes in oil will lead to changes in expected firm's costs and thus the stock prices depending whether the firm is an oil producer or consumer (R. D. Huang, Masulis, & Stoll, 1996).

Narayan & Narayan (2010) argue that there are two channels which oil prices can impact stock prices. Firstly, oil affects production costs as it is used in the production process of goods. A rise in oil prices increases production costs and lowers stock prices. Secondly, through the discount rate which includes the expected real interest rates and expected inflation.

Degiannakis, Filis, & Arora (2017) postulates that stock-valuation, monetary, output, fiscal, and uncertainty are the five (5) channels which link the impact of oil prices on stock market returns. The authors indicate that through the stock-valuation channel, the firm's stock returns are affected by oil prices directly through future cash flows and/or discount rates positively or negatively depending on whether the firm is an oil producer or consumer. For oil consuming firms an increase in oil prices increases the firm's production costs which will reduce profits and thus cash flows.

Through the monetary channel, Degiannakis et al. (2017) posits that as oil prices affect discount rates of future cash flows, the discount rates are partially composed of expected real interest rates and expected inflation. Increases in oil prices effect increases in the production costs, the firms transmit the increased costs to the consumers leading to higher retail prices and higher expected inflation. In response to inflationary pressure, assuming the policy makers follow the Taylor rule, there is an expectation that short-term interest rates will be increased. The increase will lead to

increases in the cost of borrowing and reduce stock prices due to increased discount rates and /or lower cash flows. This however depends on the stability and credibility of the central bank.

According to Degiannakis et al. (2017) the third channel is the output channel, where the transmission from oil price fluctuations to the aggregate output is through the income and production cost effect. Increase in oil prices tend to lead to lower discretionary households' income, which leads to lower consumption and therefore lower aggregate output.

Through the fiscal channel, Degiannakis et al. (2017) posits that oil exporting countries financing their physical and social infrastructures using oil revenues, increase in oil prices tend to increase the exporting countries' wealth through the transfer of wealth from the oil importing countries which leads to increased exporting countries' government spending. Assuming that government spending and consumption complement, government spending will lead to increased household consumption and therefore profits will increase and thus stock prices.

The final transmission according to Degiannakis et al. (2017) is the uncertainty channel, where high oil prices cause uncertainty in the real economy due the effects of inflation, output, consumption etc.

#### Stock Market and Macroeconomic Volatility

According to Schwert (1989), the stock prices are given by the discounted present value of the future expected cash flows in a form of dividends/capital gain, and the conditional variance of the stock price at a point in time depends on the future cash flows and future discount rate conditional variance. If future discount rates were to be kept constant over time, then the conditional variance of stock prices will be proportional to the conditional variance of expected future cash flows. Therefore, Schwert (1989) argues that at aggregate level, the stock market should depend on the status of the economy.

The studies following Schwert (1989), such as Liljeblom & Stenius (1997), Morelli (2002) and Chinzara (2011) are consistent with the theoretical linkage between stock markets and the macroeconomy. Kumari & Mahakud (2015) postulate that the behaviour of macroeconomic fundamentals can be linked to the stock market volatility through the theoretical provisions of the dividend discount model (DDM) and the arbitrage pricing theory (APT).

Acikalin, Aktas, & Unal (2008) argues that the exchange rate has influence on the stock prices through the effect of trade effect. Provided that the demand for export goods is elastic, the depreciation of local currency will increase the volume of exports and local companies will have increased cash flows which results in increased in the stock prices.



Ratanapakorn & Sharma (2007) suggests that short-term and long-term interest rates have negative influence on stock prices, as an increase in interest rates may increase firms' financing costs which have an impact on the profitability and stock prices.

Additionally, Ratanapakorn & Sharma (2007) posits that stock prices are lead indicators of the economy first through consumption and investment activity which may lead to changes in output. Second the increase in the firms' output may cause increase in profits that will increase cash flow and as a result stock price.

## EMPIRICAL LITERATURE

The relationship between Oil prices and Stock prices movements

According to Mokni & Youssef (2019), the relationship between crude oil prices and the six (6) GCC stock markets is significantly positive, with Saudi Arabia stock market having the highest degree of persistence relative to other countries from the dependence of oil. The authors also found that distribution from the dependence of oil between the GCC stock markets is stronger in the tails than the centre and sensitive to both bad and good news. Furthermore, the results show that there is more distinct persistence of dependence between oil markets and the stock markets before the crisis in most GCC markets.

These findings are consistent with findings from Arouri & Fouquau (2009), which indicate that there is a positive and significant link between the short-run relationship of oil price changes and GCC stock markets of Qatar, Oman and the UAE. The authors showed that oil price changes do not affect the GCC stock markets returns of Bahrain, Kuwait and Saudi Arabia.

In recent studies from the GCC region, Hamdi, Aloui, Alqahtani, & Tiwari (2019) indicate that at sectoral level the energy, industrial, financial and basic materials sectors have a positive relationship with the oil price volatility and that the banking, oil/gas and transport sectors have negative relationship with the oil price volatility in a high market (90<sup>th</sup> quantile). The findings also indicate that in the high quantile market oil price volatility does not affect sectors such as insurance, telecommunications, utilities and minerals.

In addition, the results show that in the middle market (50<sup>th</sup> quantile) oil price volatility does not affect the minerals, utilities and telecommunications sectors, however both positive and negative oil price volatility negatively affect the energy, utilities, banking, financial, industrial, insurance, oil/gas and transportation sectors. Whereas in a low market (10<sup>th</sup> and 25<sup>th</sup> quantile) a significant

and positive oil price volatility influences the industrial and insurance sectors, while utilities, minerals and telecommunication are not affected by oil price volatility.

Regarding causality from oil price volatility on GCC sector returns, Hamdi et al. (2019) show that causality is affected by interdependency and contagion impact in the long and short run. The researchers conclude that all sectors have interdependency with the oil price volatility apart from the transport and energy sectors.

According to Akoum, Graham, Kivihaho, Nikkinen, & Omran (2012), there is evidence of the changing nature of oil prices and stock prices co-movements in the GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi-Arabia and United Arab Emirates -UAE) in the long run at frequencies of 6 months. The researchers further found that the dependency between oil prices and stock prices is weak in the short run for periods between two (2) weeks and six (6) months. The authors also found similar results of the co-movements dependency between oil prices and stock prices of Egypt and Jordan in the short run, however in the long run dependency is weaker in Egypt relative to Jordan, suggesting that countries differ in the relationship between oil prices and stock prices in the long run.

Using the Markov regime switching models, findings from Naifar & Al Dohaiman (2013) indicate that the relationship between oil price volatility and stock market returns relies on the state of the regime (crisis or tranquil) in the GCC countries excluding Oman in the state of low volatility. In a more recent study to investigate the long run relationship between oil price risk and Tehran stock exchange return in the presence of structural breaks, Nejad, Jahantigh, & Rahbari (2016) presented findings that indicate that the Tehran stock market returns have a long run relationship with the oil price risk. The authors indicate that the international sanctions imposed on Iran have an impact on the study.

Bastianin, Conti, & Manera (2016) investigated the effects of crude oil price shocks on the stock market volatility of the G7 countries (US, Canada, UK, Japan, Germany, France and Italy), the findings indicate that there is significant effect of oil demand side shocks on the stock market volatility of the G7 countries and that the supply side shocks had no effect on the volatility of the stock market. The authors found evidence that the aggregate demand shocks particularly impacted on the volatility of the stock market and approximated that at least 10% of the changes in stock market is attributable to the aggregate demand shocks in the long run for the G7 countries.

The study further suggests that in the long run the level of aggregate demand growth rate of the oil should be reduced to limit the effects of the oil price shocks on the stock markets. The findings are consistent with findings presented by Kilian & Park (2009), who concluded that global aggregate and oil specific demand shocks play a vital role than the oil supply shocks in explaining the changes in aggregate US stock market returns. In contrast, (Kang, Ratti, & Vespignani, 2016) found that both oil demand and supply shocks are important in explaining the changes in US stock market returns.

Silvapulle, Smyth, Zhang, & Fenech (2017) examined the price index and the oil price indices of the ten (10) large net oil importing countries (USA, Japan, China, South Korea, India, Germany, France, Singapore, Italy and Spain), the results show that there is a positive and significant impact of the oil price on the stock market prices more especially after the global financial crises. Moreover, Silvapulle et al. (2017) stated that previous studies found a negative relationship between oil and stock market, which the authors indicate to suggests a behaviour change between the oil and stock price in the long run.

Findings of a changing relationship are consistent with Miller & Ratti (2009), who analysed the relationship between world price of crude oil and international stock markets for six (6) OECD countries (Canada, France, Germany, Italy, UK and USA) for the period 1971 to 2008. The findings indicate that there is evidence of a significant negative relationship in the long run between oil price and stock prices in the six (6) OECD countries for the period January 1971 to May 1980, as well as for the period February to September 1998. Miller & Ratti (2009) also document evidence of a change in the relationship after September 1999, attributing the change to the stock market and/or oil price bubbles.

Furthermore, Reboredo & Rivera-Castro (2014) investigated the relationship between oil and stock markets in both Europe and the USA at aggregate and sector levels for the period June 2000 to July 2011, using a wavelet multi-resolution analysis. The findings indicate that pre-global financial crisis (2008-2009), there is no influence of oil price changes on the stock market returns at both aggregate or sector level, besides the positive influence of oil and gas listed firms. The researchers state that when the global crisis started there was existence of contagion and positive interdependence between the oil and stock markets in Europe and the USA.

According to Reboredo & Rivera-Castro (2014), post global financial crisis, oil prices and stock prices influence each other at high frequencies and at lower frequencies the effects examined using wavelet cross correlations had both significant negative and positive lead lag correlations. The findings from Reboredo & Rivera-Castro (2014) are consistent with the findings from Bagirov & Mateus (2019) , which indicate that crude oil prices have a significant positive relationship with the performance of listed oil and gas firms. The authors concluded that the global financial crisis (2008-2009) only negatively impacted the financial performance of the listed oil and gas firms in the western European region.

Huang, Gao, & Huang (2015) identified that there is evidence of a dynamic relationship between crude oil price and sector stock indices in the short, medium and long term, apart from indices of basic commodities such as the health, utility and other consumption sectors in China. According to Huang et al. (2015), results indicate that reaction of different sectors reaction to crude oil price shocks vary over different horizons. Using the wavelet transformation, the authors found that there is a negative relationship of the stock indices in Chinese sectors (particularly material, telecommunication, energy, information sectors) in the short-run and a positive relationship in the medium/long-run and the finance sectors respond positively throughout the different time scales.

Stavros Degiannakis & Vipin (2018) found evidence that high oil prices result in lower stock market returns for oil importing countries, whilst higher oil prices result in higher oil stock market returns for oil exporting countries. The supply or precautionary demand shocks of an oil price increase causes a negative response of the stock markets and a boost from global economy/ global aggregate demand shocks causes a positive response of the stock market, the authors also concluded that conclusions vary based on use of symmetric/asymmetric or unexpected changes in the price of oil.

According to Guesmi & Fattoum (2014), the dynamic correlations between oil prices and stock markets are not different between oil importing (USA, Italy, Germany, Netherland and France) and oil exporting (United Arab Emirates, Kuwait, Saudi Arabia and Venezuela) countries. The relationship between oil prices and stock markets is positive. In addition, Creti, Ftiti, & Guesmi (2014) indicated that in exporters market the interdependency between the oil price and stock market is stronger that it was found in importers market.

## Relationship between Oil price and Stock price in Emerging markets

There are a few studies done on the effects of the oil price impact on the emerging market stock markets. Maghyereh (2004) investigated the linkage between 22 emerging markets stock market returns and crude oil shocks and found that there is a weak relationship between the stock market returns and crude oil price and observed a slow transmission of innovations in the oil market to the stock market. The researcher stated that this suggests that the emerging markets have an inefficient stock market transmission of the oil market shocks. The findings also indicate that the differences in the impact of oil price changes are due to the intensity of oil consumption and production of the countries.

In an investigation between oil price risk and the stock market returns of the new members of the European union and Russia, Asteriou & Bashmakova (2013) found statistically significant results that indicate that oil prices can predict stock market returns and that there exist a negative relationship between the two variables such that an increase in oil prices causes a decrease in stock returns.

In other studies, Dutta, Nikkinen, & Rothovius (2017) found using the GARCH model that oil price uncertainty measured using the OVX (crude oil volatility index) has an impact on the stock market volatility of the Middle East and African countries, and that the effects of volatility are persistent. The findings report that there is a significant positive relationship between oil prices and realised stock market uncertainties and further indicated existence of jumps that are time varying. These findings are consistent with findings presented by Dutta, Noor, & Dutta (2017) who also indicate that there is a positive relationship between the global oil price and emerging economies' stock prices. The authors also state that the impact of the oil price volatility seems to have decreased in periods of global financial crises.

Awartani, Javed, Maghyereh, & Virk (2018) found strong evidence from the MENA region that shows that the volatility of equities is affected by the oil price volatility in the long run. The authors found positive conditional correlations between oil and stock markets particularly Saudi Arabia, Egypt and Turkey and observed that the correlations are sometimes negative and small. The results further indicate that the correlation is increased following a big fall in oil prices. In addition, the researchers found that in the short run correlations between oil price and stock prices are tiny and deteriorate particularly in the oil importing countries. According to Awartani et al. (2018) ,this

suggests that diversification and risk management benefit can be realised in the short run especially in the oil importing economies in the MENA region.

Regarding major emerging economies, Nasir, Naidoo, Shahbaz, & Amoo (2018) investigated the implications of oil price shocks on the BRICS countries (Brazil, Russia, India, China and South Africa) using a time varying structural vector autoregressive (TV-SVA) approach and examined quarterly data from 1987 and 2017. The results show that the five (5) countries are impacted by the oil price shocks and stated that there are differences to the response and asymmetries of different countries to oil price shocks.

Findings from Nasir et al (2018) further reveal that differences between oil importers and exporters are distinct and strong, in that oil exporters' economies are strongly influenced by oil price shocks relative to oil importers. The Russian economy was found to be more reliant on oil than the Brazilian economy from the impact of oil price shocks to their key macro-economy. In terms of the oil importers, a negative impact was found between the oil price shocks with inflation, GDP and balance of trade. In the South African context, the researchers found that there is negative impact of oil price shocks which are time varying in nature relative to other BRICS members.

Nasir et al. (2018) also indicated that the differences found within the oil importing and exporting countries based on their intensity of impact, suggests that in addition to countries being oil importers or exporters, the structure of the economy plays a significant role on the impact of oil prices on the stock market.

The above findings are consistent with other studies regarding the oil importing or exporting nature of countries such as Aloui, Nguyen, & Njeh (2012), who examined the impact of oil shocks on the 25 emerging market returns and found variations between the oil exporting and importing countries. In addition, Aloui et al. (2012) found that the oil price fluctuation impacts are asymmetrical to the market conditions.

## Developing African countries: Relationship between Oil prices and Stock prices movements

Few researchers have studied the relationship between oil prices and stock price in African countries.

### Nigeria

According to Gil-Alana & Yaya (2014), there is a significant positive relationship between oil prices and the Nigerian stock market with a short memory effect, the positive relation is only significant during the following three (3) months. The authors indicate that they did not consider cyclical structures or asymmetric models that affect the relationship between oil prices and the stock market in Nigeria.

Olufisayo Akinlo (2014) investigated the long run relationship between changes in oil prices and stock market growth over the period 1981- 2011, the findings show that there is a unidirectional granger causality from oil price fluctuations to the stock market in Nigeria. The results also indicate that oil prices, stock market and exchange rate are co-integrated.

According to the results presented by Fowowe (2013) using GARCH-jump models, there is evidence of insignificant negative impact of oil prices on the stock returns of the Nigerian Stock Exchange (NSE). The author posits that the results could be that the NSE contains less of oil related firms to influence and channel oil price movements to the stock market, and that the NSE is more dominated by the banking sector stocks. Fowowe (2013) indicates that the results could also be due to discouraged investment because of high transaction cost on the stock exchange or the low liquidity in the NSE.

Consistent with findings of Fowowe (2013), Adenikinju, Adetunji Babatunde, & Adenikinju (2013) found that there is evidence of positive stock market returns response to oil price shocks in Nigeria for the period 1995 and 2008. However, the authors indicate that response to oil price shock is statistically insignificant which depending on the type of shock, response reverts to negative after some time. Moreover, the authors indicate that when there is volatility in the price of oil, then there is a negative impact on the stock market returns.

### Tunisia

To capture the effect of oil price volatility on the Tunisian stock market at sector level together with the hedging strategy, Hamma, Jarboui, & Ghorbel (2014) used the bivariate GARCH model and found evidence of unidirectional relationship from the oil market to the Tunisian stock market at sector level. The authors indicated that there is significant volatility and shock transmission to

the various stock market sectors. In addition, the findings also report that stock sector returns' conditional variance is also affected by the oil market and not only by the volatility in the stock market.

In recent studies, Dutta et al. (2017) found that there is a significant negative relationship between oil prices and stock markets of Nigeria, Egypt, Tunisia, South Africa and Mauritius. For Tunisia, the findings from Dutta et al. (2017) are consistent with findings presented by Bouri, Mohamed & Zaabouti (2016), who investigated the effect of oil prices on the value of nineteen (19) firms in Tunisia and found results that show that higher oil prices negatively affect the value of the industrial firms and concluded that the size of the firm is not significant to explain the firms' loss of value.

### Egypt

According to Zaki et al. the Egyptian stock market returns show a positive significant relationship with the oil price fluctuations. The results are in contrast with those by Dutta et al. (2017), which indicate that the Egyptian stock market have a negative relationship with the oil price.

### Algeria

According to Kamel Si, Benhabib, & Maliki (2016), there is evidence of a positive effect of oil price movements on the Algerian economy.

### South Africa

According to Goodness (2015) oil price uncertainty has a negative effect on the South African stock market returns, the author also found that there exists an asymmetric response of stock market returns to both negative and positive oil price uncertainty shocks.

The results from Goodness (2015) are consistent with the earlier findings presented by (Gupta & Modise, 2013). The findings from Gupta & Modise (2013) show that there is evidence of significant negative relationship between stock returns and real price of oil from the effect of oil supply shock and speculative demand shocks. The findings of the negative relationship between oil prices and the stock market for South Africa are consistent with those indicated by (A. Dutta et al., 2017).

Gourène & Mendy (2018) investigated the co-movement of OPEC (Organisation of Petroleum Exporting Countries) oil prices and the six African stock markets (Egypt, Morocco, South Africa, Nigeria, Kenya and BRVM: Benin Burkina Faso Guinea Bissau Côte d'Ivoire Mali Niger, Senegal, Togo) using a wavelet coherence analysis.



The authors found that at large scales (128-512 days) the OPEC prices and the African stock markets co-movement is very low, apart from the Egyptian and South African stock market. The authors further indicate that during and after the global financial crisis (2008-2009) there is evidence of strong correlation between the oil price and stock markets.

Gourène & Mendy (2018) conclude that the co-movements of oil and stock markets are weak in the short and medium run, however in the long run the co-movements are stronger.

In a working paper, (Alfred) found that oil price changes would negatively impact the economies of Mauritius, Mozambique, Tanzania, and Zambia

#### [The Relationship between the Stock market and the Macro economy](#)

Using cointegration tests and vector error correction models to examine the relationship between Istanbul stock markets and macroeconomic variables for the period 1991 to 2006, Sezgin, Rafet, & Seyfettin (2008) found evidence of cointegration between the stock price index and the macroeconomic variables (production, exchange rate, interest and current account balance) which also indicates a long run relationship between the variables. The results show unidirectional causality from the stock price index to interest rates. The findings were not conclusive on whether there is positive or negative relationship between stock price index and interest rates.

The other causality observed from the findings is from macroeconomic variables to the stock market returns, the lagged stock price index, GDP, exchange rate and current account balance have negative impact on the current variations of the stock price index.

Similarly, Christopher, Minsoo, Hua Hwa Au, & Jun (2006) found that the New Zealand stock market is cointegrated with some macroeconomic variables (inflation rate, long term interest rate, real trade weighted exchange rate index, GDP, money supply and domestic retail prices) in the long run. Impulse response analysis results indicate that inflation rate shocks have a negative impact on the New Zealand stock index (NZSE40).

According to Christopher et al. (2006), the granger causality tests indicate that the NZSE40 is not a leading indicator of any of the macroeconomic variables. Findings also show that a shock on the exchange rate, inflation rate, long term interest rates and GDP have a significant impact on the NZSE40. The authors concluded that long term interest rates, short term interest rates, money supply and GDP could explain the NZSE40.

By using linear regression to test the effects of macroeconomic factors (GDP, employment rate, exchange rate, inflation and money supply) on stock returns over the period January 2003 to

December 2008 in Taiwan, findings from Singh, Mehta, & Varsha (2011) show that exchange rate and GDP portfolio have a strong significant impact on stock returns of firms in Taiwan, except for stock returns of small firms. However, it was found that inflation has significant impact on stock returns of small firms only. The results indicate that employment rate and money supply have no significant influence on stock returns of all firms. The researchers found a negative relationship between stock returns (medium and big firms) and macroeconomic variables (inflation rate, exchange rate, and money supply)

In an investigation of conditional volatility between stock markets and macroeconomic factors in the G7 countries for the period July 1985 to June 2015 using GARCH and VAR models, Abbas, McMillan, & Wang (2018) found evidence that there is persistence in volatility and evidence of asymmetric characteristics between the stock market returns and macroeconomic (industrial production, short term interest rates and oil price) variables in the G7 countries.

The findings also reveal that inflation, industrial production growth and money supply have a positive relationship with stock market volatility for all countries, however for interest rates the volatility transmission is negative and insignificant excluding for Japan. The author found that there is bidirectional causality between the macroeconomic variables and stock market returns except for the UK where unidirectional causality was observed.

Abbas et al. (2018) posits that causality between stock market and macroeconomic factors highlights the interdependence of the variables. The G7 countries macroeconomic factors have a significant volatility transmission to stock market volatility; however, the effect is weak when individual macroeconomic factors are observed.

These findings are consistent with those presented by Borjigin, Yang, Yang, & Sun (2018) that indicated presence of nonlinear granger causality from Chinese stock market to the macro economy and vice-versa.

According to Filis (2010) , oil prices with stock markets have a significant and positive impact on the CPI (consumer price index) and when employing cyclical components, the oil prices have a significant and negative impact on the stock market. Oil prices also have a negative and significant impact on CPI. Moreover, the results did not indicate any impact of oil prices on industrial production growth and CPI in the Greek market. The stock market was also found to not have relationship with industrial production growth.

### The Stock market volatility and Macro economy

According to Beltratti & Morana (2006) the stock market volatility influences the macroeconomic volatility especially that of output and inflation volatility. Evidence of bidirectional causality relationship between the stock market volatility and macroeconomic volatility was found. Moreover, the results indicate that the causality from macroeconomic volatility to stock market is stronger relative to the causality from stock market to macroeconomic volatility.

The results are consistent with those indicated by Liljeblom & Stenius (1997), which show that through VAR estimations there is evidence of significant relationships between the stock market volatility and macroeconomic volatility for Finland for the period 1920 to 1991. Findings indicate that the stock market volatility can explain macroeconomic volatility, and the macroeconomic volatility can explain stock market volatility

Similar findings were observed by Chinzara (2011) who found that there is evidence of volatility transmission between the stock market and microeconomic factors. The author also indicates that the observed transmission between the stock market and the macroeconomic variables is bidirectional particularly for the exchange rate and the Treasury bill rate. The author posits that the bidirectional transmission indicates interdependence in financial markets of South Africa. Furthermore, Chinzara (2011) indicates that during financial crises the stock market and macroeconomic volatility significantly increases.

In other studies, Oseni & Nwosa (2011) investigated the relationship between stock market volatility and macroeconomic (real GDP, inflation, and interest rate) volatility in Nigeria, using an E-GARCH model on time series data for the period 1986 to 2010. Results show that there is evidence of bidirectional causality between the stock market volatility and the real GDP. The authors found no evidence of granger causality between the stock market volatility and the interest rates and inflation rate volatility.

Oseni & Nwosa (2011) posits that the stock prices were not found to be significant in indicating the interest rates and inflation rates, similarly interest rates and inflation rates do not indicate the stock prices. The findings from Chowdhury & Rahman (2004) are in contrast with the recent findings that indicated bidirectional causality between the stock market volatility and the macroeconomic variables. According to Chowdhury & Rahman (2004), there is evidence of significant unidirectional relationship running from macroeconomic variables volatility to stock market volatility in Bangladesh.

Beetsma & Giuliodori (2012) examined the macroeconomic (GDP growth, inflation and the federal funds rate) response to stock market volatility shocks for the period 1950 to 2011. The findings show that the impact of stock market volatility results in the decrease in the US real GDP growth. Moreover, the findings show that over time the negative response of real GDP growth to stock market volatility shocks has reduced. Furthermore, the results from Beetsma & Giuliodori (2012) also show that for the period 1950 to 1984, GDP growth respond negatively to a fall in consumption and investment growth. For the period 1984-2011, only a fall in investment growth effect a decrease in GDP growth.

Findings from Chauvet, Senyuz, & Yoldas (2015) show that since year 2000, industrial production growth and employment growth can be forecasted by both the stock market volatility measures and the common volatility factor. In addition, the authors indicate particularly in the short run that the stock market and the common volatility factor can improve forecasting the term spread, the credit spread and the stock market return. Asymmetry in mean, variance and autoregressive parameters of the common factor were observed for the two states of financial volatility.

The authors conclude that the low financial volatility state is linked to economic expansion with healthy growth, while the high financial volatility state is linked to economic downturn or recessions. Chauvet et al. (2015) posits that warnings of great recessions can be detected early using nonlinear dynamic factor models.

## SUMMARY OF FINDINGS

A lot of studies have examined the relationship between oil prices and the stock market, some authors indicate a significant negative relationship between the two variables, while other studies show that there is a positive relationship between oil prices and the stock market. Whilst some studies find a weak relationship between oil prices and the stock market. The literature evidence, however, indicates that there is strong evidence that countries stock markets have a relationship with the oil price changes. Moreover, literature findings also suggest that there is a distinct significant relationship between oil prices and the stock market which depends on whether a country imports or exports oil.

Some of the literature findings suggest that the oil importing countries exhibit a negative relationship between oil prices and the countries' stock market. Whereas the oil exporting countries indicate that there is a positive relationship between oil prices and stock market. However, recent studies suggest that some oil importing countries' show that stock markets react positively to the changes in oil prices due to the countries' aggregate demand of oil. In addition, evidence from the GCC region which comprises mostly of oil exporters, is not conclusive. Some studies indicate a positive relationship, while others indicate a negative relationship between oil prices and stock markets, also at sectoral level. The findings also suggest that the relationship between oil price and stock price varies across countries, depending on the structure of the economy.

A few studies indicate that the relationship between oil prices and stock markets has changed over time for various countries and further indicated the impact of the global financial crises on the relationship. A few studies have been done to investigate the developing African countries' relationship between oil price and stock markets, the presented results indicate that the relationship is not conclusive.

Most literature findings show that there is evidence of volatility transmission between the stock markets and the macro economy and that the causality is bidirectional, with a few studies indicating that the transmission is bidirectional either from stock market to the macroeconomic variables and vice versa. Other studies indicate that there is no volatility transmission either from stock markets to the macro economic variables and vice versa.

Very limited literature was examined from the African countries. The impact of volatility transmission from the stock market to the macroeconomic variables, differs across countries and economic periods. There is little research on African countries regarding the identification of the volatility transmission channels through which oil prices volatility affect the economic performance.

## CHAPTER 3: METHODOLOGY

### 3.1 Introduction

Chapter two (2) reviewed the literature on theoretical and empirical studies on the volatility of oil prices, stock markets and the economy in the world across different time periods. This chapter builds on the background and sets the analytical framework used to answer the questions of this research.

### 3.2 Population and Sample

This study's period and the selection of the countries are restricted by the availability of data. These countries include a group of three (4) upper middle-income countries, three (3) lower middle-income countries and one (1) low income county according to the World Bank (2018). The countries chosen for the examination of the volatility transmission in developing African countries are South Africa, Botswana, Mauritius, Kenya, Tanzania, Tunisia and Nigeria for the period July 2003 to November 2019 (16 years). These countries cover developing countries in East, West, South and North African region.

The period for this study is selected based on the availability of data for all variables in the study. In addition, the period selected covers the times which oil markets and financial markets experienced turbulences such as the 2007/8 financial crisis and the European debt crisis in 2011. Furthermore, the period experienced sharp oil price movements caused by conflicts in the Middle East, increases in the global demand driven by the Chinese economic growth and the actions of OPEC.

### 3.3 Data

#### 3.3.1 The relationship between oil price volatility and stock price volatility of the selected African countries

$$H_i = C'C + \sum_{i=1}^k A_i' \varepsilon_{t-i} \varepsilon'_{t-i} A_i + \sum_{i=1}^k G_i' H_{t-i} G_i \dots \dots \dots (1)$$

Where, C is a lower triangular matrix of constants while A and B are  $n \times n$  parameter matrices. The dimension N is the number of variables in the model. The matrix A shows the extent to which conditional variances are correlated with past squared errors. Therefore, the elements of matrix

A capture the effects of shocks on conditional variances (volatility). On the other hand, matrix B shows how current levels of conditional variance are affected by past conditional variances. The diagonal parameters of the matrices A and B measure the impact of own past shocks and past volatility of market i on its conditional variance. Moreover, the off-diagonal elements of the matrices A and B depict how the past squared error and conditional variance of one market i affects the conditional variance of another market j, also known as volatility spillovers (Yonis 2011). Equation 1 ensures definite positive diagonal representations. This study modifies this equation as also presented by Mohammadi and Tan (2015) by setting the lag length to one which results in a parsimonious specification of the diagonal BEKK (1,1) model and is presented as follows;

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon'_{t-1} + G'H_{t-1}G \dots \dots \dots (2)$$

The conditional variance is conveniently decomposed by the BEKK model into ARCH and GARCH components (Mohammadi & Tan, 2015). This research employs the Baba-Engle Kraft-Kroner (BEKK) as defined in Engle and Kroner (1995) and extends previous literature by employing the BEKK GARCH model to examine and understand the relationship between oil prices and the selected developing African stock prices in terms of volatility.

In financial applications multivariate models are useful tools for making better inferences in areas such as risk assessment (Value at risk forecasts etc.), asset pricing models, portfolio selection, hedging etc. more than univariate models offer, as suggested by (Bauwens, Laurent, & Rombouts, 2006). According to Silvennoinen and Teräsvirta (2009) , the BEKK GARCH has a desirable property of ensuring positive definiteness of the conditional covariance matrices. The BEKK GARCH model allows for conditional variance dependence of a variable on the lagged values of the other, which enables for modelling of causalities in variances.

In a similar study to examine the volatility and conditional relationship between inflation rates, exchange rates and interest rates in Ghana for the period January 1990 to December 2013 using GARCH DCC and BEKK models, Nortey, Ngoh, Doku-Amponsah, and Ofori-Boateng (2015) found the BEKK model to be more robust in modelling and forecasting volatility, whilst the DCC model was found to be robust in modelling conditional and unconditional correlation.

In a recent study by Mademlis and Dritsakis (2018), who employed the bivariate BEKK-GARCH (1,1) approach and examined the conditional volatility between the oil prices and the stock market index Dow Jones and found no evidence of transmission of shock as well as volatility spillover



between the oil and stock market. Furthermore, the researchers found that the stock and oil indices are only affected by their own shocks and own lagged conditional volatility.

Finally, Chen, Li, and Jin (2018) analysed the mean spillover effect and the volatility spillover effect between the crude oil futures prices and the Chinese energy stock, the BEKK model is found to fit the data sample best in comparison to the DCC and CCC GARCH models. The results indicate that there is spillover effects between the two markets. The time varying conditional correlations indicate high conditional correlations in November 2010 as a result of economic crisis recovery.

### 3.3.2 The impact of oil price volatility on macroeconomic performance of the selected African countries

The model by Van Eyden et al. (2019) is presented in Equation 3 as:

$$gr_{it} = \beta_0 + \beta_1 gr_{i,t-1} + \beta_2 roilunc_{it} + \beta_3 infl_{it} + \beta_4 liy_{it} + \beta_5 lgov_{it} + \beta_6 ldebt_{it} + \beta_7 rstockret_{it} + \beta_8 crisisjst + \mu_i + \epsilon_{it} \dots \dots \dots (3)$$

Where *gr* is the dependent variable, defined as growth in real GDP. A lagged dependent variable is included amongst the regressors to capture the dynamic nature of the economic growth process. The primary variable of interest, *roilunc*, is the annualised real oil price volatility, while *infl* signifies the inflation rate. The investment to GDP ratio, expressed in natural log terms, is indicated by *liy*. Variable *lgov* is defined as the log of government expenditure as a ratio to GDP, while *ldebt* denotes log of public debt as a ratio of GDP, *rstockret* denotes real stock returns, and *crisisjst* is a dummy capturing systemic financial crises.

This study adopts the panel data Generalised Method of Moments model and modifies equation 3 as:

$$gdp_{it} = \beta_0 + \beta_1 gdp_{i,t-1} + \beta_2 bpvol_{it} + \beta_3 infl_{it} + \beta_4 liy_{it} + \beta_5 lgov_{it} + \beta_6 pd_{it} + \beta_7 stockp_{it} + \mu_i + \epsilon_{it} \dots \dots \dots (4)$$

Where *gdp* is the dependent variable, defined as growth in real GDP. A lagged dependent variable is included among the regressors to capture the dynamic nature of the economic growth process. The primary variable of interest is brent crude price volatility (*bpvol*) as a proxy for oil price volatility. The conditional variance of the parsimonious GARCH (1, 1) model is used as a proxy of oil price volatility over the sample.

The Control variables include inflation indicated as *infl*, public debt as a ratio to GDP *pd*, and the stock price indicated as *stockp*.

The investment to GDP ratio and the government expenditure as a ratio to GDP variables have been dropped in the modified equation as there is no data for most of the selected countries in the sample for the sample period.

In order to estimate the impact of oil price volatility on macroeconomic performance of the selected African countries, this research utilised the Blundell and Bond (1998) system-GMM dynamic panel estimator, a method compiled of first-differences instrumented on lagged levels, and of levels instrumented on lagged first-differences, to control for possible endogeneity. In addition, it also holds two further attractive statistical features. First, comparing to the cross-sectional regressions, tackling measurement error, the GMM dynamic panel estimator is more robust. Second, if the instrumental variables are adequately lagged, the GMM dynamic panel estimator remains steady. This study also employed the two-step estimator following Wooldridge (2010) who stated that it solves the problems of heteroscedasticity, autocorrelation of errors, simultaneity bias and measurement mistakes.

Hsiao (2014) argues that panel data set for economic research has an advantage over conventional cross sectional or time series data sets as it allows the researcher to analyse a number of important questions. The author also indicates that the efficiency of econometric estimates is improved with panel data for it gives the researcher large data points increasing the degrees of freedom and reducing collinearity among explanatory variables.

In a similar study, Buddelmeyer, Oguzoglu & Webster (2008) present findings that indicate that LSDVC, A-HIV and GMM estimators perform well across a range of different panel dimensions compared to the OLS estimators.

Other similar studies have employed the panel data models, such as Sibanda, Gonese, Mukarumbwa (2018), who used panel data analysis technique such as FE and FGLG to examine the impact of oil prices on sectorial output in South Africa from 1994 to 2016.

In a recent study, Van Eyden et al. (2019) used panel data estimators including fixed effects (FE), bias corrected least squares dummy variables (LSDVC), generalised methods of moments (GMM), feasible generalised least squares (FGLS) and random coefficients (RC) to analyse the impact of real oil price volatility on the growth of 17 OECD countries.

### 3.3.3 The transmission channels through which oil price volatility affect the economy of the selected African Countries

This study employed the Vector Error Correction Model (VECM) to identify the transmission channels through which oil price volatility affect the economy in selected African countries. The VECM is a special case of vector autoregressive (VAR) where variables are stationary in their difference, unlike in the instance of VAR where variables are stationary at level. The VECM has been broadly applied in empirical analysis to analyse oil price fluctuations impact on economic growth (Polbin, 2017). Recent studies have examined oil price shocks transmission channels to economic growth using the Vector Error Correction Model (VECM) such as (Chuku, Effiong, & Sam, 2010), Burakov (2017) and Asari et al. (2011).

Following Barro and J. Lee (1993), the model that describes the linear relationship between variables in the Vector Error Correction Model can be stated as follows:

$$LGDP_{it} = f(EXR_{it}, RIR_{it}, INF_{it}, BPVOL_{it}, SPVOL_{it}) \dots \dots \dots (5)$$

Where  $LGDP_{it}$  is the level of economic growth in the selected African countries,  $EXR_{it}$  denotes the exchange rates in the selected African countries in relation to the US dollar,  $RIR_{it}$  epitomises the real rate of interest in the selected African countries,  $INF_{it}$  refers to the inflation rate in the selected African countries,  $BPVOL_{it}$  is the Brent crude price volatility characterised by the conditional variance of the GARCH (1,1) model (a proxy for oil price volatility) and  $SPVOL_{it}$  is the stock price volatility also measured by the conditional variance of the GARCH(1, 1) model. Brent crude price volatility is the principal exogenous variable identified in the model because it is determined by factors outside the model or forces beyond the control of the selected African countries. The current study used variance decomposition and impulse responses to identify the transmission channels through which the shocks from oil price volatility (as measured by the Brent crude price volatility) are transmitted to the level of economic growth.

#### 3.3.3.1 Tests for Cointegration

The variables identified in the linear model above were tested for cointegration as a necessary condition for VECM estimation. It is a common phenomenon that many financial time series may contain a unit root and there is a possibility that a linear combination of two or more non-stationary series may be stationary (Brooks 2014). If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. Consequently, the stationary linear combination is known as the cointegrating equation which resembles the long-run equilibrium relationship

among the variables. The study utilized the vector auto regression-based Johansen cointegration test to test for the cointegration of the variables. According to Brooks (2004), the Johansen Cointegration Test returns two test statistics known as the trace statistic and the maximum Eigen values statistic.

### 3.3.3.2 Trace test statistic

The trace statistic tests the null hypothesis of  $r$  cointegrating relations against the alternative hypothesis of  $k$  cointegrating relations, where  $k$  is the number of endogenous variables, for  $r = 0, 1, \dots, k - 1$ . According to Brooks (2014), the null hypothesis is rejected if all the variables tested are stationary in their levels or  $I(0)$ .

### 3.3.3.3 Maximum Eigen values test statistic

The maximum eigenvalue statistic tests the null hypothesis of  $r$  cointegrating relations against the alternative hypothesis of  $r + 1$  cointegrating relations for  $r = 0, 1, \dots, k - 1$ . As in the above mentioned case of the Trace test, the null hypothesis is rejected if all the variables tested are stationary in their levels (Brooks, 2014).

### 3.3.3.4 Vector Error Correction Model (VECM)

A vector error correction (VECM) model is a restricted VAR tailored to handle non-stationary series that are cointegrated. The VECM is highly specialized and has cointegration relations built into the specification such that it can effectively restrict the long run behaviour of the dependent variables to converge to their cointegrating relationships without compromising short-run adjustment dynamics. The cointegration term (error correction term) gives an indication of how the deviations from long-run equilibrium are gradually corrected by partial short-run adjustments. For a two-variable system with one cointegrating equation and no lagged difference terms. The cointegrating equation of the VECM is given by:

$$\Delta y_{1,t} = \alpha_1(y_{2,t-1} - \beta y_{1,t-1}) + \epsilon_{1,t} \dots \dots \dots (6)$$

$$\Delta y_{2,t} = \alpha_2(y_{2,t-1} - \beta y_{1,t-1}) + \epsilon_{2,t} \dots \dots \dots (7)$$

In the system of equations above, the error correction term is denoted by the right-hand side variable. If  $y_1$  and  $y_2$  deviate from their long run equilibrium, the error correction term will be non-zero and each variable adjusts to partially restore the equilibrium relation (Brooks, 2014). The coefficient  $\alpha_1$  measures the speed of adjustment of the  $i$ -th endogenous variable towards the equilibrium. The VECM model is interpreted in the context of the following categories:

#### 3.3.3.4.1 Impulse Responses

An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables (Gujarati, 2004). A shock to the  $i$ -th variable not only directly affects the  $i$ -th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR (Brooks, 2014). If the innovations  $\epsilon_t$  are contemporaneously uncorrelated, interpretation of the impulse response is straightforward. The  $i$ -th innovation  $\epsilon_{i,t}$  is simply a shock to the  $i$ -th endogenous variable  $y_{i,t}$ .

#### 3.3.3.4.2 Variance decomposition

Unlike the impulse responses, the variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR or VECM. Thus, the variance decomposition provides information about the relative significance of each Random innovation in affecting the variables in the system of equations (Gujarati, 2004).

#### 3.3.3.4.3 Pairwise Granger Causality or Block Exogeneity tests

The pairwise granger causality or block exogeneity test, tests whether a dependent variable can be treated as an explanatory variable. It traces the direction of cause and effect between the variable in the VAR or VECM (Brooks, 2014). The test returns the Wald statistics for the joint significance of each of the other lagged endogenous variables in that equation which follows a  $\chi^2$  distribution.

### 3.3.4 Variables

Table 1: Variables and definitions

Variable	Description	Data source
Growth rate of real gross domestic product (GDP)	The real GDP is the inflation adjusted measure of goods and services produced at national prices for each selected country (Rotimi & Ngalawa (2017). The growth rate of real GDP is measured by the quarterly percentage growth rate of real GDP	International Financial Statistics (IFS), World Bank Development Indicators, Bloomberg and national accounts dataset portal.
Oil price	The crude oil price traded on the crude oil market. Primary benchmarks for crude oil prices include the Brent crude (BRENT), the West Texas Intermediate (WTI) and the Dubai prices. For this study, the Brent crude oil price will be used as a proxy as it is a major benchmark price for oil purchases worldwide (OPEC, 2016).	Bloomberg, OPEC database, World Bank Development Indicators.
Stock price	The main index of the respective countries tracking index are used as proxy for stock price. These are South African JSE ALL SHARE index (JALSH), Nigeria's all share index (NGSEIDX), Kenya's Nairobi Securities all share index (NSEASI), Tunisia's all share index (TUSISE), Tanzania's all share index (DARSDEI), Botswana's Gaborone index (BGSMD) and Mauritian all share index (SEMDEX).	Individual country stock exchange website, African markets database, Bloomberg and national accounts dataset portal.
Public debt as a ratio of GDP	The ratio of the country's debt to its GDP. Large public debt may have adverse effects on the country's capital accumulation, productivity and economic performance (IMF, 2010).	IFS, World Bank Development Indicators and Blomberg
Inflation	The change in consumer price index (CPI) was used as a proxy for inflation in the current study. According to Rotimi & Ngalawa (2017) inflation functions as a key to monetary policy decisions, through which economic stability is achieved.	IFS, World Bank Development Indicators, Bloomberg and national accounts dataset portal.
Exchange rate (EXR)	The nominal effective exchange rate adjusted for inflation rate differentials, this exchange rate is for the selected countries against the US dollar as the benchmark (Rotimi & Ngalawa, 2017).	IFS, World Bank Development Indicators, Bloomberg
Bank Interest rates (RIR)	The average repo rate, which is monetary policy indicator through which Reserve or Central bank of the selected countries set the interest rates. The extent of shocks from oil prices can be examined through interest rates (Rotimi & Ngalawa, 2017).	IFS, World Bank Development Indicators, Bloomberg, and national accounts dataset portal.

## CHAPTER 4: DATA ANALYSIS

### 4.0 Introduction

The main thrust of this chapter is to present empirical findings of the study. To this end, descriptive statistic, diagnostic tests results together with the Multivariate BEKK GARCH, Panel GMM and VECM estimates are presented. This section proceeds to give interpretation to the estimated results relative to a priori expectations and their econometric implications documented in the literature.

### 4.1 The relationship between oil price volatility and stock price volatility of the selected African countries

#### 4.1.1 Unit root test results

According to Brooks (2004), regression analysis based on time series data is based on an implicit assumption that the underlying time series data variables do not suffer from a unit root problem (stationary). However, in practice most time series, cross-sectional and panel data series are often found to be having a unit root problem (nonstationary). Following Gujarati (2004) , performing a regression involving one or more nonstationary time series variables often yields spurious results. Spurious regression refers to a situation where the regression results appear to be excellent, yet they are in fact redundant, vague and empty from a statistical point of view. One way to guard against spurious regression is to test the variables for a unit root problem.

The unit root test is premised on the null hypothesis that the data series is nonstationary. This study employed, the Augmented Dickey-Fuller (ADF) and the Phillips Perron (PP) test to test whether the variables used as a unit of analysis in this study are stationary in their levels or at first deference. The unit root test results are presented in Table 2. The unit root test results based on both the ADF and the PP tests confirmed that the null hypothesis that the variable Botswana have a unit root problem in its levels cannot be rejected at 5% level of significance since both the ADF (-1.55) and the PP (-1.38) have p-values exceeding 0.05. However, the unit root test results based on the same test methods and performed for first deference of the Botswana variable (*DBotswana*), indicate that the null hypothesis for *DBotswana* variable have a unit root and can be rejected at 5% level of significance since both test statistics for the ADF (-1.55) and the PP (-8.57) were found to be statistically significant.

Table 2: Unit root test results for the original stock indices and commodity price series

TEST METHOD			VARIABLE							
			Botswana	Tanzania	South Africa	Nigeria	Kenya	Mauritius	Tunisia	Brent crude (Brent)
ADF	Level	Trend & Intercept	-1.55	-1.21	-2.03	-2.911	-3.23	-2.70	-2.64	-2.55
	First Deference	Trend & Intercept	-8.59***	-13.22***	-15.84***	-5.99***	-6.73***	-5.40***	-11.43***	-10.19***
PP	Level	Trend & Intercept	-1.38	-1.13	-2.36	-2.47	-2.45	-2.39	-2.66	-2.34
	First Deference	Trend & Intercept	-8.57***	-13.20***	-15.81***	-11.67***	-11.12***	-10.22***	-11.52***	-10.17***
<b>ORDER OF INTEGRATION</b>			<b>I(1)</b>	<b>I(1)</b>	<b>I(1)</b>	<b>I(1)</b>	<b>I(1)</b>	<b>I(1)</b>	<b>I(1)</b>	<b>I(1)</b>

**Notes:** \*\*, indicates statistical significance at 5% level of significance. A test statistic is statistically significant at 5% level of significance if its associated *p*-value is less than 0.05. The ADF and the PP tests are both based on the null hypothesis of unit root against an alternative hypothesis of no unit root.



Therefore, the results in Table 2 authenticated that the Botswana variable is integrated of order one (Sui & Sun) since it was found to be non-stationary in its levels but stationary at first difference. Moreover, the results obtained from both the ADF and the PP unit root test performed on variables such as Tanzania, South Africa Nigeria, Kenya, Mauritius, Tunisia and Brent crude confirmed that each of these variables is not stationary in its levels but rather stationary at first difference. Against this background, the results presented in Table 2 connotes that none of the variables can be employed for regression analysis purposes in its levels or original state because the outcome will be spurious. That is, these variables can only be used for further statistical inference once they are transformed or differenced to become stationary and usable. Based on this, all the variables mentioned above were transformed into continuously compounded returns using the following formula:  $r_t = LN \left( \frac{P_t}{P_{t-1}} \right) \times 100$ , Where  $r_t$  is the return of the stock market index,  $P_t$  is the index value at time t while  $P_{t-1}$  is the value of the indices at time t-1.

#### 4.1.2 Descriptive statistics

Apart from the unit root test results discussed, Table 3 shows the descriptive statistics of the variables employed in the current study. The results presented in Table 3 shows that the returns of the Tanzanian stock index have the highest average return of about 0.96 units while the Nigerian stock index have the least average return equivalent to 0.31 units. On the other hand, Botswana stock index return has the least standard deviation of approximately 3.2 while the Brent crude price return exhibited the highest dispersion about the mean of about 8.7 units.

As is evident in Table 3, most of the variables revealed negatively skewed distributions. These negatively skewed variables include: South Africa (-0.290123), Nigeria (-0.357582), Kenya (-1.009710), Mauritius (0.490400), Tunisia (-0.357978) and Brent crude (-0.762915). However, variables such as Botswana (0.297560) and Tanzania (0.146311) revealed positively skewed distributions that are closer to that of a normally distributed variable. The results presented in Table 3 further authenticated that all the variables exhibited excess kurtosis relative to the kurtosis value of 3 for a normal distribution even though the South African stock index return series have a kurtosis value that approximates the kurtosis of a normally distributed variable. Consequently, these findings imply a significant departure from normality.

Moreover, the results in Table 3 indicated that the Jarque-bera (JB) statistics for each of the eight (8) variables that constituted the unit of analysis herein the current research are statistically significant at 5% level of significance since their p-values were found to be less than 0.05.

Precisely, significant JB-statistics were revealed for variables such as Botswana (128.4968) and Tanzania (93.80865), South Africa (8.473868), Nigeria (190.5093), Kenya (98.89490), Mauritius (371.5510), Tunisia (39.81145) and Brent crude (60.08492). Thus, based on the findings presented in Table 3, sufficient statistical evidence exists at 5% level to reject the null hypothesis that the variables are random (normally distributed). Overall, descriptive statistics outlined below indicated that all the stock indices and commodity price return variables employed in the study exhibited leptokurtic distributions (kurtosis  $>3$ ) with fat tails, a phenomenon often observed in financial time series data. To gain more insights into the underlying distributions of the variable employed in this study, graphical plots of the raw stock indices and Brent crude (commodity) prices were made and they appeared as shown in Figure 1.

Figure 1 shows plots of stock indices plots as well as Brent crude prices observed over the period from June 2003 to November 2019. The observed price series exhibited periods of extraordinarily sharp spikes and subsequent periods of relative tranquillity over the sample period implying that both stocks and commodity prices are subject to random fluctuations due to the realisation of new information or innovations (news) into the market. Apart from the plots of raw stock and commodity prices portrayed in Figure 1, Figure 2 shows the returns of these stock and commodity prices observed over the sample period. The return plots below also show periods of high fluctuations followed by periods of low fluctuations and these patterns manifest themselves repeatedly over the sample.

Among the variables shown in Figure 2, Botswana, Tanzania, South Africa and Tunisia exhibited relatively larger volume of random fluctuations as compared to stock indices such as Nigeria, Kenya, and Mauritius. Meanwhile, the returns of the commodity (oil) prices epitomized by Brent crude also revealed periods of persistent fluctuation that appears in bunches, followed by some periods of relative calmness which are preceded by another bunch of volatile upswings and down swings. Figure 2 also indicated that all the eight (8) returns' series exhibit periods of low volatility and periods of high volatility around the same time. For instance, each return series experienced high volatility between the year 2008 and 2010 and between 04/2012 and 08/2014, while a period of low volatility occurs between 2012 and 2014 in all the eight series.

Table 3: Descriptive statistics for the stock indices and commodity price return series

Statistics	Botswana	Tanzania	South Africa	Nigeria	Kenya	Mauritius	Tunisia	Brent crude
Mean	0.613163	0.453226	0.959966	0.314613	0.334100	0.748695	0.906104	0.401078
Median	0.422551	0.177905	1.113252	0.023700	1.209057	0.405268	0.688749	0.872416
Maximum	14.78628	12.62604	11.58926	32.99624	17.19471	15.38056	9.549151	25.44591
Minimum	-10.69747	-14.68565	-15.03110	-36.57614	-24.27069	-20.56301	-14.26114	-40.74024
Std. Deviation ( $\sigma$ )	3.229951	3.348815	4.218333	7.265959	5.792759	4.029324	3.511995	8.713297
Skewness	0.297560	0.146311	-0.290123	-0.357582	-1.009710	-0.490400	-0.357978	-0.762915
Kurtosis	6.911556	6.787674	3.834064	7.764220	6.571431	9.656060	5.082675	5.234241
Jarque-Bera	128.4968**	93.80865**	8.473868***	190.5093**	98.89490**	371.5510**	39.81145**	60.08492**
Probability	0.000000	0.000000	0.014452	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	120.7931	70.70323	189.1134	61.97884	47.10806	147.4929	178.5025	79.01246
Sum Sq. Dev.	2044.787	1738.257	3487.689	10347.66	4697.847	3182.149	2417.485	14880.62
Observations	197	156	197	197	141	197	197	197

**Notes:** \*\*, indicates statistical significance at 5% level of significance. A test statistic is statistically significant at 5% level of significance if its associated  $p$ -value is less than 0.05. The Kurtosis and skewness statistics are interpreted in comparison to the values of a normally distributed variable whose kurtosis and skewness values are known to be equivalent to 3 and 0 respectively. The Jarque-Bera normality test is premised on the null hypothesis of randomness or that the variable is normally distributed.

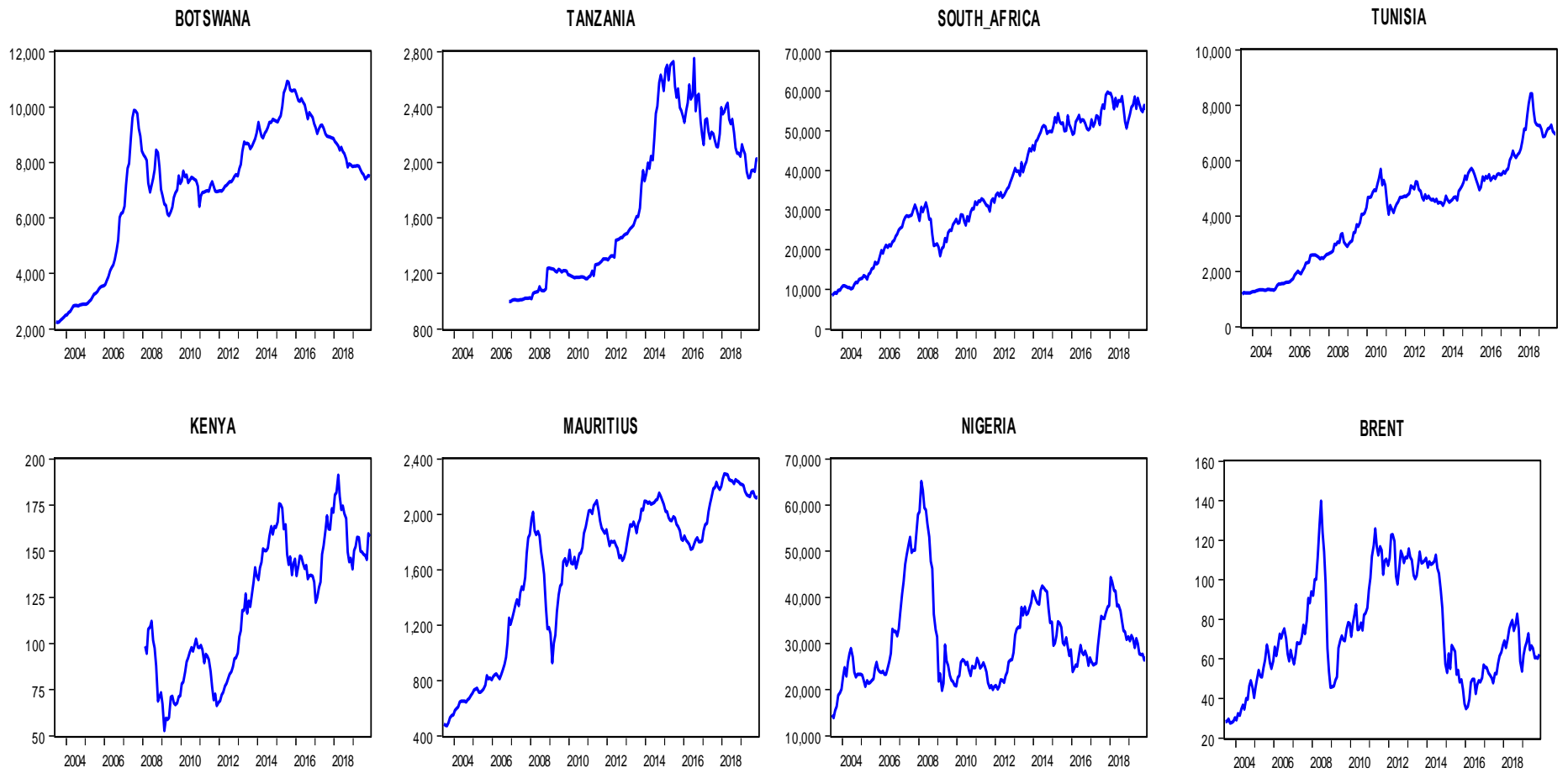


Figure 1: Stock indices and commodity price time series graphs

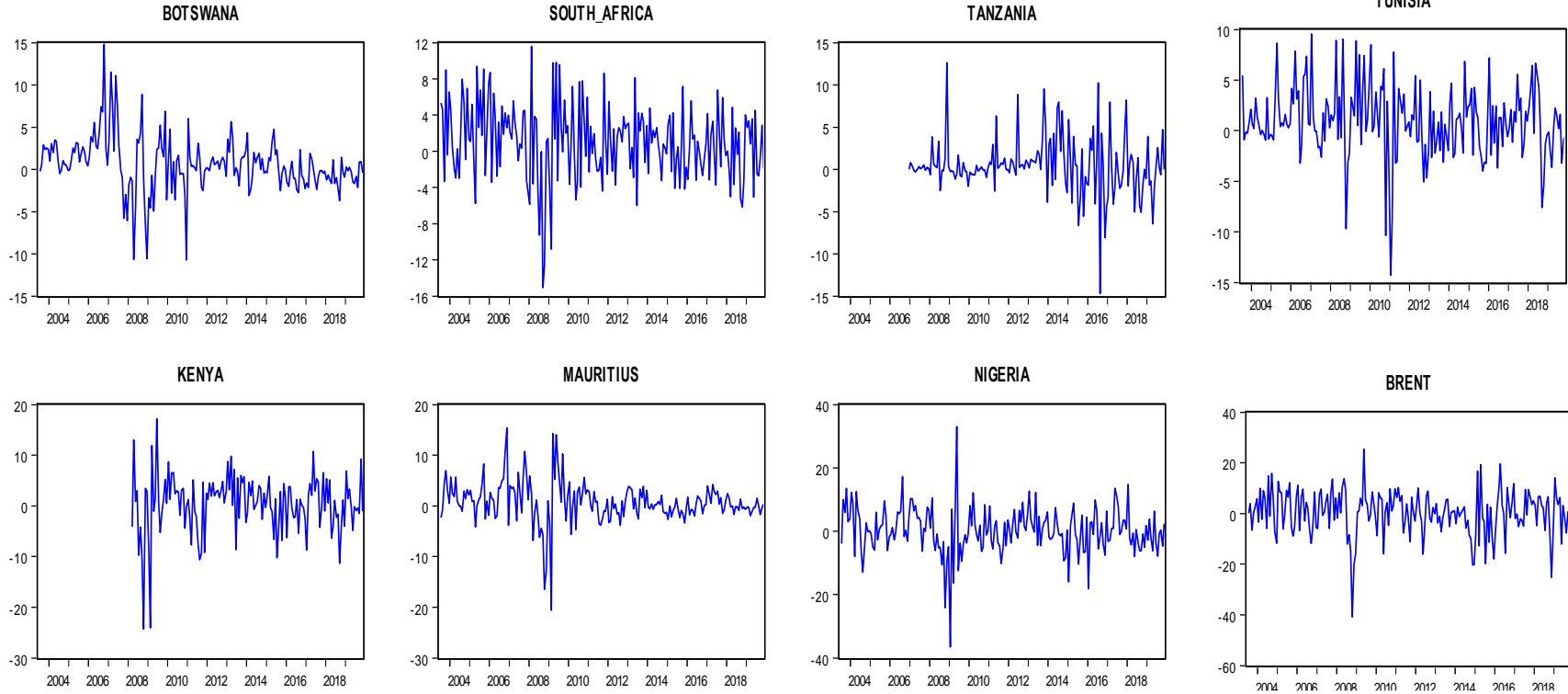


Figure 2: Stock indices and commodity price return series graphs

In addition to the observed trends above, the kernel density functions of the return series were also compared against the theoretical distribution as shown in Figure 3. While the plots displayed in Figure 3 are just a hint of volatility clustering based on visual examination of the graphs, it appears that for each of the eight returns' series (Botswana, Tanzania, South Africa, Nigeria, Kenya, Mauritius, Tunisia and Brent crude) there is a strong evidence of volatility clustering and leptokurtosis. This phenomenon occurs when volatility appears in bunches such that large negative changes tend to be followed by large negative changes and large positive changes also tend to be followed by large positive changes and the same is true for small changes which also tend to be followed by small changes.

Moreover, by merely examining the trends shown in Figure 1, Figure 2 and Figure 3 the choice of employing a member of the GARCH family models to capture the volatility of stock and oil price returns becomes more appealing. With just a minor exception for South African stock index which exhibited a near normal distribution, there is evidence that the return series exhibited fat-tailed distributions and volatility clustering, necessary though not sufficient conditions for ARCH/GARCH methodology adoption. According to Brooks (2014), the ARCH or GARCH methodology can only be adopted if and only if there is evidence of Heteroscedasticity or ARCH effects in the residuals of the mean equation. Consequently, the current study employed the Autoregressive Conditional Heteroscedasticity Lagrange Multiplier (ARCH-LM) test to investigate the presence of time varying conditional Heteroscedasticity in the returns of the theoretically founded mean equations of the returns' series.

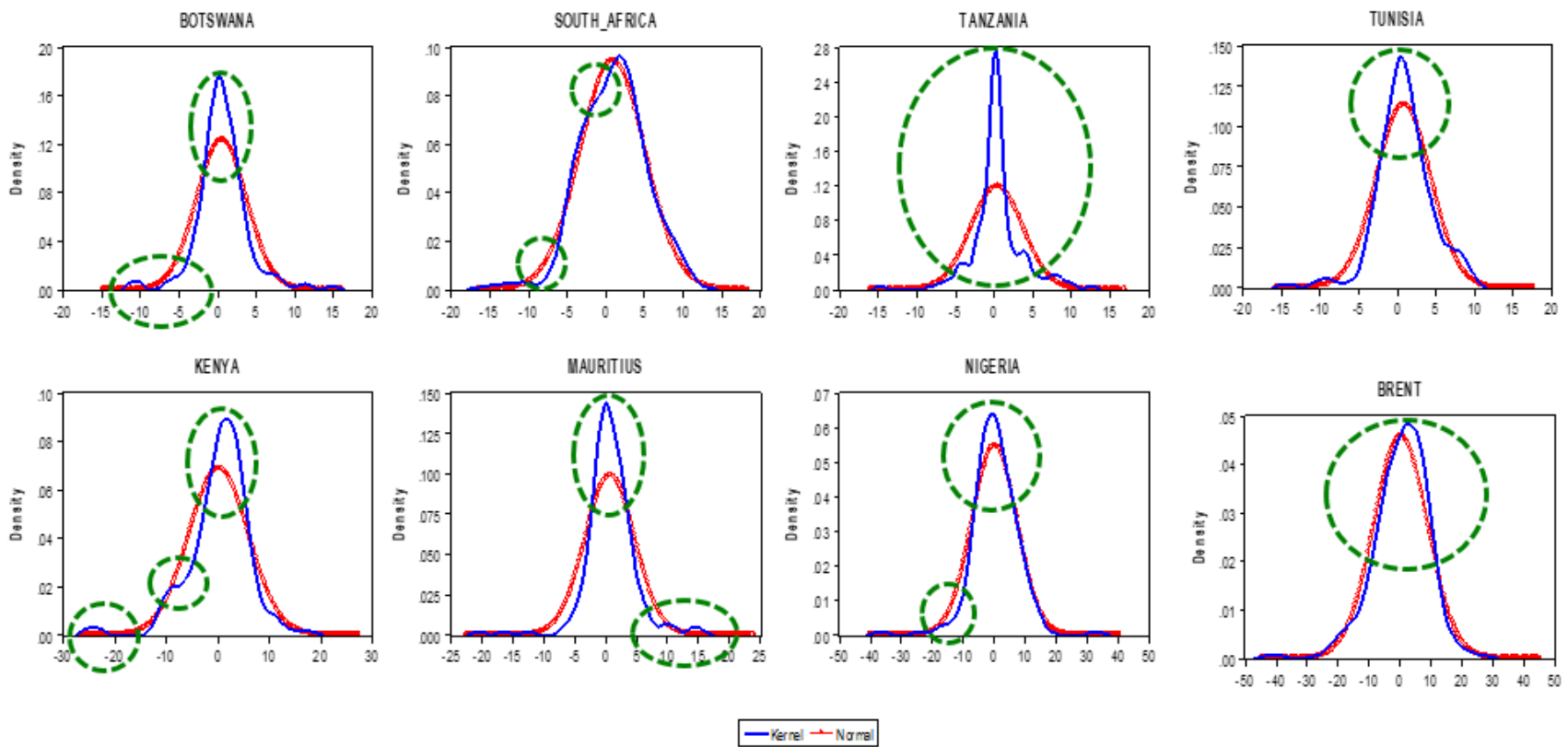


Figure 3: Evidence of volatility clustering and excess kurtosis in stock index and commodity price return series

#### 4.1.3 ARCH effects test results

To complement the descriptive statistics and visual assessments made on returns plots above, the current study also employed the ARCH LM test premised on the null hypothesis that the residuals of the auxiliary regression of the specified mean equation are homoscedastic (no ARCH effects) against an alternative hypothesis that they are heteroscedastic (presence of ARCH effects). Table 4 shows the ARCH LM test results obtained for each of the eight return variables used as a unit of analysis herein this study.

Table 4: Conditional Heteroscedasticity 'ARCH-effects' test results

Variable	ARCH LM test statistics			
	F-Statistic		Obs*R <sup>2</sup> (TR <sup>2</sup> )	
	Coefficient	p-value	Coefficient	p-value
Botswana	5.128882**	0.0002	23.26415**	0.0003
Tanzania	2.489274**	0.0339	11.93678**	0.0357
South Africa	18.20171**	0.0000	16.81200**	0.0000
Nigeria	8.488108**	0.0000	35.67048**	0.0000
Kenya	10.92486**	0.0000	40.23796**	0.0000
Mauritius	19.82915**	0.0000	66.75879**	0.0000
Tunisia	3.439845**	0.0000	16.25130**	0.0000
Brent crude	10.39323**	0.0015	9.966443**	0.0016

**Notes:** \*\*, indicates statistical significance at 5% level of significance. A test statistic is statistically significant at 5% level of significance if its associated p-value is less than 0.05. The ARCH LM test is based on the null hypothesis that the error variances are the same or Homoscedastic against an alternative hypothesis that they are Heteroscedasticity.

The results of the study found both the F-Statistic (5.128882) and the chi-square statistic (Obs\*R<sup>2</sup> =23.26415) of the ARCH LM test performed for Botswana's stock index returns to be statistically significant at 5% level. This result infers that there is enough evidence from a statistical standpoint to reject the null hypothesis of no ARCH effects in favor of the alternative hypothesis of the presence of ARCH effects in the residuals of the mean equation. The results presented in Table 4 further indicated that both the F-Statistic (5.128882) and the chi-square statistic (Obs\*R<sup>2</sup>) of the ARCH LM test performed for each of the remaining seven (7) stock indices and commodity price returns (Botswana, Tanzania, South Africa, Nigeria, Kenya, Mauritius, Tunisia and Brent crude)



are statistically significant at 1% significance level. The results of the study presented in table 4 connote that the null hypothesis of no ARCH-effects (homoscedasticity) can be rejected at 1% level, leading to the conclusion that a strong evidence of ARCH effects exist in the stock indices returns of the seven (7) selected African countries and their presence (ARCH effects) was also confirmed in the Brent crude price returns. Overall, these results certify the applicability of the ARCH/GARCH family models in general, Multivariate BEKK (1, 1) in particular model for modeling the relationship between oil price fluctuations and stock prices volatility in selected African countries between July 2003 and November 2019.

#### 4.1.4 Multivariate GARCH model estimation results

Due to the complexity of the relationship between stock markets and oil prices observed by several researchers in recent years, the current research employed the multivariate BEKK-GARCH model to analyze the relationship between oil price fluctuations and stock prices volatility in selected African countries over the sample period which spanned from mid-2003 to end of 2019. Table 5 shows the results of the estimated multivariate BEKK (1, 1) model. The results of the study indicated that the coefficient of the mean equations relating to the Botswana (-0.217125) and the Brent crude (-0.046214) variables are negative but not statistically significant at 5% level of significance.

Similarly, coefficients of the mean equations relating to the variables such as South Africa (0.480373), Nigeria (0.124106), Kenya (0.549689) and Mauritius (0.115061) are positive but not statistically significant at 5% level. These results suggest that there no sufficient evidence from a statistical background to support the fact that the average returns of the aforementioned stock indices are positive. However, only the mean equation coefficients linked to the Tanzania (0.556963) and the Tunisia (0.648817) variables were found to be both positive and statistically significant at 5% significance level. These findings are consistent with Brooks (2014) and they imply that holding the ARCH and GARCH effects, the returns of both the Tanzanian and Tunisian stock indices are positive. Apart from the coefficients of the mean equation discussed above, the results reported in Table 5 also indicated that all the eight (8) coefficients of the mean parameter in the variance equation of the estimated Multivariate BEKK (1, 1) model are all positive ( $>0$ ) and consistent with their expected signs on a priori basis.

Table 5: Multivariate Diagonal BEKK (1, 1) model estimation results

Parameters		Botswana	Tanzania	South Africa	Nigeria	Kenya	Mauritius	Tunisia	Brent crude
Mean Equation		-0.217125 (0.199158) [-1.090217]	0.556963** (0.247099) [2.254004]	0.480373 (0.317141) [1.514700]	0.124106 (0.358112) [0.346556]	0.549689 (0.424392) [1.295239]	0.115061 (0.178772) [0.643618]	0.648817** (0.251607) [2.578694]	-0.046214 (0.766677) [-0.060278]
Variance Equation	Mean (M)	0.017516 (0.016133) [1.085702]	0.017516 (0.016133) [1.085702]	0.017516 (0.016133) [1.085702]	0.017516 (0.016133) [1.085702]	0.017516 (0.016133) [1.085702]	0.017516 (0.016133) [1.085702]	0.017516 (0.016133) [1.085702]	0.017516 (0.016133) [1.085702]
	ARCH effects ( $a_{1i}$ )	0.315507** (0.043319) [7.283326]	0.043952** (0.045776) [0.960159]	0.021209** (0.022167) [-0.956743]	0.073349** (0.016957) [4.325585]	0.168854** (0.021189) [7.968934]	0.344110** (0.044895) [7.664865]	0.323546** (0.051589) [6.271651]	0.035958** (0.027380) [1.313312]
	GARCH effects ( $b_{1j}$ )	0.949168** (0.008871) [-106.9992]	1.004421** (0.002363) [425.0817]	0.994625** (0.001140) [872.4792]	0.994488** (0.001823) [545.4534]	0.981441** (0.003303) [297.1034]	0.936465** (0.010630) [88.09988]	0.955488** (0.012998) [73.50994]	0.996968** (0.001300) [767.1116]

**Notes:** \*\*, indicates statistical significance at 5% level of significance. A test statistic is statistically significant at 5% level of significance if its associated  $p$ -value is less than 0.05. The parameters branded  $a(1,2,.. i)$  and  $b(1,2,.. , j)$  are the corresponding estimated ARCH and GARCH coefficients for markets  $i$ . The standard errors are reported in parentheses ( ) and the z-statistics are reported in brackets [ ].

Furthermore, the coefficients of the mean parameter in the variance equation relating to Botswana, Tanzania and Tunisia each valued at 0.017516 were found to be not statistically significant at 5% conventional level. These findings indicated that there is dearth of statistical evidence to support the fact that conditional volatility for these stock indices returns are mean reverting. This piece of empirical evidence strongly also consistent with Brooks (2014) who emphasized that a good volatility model should have a long memory and exhibit mean reversion.

Moreover, the estimated coefficients of the mean parameters connected to variables such as South Africa, Nigeria, Kenya, Mauritius and Brent crude, each equivalent to 0.017516 are only positive but not statistically significant at 5% level. These findings imply that there is not enough evidence of volatility mean reversion among these observed returns from a statistical perspective. The results also imply that there is lack of statistical evidence to validate the fact that among these stock indices and commodity prices, when the volatility of their returns is higher than its mean in the current period, it will automatically adjust back towards the mean in the next period, a 'long memory' behavior that is often observed in volatility models.

Above and beyond, the results of the current research also indicated that all the ARCH effects coefficients (diagonal elements) for the estimated multivariate BEKK (1, 1) model including; Botswana (0.315507), Tanzania (0.043952), South Africa (0.021209), Nigeria (0.073349), Kenya (0.168854), Mauritius (0.344110), Tunisia (0.323546) and the proxy of oil prices return denoted by Brent crude (0.035958) are positive and statistically significant at 5% level of significance. These results suggest that each of the eight (8) conditional variances estimated in the model depends on its own squared lagged innovations. Based on the results of the study, the Mauritius variable has the largest own ARCH-effect whose coefficient value is equivalent to 0.34411, while South Africa has the least own ARCH-effect valued at 0.021209.

In addition to the above mentioned, the findings of the current study also revealed that the estimated coefficients of the GARCH effects for all the eight variables employed in the multivariate BEKK (1, 1) model estimation which comprising: Botswana (0.949168), Tanzania (1.004421), South Africa (0.994625), Nigeria (0.994488), Kenya (0.981441), Mauritius (0.936465), Tunisia (0.955488) and Brent crude (0.996968) were found to be positive and statistically significant at 5% level of significance. These findings connote that the conditional variances for each of the eight variables also depend on their own lags.

Consequently, the following conditional variance data generating processes were synthesized from the estimated coefficients of both the ARCH and GARCH effects:

$$h_{1t} = 0.0175 + 0.0996u_{t-1}^2 + 0.901h_{t-1} \quad \dots\dots (4.1)$$

$$h_{2t} = 0.0175 + 0.00196u_{t-1}^2 + 1.00891h_{t-1} \quad \dots\dots (4.2)$$

$$h_{3t} = 0.0175 + 0.0004u_{t-1}^2 + 0.9893h_{t-1} \quad \dots\dots (4.3)$$

$$h_{4t} = 0.0175 + 0.0054u_{t-1}^2 + 0.9890h_{t-1} \quad \dots\dots (4.4)$$

$$h_{5t} = 0.0175 + 0.0285u_{t-1}^2 + 0.9632h_{t-1} \quad \dots\dots (4.5)$$

$$h_{6t} = 0.0175 + 0.1184u_{t-1}^2 + 0.8770h_{t-1} \quad \dots\dots (4.6)$$

$$h_{7t} = 0.0175 + 0.1047u_{t-1}^2 + 0.9130h_{t-1} \quad \dots\dots (4.7)$$

$$h_{8t} = 0.0175 + 0.0013u_{t-1}^2 + 0.9939h_{t-1} \quad \dots\dots (4.8)$$

where  $h_{1t}$  is the conditional variance for Botswana is,  $h_{2t}$  epitomizes the conditional variance for Tanzania,  $h_{3t}$  denotes the conditional variance for South Africa,  $h_{4t}$  refers to the conditional variance for Nigeria,  $h_{5t}$  is the conditional variance for Kenya,  $h_{6t}$  represents the conditional variance for Mauritius,  $h_{7t}$  is the conditional variance for Tunisia and  $h_{1t}$  signifies the conditional variance for Brent crude variable. The plots for the conditional variance for each variable used as a unit of analysis in the in the multivariate BEKK (1, 1) model estimation are presented in Figure 4. Apart from the conditional variances, the data generating processes for the covariances between the sampled stock indices return volatility and the volatility of Brent crude price returns are as follows:

$$Cov(1; 8)_t = 0.0175 + 0.0113u_{1t-1}u_{8t-1} - 0.9463Cov(1; 8)_{t-1} \quad \dots\dots (4.9)$$

$$Cov(2; 8)_t = 0.0175 + 0.0016u_{2t-1}u_{8t-1} + 1.0014Cov(2; 8)_{t-1} \quad \dots\dots (4.10)$$

$$Cov(3; 8)_t = 0.0175 + 0.0008u_{3t-1}u_{8t-1} + 0.9916Cov(3; 8)_{t-1} \quad \dots\dots (4.11)$$

$$Cov(4; 8)_t = 0.0175 + 0.0263u_{4t-1}u_{8t-1} + 0.9915Cov(4; 8)_{t-1} \quad \dots\dots (4.12)$$

$$Cov(5; 8)_t = 0.0175 + 0.0061u_{5t-1}u_{8t-1} + 0.9785Cov(5; 8)_{t-1} \quad \dots\dots (4.13)$$

$$Cov(6; 8)_t = 0.0175 + 0.0124u_{6t-1}u_{8t-1} + 0.9785Cov(6; 8)_{t-1} \quad \dots\dots (4.14)$$

$$Cov(7; 8)_t = 0.0175 + 0.0116u_{7t-1}u_{8t-1} + 0.9526Cov(7; 8)_{t-1} \quad \dots\dots (4.15)$$

where  $Cov(1;8)_t$  is the covariance between Botswana and Brent crude,  $Cov(2;8)_t$  is the conditional covariance between Tanzania and Brent crude,  $Cov(3;8)_t$  denotes the conditional covariance between South Africa and Brent crude,  $Cov(4;8)_t$  indicates the estimated conditional covariance between Nigeria and Brent crude,  $Cov(5;8)_t$  refers to conditional covariance between Kenya and Brent crude and  $Cov(6;8)_t$  represents the conditional covariance between Mauritius and Brent crude over the sample. Finally,  $Cov(7;8)_t$  denotes the conditional covariance between Tunisia and Brent crude variable. The covariance expression above suggests that there is a long run relationship between oil price volatility and stock prices volatility in the selected African countries. These results are consistent with Awartani, Javed, Maghyereh, & Virk (2018) who found strong evidence from the MENA region that shows that the volatility of equities is affected by the oil price volatility in the long run. The conditional covariance plots for each pair of variables are shown in Figure 4 also confirmed the existence of a long run relationship between stock prices and oil prices volatility.

Figure 5 shows the forecasts of the correlations during the sample period derived from the estimated multivariate BEKK (1, 1) model. The dynamic conditional correlations between each stock index and the Brent crude prices returns series purported above indicated that most of the stock indices were positively correlated with Brent crude price returns particularly during the peak of the global financial crisis between the year 2007 and 2008. The trends in Figure 5 also confirmed that the correlations between the stock indices and oil price returns are highly volatile throughout the period. Moreover, for many stock indices, this volatility is particularly more amplified in the after math of the 2007–2008 financial crisis. In all cases, there is an increase in volatility during and after the crisis. These results are consistent with Dutta et al. (2017) ,who found using the GARCH model that oil price volatility measured using the OVX (crude oil volatility index) has an impact on the stock market volatility of the Middle East and African countries, and that the effects of volatility are persistent.

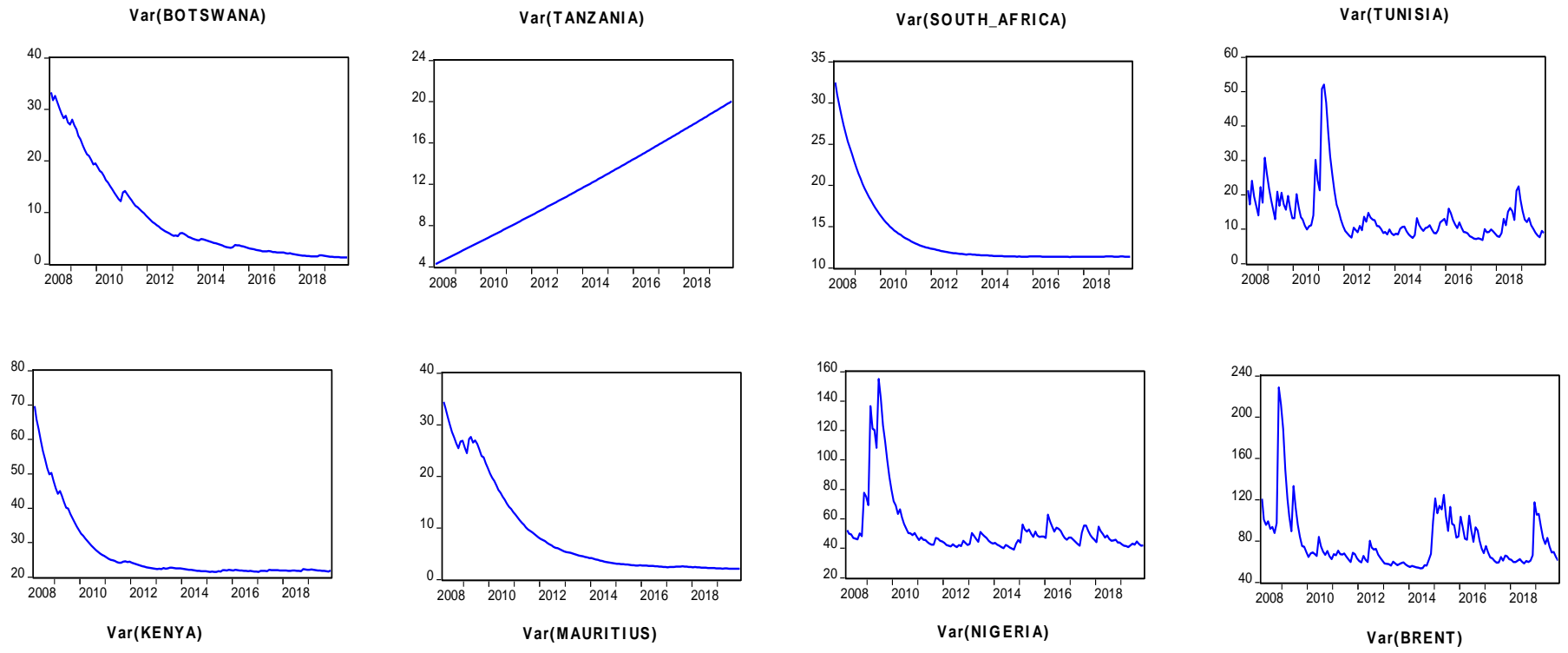


Figure 4: Conditional variance of the Multivariate Diagonal BEKK (1, 1) model

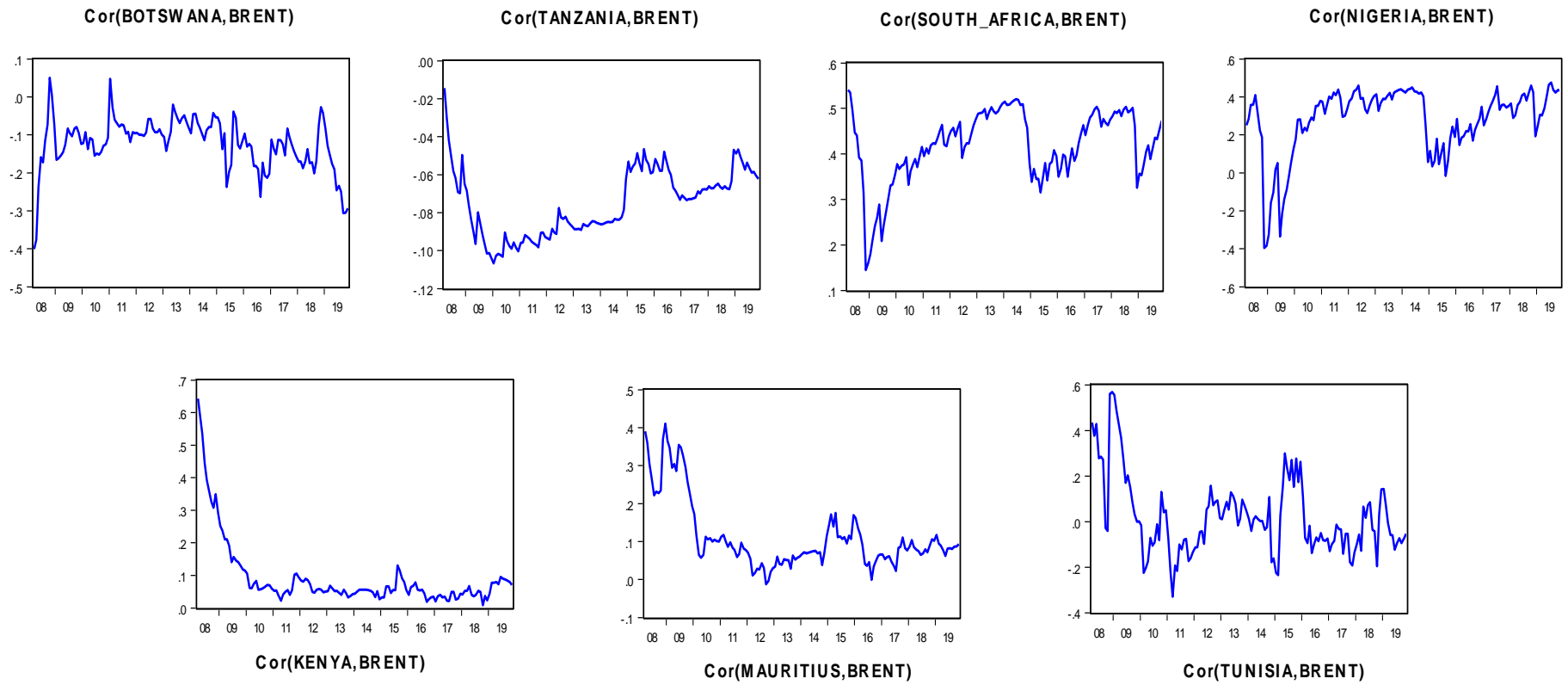


Figure 5: Conditional correlations of the Multivariate Diagonal BEKK (1, 1) model

## 4.2 The impact of oil price volatility on macroeconomic performance of the selected African countries

In particular, the current study constructed a GARCH (1, 1) measure of Brent crude prices volatility as a proxy for oil price volatility.

### 4.2.1 Estimating the volatility of oil prices

Most prevalent stylized facts about financial time series data include the tendency for volatility to occur in bunches also known as volatility clustering and the tendency for new innovations (news) to have an asymmetric impact on future volatility, a phenomenon referred to as leverage effects. To capture the stylized facts about financial time series variables, the conditional variance of the parsimonious GARCH (1, 1) model was used as a proxy of oil price volatility over the sample.

### 4.2.2 GARCH (1, 1) model estimation results for Brent crude price returns

Since the Brent crude price returns volatility was used as a proxy for oil prices volatility and that the presence of ARCH effects in the residuals of the mean equation relating to Brent crude price returns series was confirmed in Section 4.1.3 based on the results presented in Table 5 above, the next step in the conditional volatility estimation procedure was to estimate the parameters of the chosen GARCH (1, 1) model. Table 6 shows the results of the estimated univariate GARCH (1, 1) model.

Table 6: Univariate GARCH (1, 1) model estimation results for Brent crude prices returns

Equation	Parameters	coefficient	p-value
Mean Equation	Constant ( $\mu$ )	0.8721** [1.5345]	0.0249
Variance Equation	Constant ( $\omega$ )	6.9583 [1.8463]	0.0648
	ARCH-effect ( $\alpha_1$ )	0.2856** [3.9018]	0.0001
	GARCH-effect ( $\beta_1$ )	0.6529** [9.5494]	0.0000
	Volatility persistence ( $\alpha_1 + \beta_1$ )	0.938466	-
<b>Additional statistics</b>			
R-squared	-0.002937	Mean dependent variable	0.401078
Adjusted R-squared	-0.002937	S.D. dependent variable	8.713297
S E of regression	0.726085	Aikaie information criterion	7.064172
Sum of squares residuals	14924.33	Schwarz criterion	7.130836
Log-likelihood	-691.8209	Durbin-Watson stat	1.901260

**Notes:** \*\*, indicates statistical significance at 5% level of significance. A test statistic is statistically significant at 5% level of significance if its associated p-value is less than 0.05. t-statistics are reported in square parentheses.



#### 4.2.2.1 Variance equation results for Brentcrude returns GARCH (1, 1) model

As indicated in Table 6, the results of the current study found the intercept of the variance equation in the fitted GARCH model (6.958270) to be positive but not statistically significant at 5 % level. This result is consistent with theory since the mean parameter is expected to be non-negative on a priori basis. The ARCH term ( $\alpha_1 = 0.285616$ ) is positive and statistically significant at 5% level of significance, indicating that the short run dynamics in the conditional variance over the entire sample were relatively small. Equally, the GARCH term ( $\beta_1 = 0.652850$ ) indicated that the volatility persistence of Brent crude prices returns over the entire sample is highly persistent and shocks to future volatility take long to die out. This result also confirmed the existence of volatility clustering in Brent crude price returns over the sample period.

Meanwhile, the current research found the volatility persistence ( $\alpha_1 + \beta_1 = 0.938466$ ) of the fitted GARCH (1, 1) model to be highly persistent and close to unity. This result means that the fitted model is variance stationary and stable since the theoretical conditions for variance stationarity and stability ( $\alpha_1 + \beta_1 < 1$ ) were not violated. Since the non-violation of non-negativity constraints imposed on the parameters and the variance stationarity of the estimated model are necessary but not sufficient conditions for the adequacy of the fitted GARCH (1, 1) model to compute the volatility of Brent crude prices returns, the current study also carried out a post estimation diagnostic test to assess the goodness-of fit of the model.

#### 4.2.2.2 Post estimation diagnostic tests result for EGARCH (1, 1) model

The current study employed the ARCH-LM test to test for any evidence of continued presence of serial autocorrelation and ARCH effects in the residuals of the estimated GARCH (1, 1) model. Table 7 shows the results of the ARCH-LM test performed with one lag indicated that both the F-statistic (1.06E-06) and the chi-square test statistic (Obs\*R2 =1.07E-06) are not statistically significant at 5% level of significance.

Table 7: ARCH-LM test for the residuals of the fitted GARCH (1, 1) model

ARCH-LM test statistic	Test value	Probability value
F-statistic (1)	1.06E-06	0.9992
Obs*R <sup>2</sup> (1)	1.07E-06	0.9992

**Notes:** \*\* indicate statistical significant at 5% levels while the number of lag are reported in parentheses. The Obs\*R indicates the actual ARCH-LM test statistic.

The findings connotes that the null hypothesis that the residuals of the fitted GARCH (1, 1) model are homoscedasticity cannot be rejected at 5% level thus, leading to the conclusion that the fitted model adequately captured and addressed the ARCH effects and autocorrelation observed before the model was estimated. Consequently, the estimated model is used to compute the conditional variance of Brent crude prices that was subsequently used as a proxy for the oil prices volatility (explanatory variable) in the Panel GMM regression model.

#### 4.2.3 Panel Unit root test results

Above and beyond, the current research also performed panel unit root test to check whether the macroeconomic time series variables employed in the GMM estimation are stationary. Three types of panel unit root tests namely; Levin, Lin & Chu, Im, Pesaran & Shin W-stat and the ADF – Fisher Chi-Square test were performed for variables including; Gross domestic product (GDP) growth rate, Stock Prices (SP), Public Debt (PD), Inflation (INF) and Brent crude price returns volatility (BPVOL).

Table 8: Panel Unit root test results

Variables	Panel Unit root test type						Order of Integration
	Levin, Lin & Chu		Im, Pesaran & Shin W-stat		ADF – Fisher Chi-Square		
	Levels	Fist Difference	Levels	Fist Difference	Levels	Fist Difference	
GDPG	4.17	-12.32**	3.21	-10.61**	6.27	123.80**	I(1)
SP	3.00967	-28.7834**	2.21789	-27.6443**	8.11160	504.027**	I(1)
PD	4.42412	-22.4666**	-1.34499	-17.9505**	18.6072	275.564**	I(1)
INF	-46.1545**	-	-38.2223**	-	723.860**	-	I(0)
BPVOL	-3.20452**	-	-3.64702**	-	17.6540**	-	I(0)

**Notes:** \*\*, indicates statistical significance at 5% level of significance. A test statistic is statistically significant at 5% level of significance if its associated p-value is less than 0.05. The order of integration is reported in parentheses ( ). The Levin, Lin & Chu, Im, Pesaran & Shin W-stat and the ADF – Fisher Chi-Square tests are both based on the null hypothesis of unit root against an alternative hypothesis of no unit root. GDPG denotes Gross Domestic Product growth rate, SP means Stock Prices, PD represents Public Debt, INF is the rate of inflation and lastly BPVOL signifies the Brent crude Prices Volatility.

Table 8 shows the panel unit root test results for each of the three test types both in levels and at first difference. The findings of the current study indicated that the GDPG variable is not stationary in levels based on the Levin, Lin & Chu (4.17), Im, Pesaran & Shin W-stat (3.21) and the ADF – Fisher Chi-Square (6.27) test statistics which were found to be statistically insignificant at 5% level. However, the results presented in Table 8 suggested that the GDPG variable is stationary at first difference since all the three test statistics for each of the three panel unit root tests described above are statistically significant at 5% level of significance.

Among other panel variables that were found to be non-stationary in their levels but stationary at first differences were SP and PD. On the contrary, variables such as INF and BPVOL were found to be stationary in their levels. Overall, the results of the panel unit root test implies that variables such as INF and BPVOL are integrated of order zero or I(0) since they are stationary in levels while variables that include; GDPG, SP and PD are integrated of order one or simply I(1) because they are not stationary in levels but rather stationary at first difference. To avoid spurious regression, all the variables that were found to be I(1) were transformed into their first difference or logarithms before any meaningful statistical inference was carried out on them.

#### 4.2.4 The impact of oil price volatility on macroeconomic performance of selected African countries

The current research used the natural logarithm of GDP growth rate as a proxy of Economic growth (the dependent variable) in the Panel GMM model estimation whose results are presented in Table 9. The findings presented in Table 9 confirm that the coefficient of the constant ( $\beta_0 = -0.569412$ ) in the estimated Panel GMM model is negative and not statistically significant at 5% level of significance. The results of the research also authenticated that the slope coefficients of the first and second lagged terms of the dependent variable denoted by  $\rho_1 (=4.016700)$  and  $\rho_2 (=0.992589)$  are both positive and statistically significant at 5% level of significance. These results imply that, holding all other things constant, economic growth in the selected African countries depends on its own past or its own lags.

Similarly, the results of the study further authenticated that the slope coefficient of the differenced stock prices (DSP) epitomized by  $\beta_1 (= -0.848759)$  is negative and statistically significant at 5% level of significance. This result implies that a one percent increase in stock prices (DSP) in selected African countries will result in a decrease in economic growth (measured by LGDP) of approximately 0.85 units all things being equal. The results empirically validated the work of Nasir et al. (2018) who investigated the implications of oil price shocks on the BRICS countries (Brazil,

Russia, India, China and South Africa) and found that stock prices in the five (5) countries are impacted by the oil price shocks.

Table 9: Panel GMM estimation results

<b>Dependent variable: Economic growth (LGDPG)</b>				
<b>Description</b>		<b>Symbol</b>	<b>Parameter</b>	<b>Coefficients</b>
Constant		C	$\beta_0$	-0.569412 (0.276056)
Lags of the dependent variable		LGDPG (-1)	$\rho_1$	4.016700** (0.187499)
		LGDPG (-2)	$\rho_2$	0.992589** (0.411060)
<b>Country specific variables</b>	Stock prices	DSP	$\beta_1$	-0.848759** (0.050670)
	Public Debt	DPD	$\beta_2$	-0.921364** (0.201430)
	Inflation	INF	$\beta_3$	-0.460298** (0.128531)
Brentcrude price return volatility		BPVOL	$\beta_4$	-0.890273** (0.547010)
<b>Summary statistics</b>				
R-squared				0.709813
Adjusted R-squared				0.672716
Durbin-Watson stat				1.999009
<b>Diagnostic test results</b>				
Wald test coefficient restrictions test	F-statistic (with degrees of freedom = 7; 187 )			108.4544**
	Chi-square (with degrees of freedom =7)			759.1807**
Sargan test results for the estimated coefficients	J-statistic (p-value = 0.912)			17.06E-13
	Instrument rank			36
Serial LM test for autocorrelation	Chi-square (df =5, p-value = 0.5842)			2.8441

**Notes:** \*\*, indicates statistical significance at 5% level of significance. A test statistic is statistically significant at 5% level of significance if its associated p-value is less than 0.05. The standard errors are reported in parentheses.

Meanwhile, the slope coefficient of the public debt (DPD) variable denoted by  $\beta_2$ (= -0.921364) was also found to be negative and statistically significant at 5% level. This empirical result infers that an increase in government debt (measured by DPD) by 1% will lead to decline in economic

growth (LGDPG) by a magnitude of 0.92 units *ceteris paribus*. Furthermore, the results of the study also revealed that the estimated coefficient inflation (INF) variable characterized by the parameter  $\beta_3$  (= -0.460298) is negative and statistically significant at 5% level of significance. This result suggests that an increase in the rate of inflation in selected African countries will trigger a downfall in economic growth by approximately 0.0003 units if all things remain unchanged.

Above and beyond, the findings presented in Table 9 confirm that the slope coefficient attached to the Brent crude price returns volatility (BPVOL a proxy for oil price volatility) variable symbolized by  $\beta_4$ (= -0.890273) is negative and statistically significant at 5% level. This piece of empirical evidence implies that a slight increase (about 1%) in oil price volatility, as measured by Brent crude price returns volatility will result in a decrease in economic growth in the selected African countries by a magnitude of 0.9 percent, *ceteris paribus*. Consequently, the data generating process for estimated Panel GMM regression model is as follows:

$$LGDPG_t = -0.38 + 4.02LGDP_{t-1} + 0.99LGDPG_{t-1} - 0.85DSP - 0.92DPD - 0.46INF - 0.89BPVOL \quad \dots\dots \quad (4.16)$$

Where  $LGDPG_t$  denotes the GDP growth rate for the selected African countries in period t,  $LGDPG_{t-1}$  is the Gross domestic Product growth rate in period t-1,  $DSP$  symbolises the differenced stock price series,  $DPD$  indicates the differenced Public debt,  $INF$  is the rate of inflation for the selected African countries and  $BPVOL$  refers to the Brent crude prices volatility

The current study also employed the Wald coefficients restrictions test to test for the significance of the estimated Panel GMM model coefficients. Table 9 above also shows the results of the Wald test performed under the null hypothesis that all the estimated coefficients ( $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \rho_1 = \rho_2 = 0$ ) are jointly equal to zero. Based on the results above, the F test-statistic (108.4544) with 7 numerator degrees of freedom and 187 denominator degrees of freedom is positive and statistically significant at a conventional level of 5%. In addition, the chi - square test –statistic (759.1807) for the same test computed with 7 degrees of freedom is also positive and statistically significant at 5% level of significance. The combined results confirmed that the null hypothesis that all the estimated coefficients are jointly equal to zero can be rejected at 5% level hence, the estimated coefficients in the estimated Panel GMM model are jointly different from zero.

Since the consistency of the Panel GMM estimator depends on the validity of instruments, the current study performed the Sargan test suggested by Arrellano & Bond (1991 cited in Brooks, 2014) to test for the validity of the instruments by analysing the sample analogue of the moment conditions used in model estimation. Table 9 also shows the results of the Sargan test for

instrument validity. The Sargan test statistic (J-statistic = 17.06E-13) was found to be positive but not statistically significant at a conventional level of 5% ( $p$ -value > 0.05). Thus, the Sargan test fails to reject the null hypothesis that the instruments are valid. Moreover, the serial LM test statistic (2.8441) for the fitted panel GMM model is not statistically significant at 5% level of significance ( $p$ -value > 0.05). This result implies that the serial LM test for autocorrelation fails to reject the null hypothesis that there is no autocorrelation in the residuals of the fitted model, leading to the conclusion that the fitted model does not suffer from autocorrelation. In the same context, these findings provide enough statistical evidence to support the argument that the GMM dynamic panel data model used in this study provided a good fit to the available data. Finally, the R-squared (0.709813) and the Adjusted R-squared (0.672716) statistics indicated that approximately 70% of the variation in the dependent variable (LGDPG) is explained by the explanatory variables in the fitted panel GMM model.

#### 4.3 The transmission channels through which oil prices and stock prices' relationship affect the economy in selected African countries

The current research employed the Vector Error Correction Model (VECM) to investigate the transmission channels through which oil prices affect the economy in selected African countries. The researcher also performed the Johansen cointegration test to establish whether the panel variables are cointegrated (on the same wavelength) prior to VECM model estimation. The results of the vector autoregression-based Johansen cointegration test are presented below.

##### 4.3.1 Vector Autoregression-based Johansen cointegration test results

Table 10: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	p-values**
None *	0.105978	22.26405	15.49471	0.0041
At most 1	0.002735	0.531235	3.841466	0.4661

Note: \* denotes rejection of the hypothesis at the 0.05 level; \*\*MacKinnon-Haug-Michelis (1999) p-values. CE stands for Cointegrating Equation.

In Table 10, the Trace statistic (22.26405) of the unrestricted cointegration rank test premised on the null hypothesis of no (none) cointegration equations is positive and statistically significant at 5% level. The results imply that there is enough evidence from a statistical background to reject the null hypothesis that the variables in the panel are not cointegrated at all. On the other hand,

the trace test statistic based on the null hypothesis of at most 1 cointegrating equation equivalent to 0.531235 is positive but not statistically significant at 5% significance level. This result indicates that there is not enough evidence from a statistical standpoint to reject the null hypothesis that there is at most one cointegrating equation.

Table 11: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.105978	21.73281	14.26460	0.0028
At most 1	0.002735	0.531235	3.841466	0.4661

Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level; \* denotes rejection of the hypothesis at the 0.05 level; \*\*MacKinnon-Haug-Michelis (1999) p-values. CE stands for Cointegrating Equation.

The research findings presented above in Table 11 show the results of the Johansen cointegration test based on the maximum eigen value test criterion. The above results confirm that, based on the maximum eigen value test statistic (21.73281), the null hypothesis of no cointegration can clearly be rejected at 5% level of significance ( $p$ -value  $< 0.05$ ). Moreover, the maximum eigen statistic valued at 0.531235 and associated with the null hypothesis of at most one cointegrating equation have a probability value (0.4661) that is greater than the conventional level of 0.05. Since the statistic is not statistically significant at the 5% level, it then implies that the null hypothesis of at most one cointegrating equation cannot be rejected at 5% level. Both the trace statistic and the maximum Eigen values statistic confirmed that there is at most one cointegrating equation tying the panel variables to their long run equilibrium or simply that the variables are cointegrated. These findings are consistent with Sezgin, Rafet, & Seyfettin (2008) who found evidence of cointegration between the stock price index and the macroeconomic variables (production, exchange rate and interest) which also indicates a long run relationship between the variables.

#### 4.3.2 Vector Error Correction Model (VECM) results

Table 12: The estimated cointegration relationship of the estimated VECM

Cointegrating Equation	CointEq1
LGDP(-1)	1.000000
BPVOL(-1)	-0.107356** (0.02305) [4.65715]
C	-11.49914

Note: \*\* denotes significance at 5% level of significance respectively. Standard errors are also presented in ( ) and the t-statistics are presented in [ ]

The results presented in Table 12 confirmed that a negative and cointegration relationship and statistically significant ( $p$  values < 0.05) exist between oil prices volatility denoted by BPVOL and economic growth characterized by LGDPG in selected countries.

Table 13: The error correction mechanism and short-run relations between Economic growth (LGDP) and Brent crude price volatility (BPVOL)

Error Correction:	D(LGDPG)	D(BPVOL)
CointEq1	3.77E-05 (0.00116) [ 0.03248]	-2.122262** (0.45459) [-4.66847]
D(LGDPG(-1))	-0.011632** (0.07344) [-2.15838]	-8.587311 (28.7433) [-0.29876]
D(LGDPG(-2))	-0.004194** (0.07380) [-3.05684]	-7.752232 (28.8817) [-0.26841]
D(BPVOL(-1))	0.000144 (0.00019) [ 0.77464]	0.074108** (0.07299) [ 2.01538]
D(BVOL(-2))	-8.21E-05** (0.00019) [-3.43991]	0.030078** (0.07302) [ 0.41192]
LEXR	-0.038770** (0.03533) [-4.09735]	40.12867** (13.8275) [ 5.90210]
LRIR	-0.003317** (0.00411) [-0.80670]	0.131229** (1.60910) [3.08155]



<b>Error Correction:</b>	<b>D(LGDPG)</b>	<b>D(BPVOL)</b>
LINF	-0.000197** (0.00114) [-3.17249]	0.023386** (0.44614) [4.05242]
SPVOL	-0.000201** (0.00041) [-2.48777]	0.069721** (0.16162) [ 4.43138]
C	0.016417 (0.01006) [ 1.63131]	-1.949497 (3.93862) [-0.49497]
<b>Additional Statistics</b>		
R-square		0.515449
Adjusted R-square		0.502708

*Note: Standard errors are presented in ( ) and the t-statistics are presented in [ ]*

The coefficient of the oil price volatility variable denoted by BPVOL (= -2.122262) in the cointegrating equation is negative and statistically significant at 5% level of significance ( $p$  value < 0.05). The results presented in Table 13 indicated that economic growth in selected African countries (as measured by LGDPG) is negatively affected by shocks from its own past lags since the coefficients of LGDPG(-1) and LGDPG(-2) were found to be negative and statistically significant at 5% level. The results further indicated that LGDPG (a proxy of economic growth) in selected countries is also affected by shocks emanating from past oil price volatility (BPVOL (-2) = -8.21E-05) and macroeconomic variables such as exchange rates (LEXR = -0.038770), interest rates (LRIR = -0.003317), the rate of inflation (LINF = -0.000197) and stock price volatility (SPVOL = -0.000201).

The results presented in Table 12 further revealed that oil price volatility as measured by Brent crude prices volatility is not significantly related to past trends of economic growth in selected African countries since the coefficients of LGDPG(-1) and LGDPG(-2) were found to be negative but not statistically significant at 5% level. The results further confirmed that BPVOL (a proxy of oil prices volatility) is positively associated with variables such as exchange rates (LEXR = 40.12867), interest rates (LRIR = 0.131229), the rate of inflation (LINF = 0.023386) and stock price volatility (SPVOL = 0.069721).

Overall, the error correction results presented in Table 13 connote that the level of economic growth in the selected countries is affected by Brent crude prices volatility in the short run and its own past lags as well as other variables like exchange rates, interest rates, inflation rate and stock price volatility in the long run. The results also suggested that the disequilibrium in economic

growth in selected African countries is corrected every period by adjustments in oil prices that is subsequently transmitted via the exchange rates, real interest rates, consumer price indices (rate of inflation) and the volatility of stock market returns. Last but not least, the R-squared (0.515449) and the adjusted R-squared (0.502708) of the VECM presented as additional statistics in Table 13 indicated that about 26% of the variation in the dependent variable is explained by the explanatory variables included in the model. This also implies that the model provided a good fit to the data.

#### 4.3.3 Impulse responses

Table 14 shows the impulse responses of economic growth in selected African countries to shocks originating from oil price volatility. The results confirmed that the level of economic development in selected African countries as measured by LGDPG initially responded negatively to shocks from its past lags for two periods and then responded positively from the third period up to the tenth period.

*Table 14: Impulse responses of economic growth (LGDP) to Brentcrude price volatility (BPVOL) shocks*

<b>Period</b>	<b>LGDPG</b>	<b>BPVOL</b>
1	-0.113033	0.000000
2	-0.111494	- 0.006566
3	0.111017	-0.002031
4	0.111007	-0.001612
5	0.111116	-0.001272
6	0.111133	- 0.001127
7	0.111144	- 0.001023
8	0.111151	- 0.000954
9	0.111155	- 0.000904
10	0.111158	-0.000869

The results above further indicated that, LGDPG does not respond to shocks emanating from Brent crude price volatility (BPVOL) in the first period. However, the results also suggested that

LGDPG responded negatively to shocks emanating from BPVOL in the subsequent period up to and until the 10<sup>th</sup> period.

*Table 15: Impulse responses of Brentcrude price volatility (BPVOL) to shocks from economic growth (LGDP)*

<b>Period</b>	<b>LGDPG</b>	<b>BPVOL</b>
1	-1.536365	44.21153
2	-2.510709	37.41488
3	-3.156751	29.64613
4	-2.734290	22.09518
5	-2.331242	16.30313
6	-1.994199	11.93576
7	-1.739591	8.719956
8	-1.550345	6.363385
9	-1.411462	4.641570
10	-1.309876	3.384600

The results presented in Table 15 revealed that BPVOL responded negatively to shocks originating from economic growth LGDPG over the entire period from period 1 up to period 10. On the other hand, BPVOL responded positively to shock from its own lags over the 10 periods even though the magnitude of the reported figures decreases gradually in each successive period. The results also confirmed the existence of a long-run relationship between oil price volatility as measured by Brent crude price volatility (BPVOL) and economic growth in selected countries (measured by LGDPG).

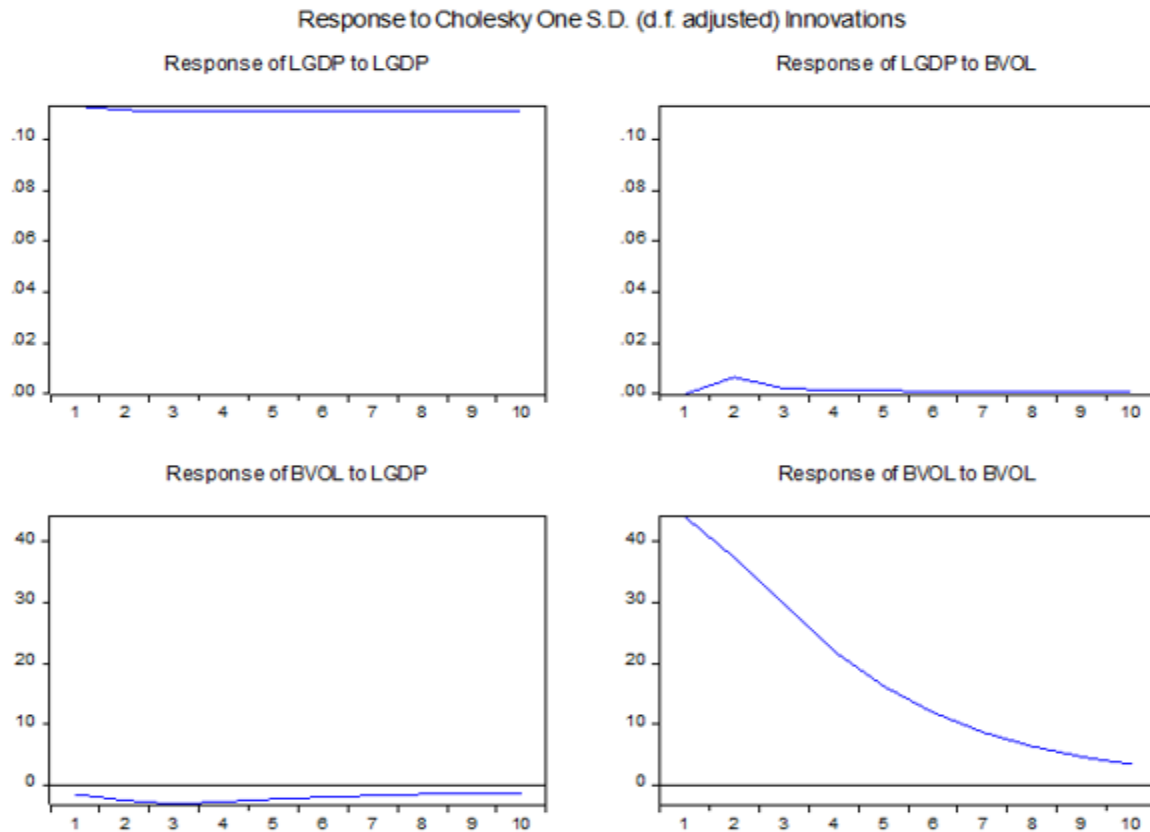


Figure 6: Impulse responses for economic growth (LGDPG) and Brentcrude price volatility (BPVOL)

Source: Researcher's analysis of the data from Bloomberg

Above and beyond, the trend presented in Figure 6 shows that the impulse response of LGDPG to shocks from its own past is relatively stable but its impulse response to shocks from BPVOL is spiky. This implies that a significant long run relationship exists between the level of economic growth in selected African countries and oil price volatility over the sample period. To analyze this confirmed long run relationship, the current research also employed the variance decomposition criterion to identify the transmission channels through which oil prices volatility affect the economy in the selected African countries.

#### 4.3.4 Variance decomposition

Results presented in Table 16 indicated that in the first period 100% of the variation in economic growth in the selected African countries (LGDPG) is entirely attributable to its own lags. In the second successive period, about 99.8% of the variance in economic growth is attributable to its own lags and the remainder (approximately 0.17%) is decomposed as follows; BPVOL (0.07073%), LEXR (0.01893%), LRIR (0.00037%), LINF (0.06533%) and SPVOL (0.01537%).

Table 16: Variance decomposition results for Economic growth (LGDP) in selected African countries

Period	S.E.	LGDPG	BPVOL	LEXR	LRIR	LINF	LSPVOL
1	0.113033	100	0	0	0	0	0
2	0.158904	99.8293	0.07073	0.01893	0.00037	0.06533	0.01537
3	0.193854	98.8743	0.81646	0.29076	0.00061	0.00040	0.01745
4	0.223393	97.9002	0.09985	1.95395	0.00073	0.00036	0.04496
5	0.249505	96.9174	0.08265	0.49946	0.00080	0.00038	2.49936
6	0.273139	95.9293	0.07066	0.54328	3.32125	0.00037	0.13510
7	0.294888	94.9382	1.30297	0.57462	0.00088	3.00037	0.18300
8	0.315142	93.945	1.05505	0.59836	0.17308	1.00037	3.22820
9	0.334171	92.9503	1.04969	1.61701	1.11312	1.00037	2.26951
10	0.352175	91.9547	1.04535	2.69209	1.00094	1.00037	2.30660
<b>Cholesky Ordering: LGDPG; BPVOL; LEXR; LRIR; LINF; LSPVOL</b>							

In the third period, BPVOL accounted for a relatively bigger proportion of variance in economic growth holding its own lags constant. Apart from the above mentioned, about 98% of the variation in economic growth in the selected African countries (LGDPG) in the fourth period is attributable to its own lags and the final 2.1% of the variation is due to exogenous factors such as BPVOL (0.09985%), LEXR (1.95395%), LRIR (0.00073%), LINF (0.00036%) and SPVOL (0.04496%). Besides its own lags, much of the variation in LGDPG in the 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup> and the 10<sup>th</sup> periods were emanating from shocks posed by LSPVOL (2.499363%), LRIR (3.321248%), LINF (3.000367%), SPVOL (3.22820%), SPVOL (2.26951%) and LEXR (2.69209%).

#### 4.3.5 Transmission channels through which oil price volatility affects economic growth of the selected African countries

The results suggests that an increase in oil prices volatility will negatively impact economic growth in selected African countries in the short run, via Brent crude price volatility in the second and third period due to increased government spending in procuring the precious commodity as government reallocate funds designated for economic growth to hedge themselves against the uncertainties caused by oil price volatility. Moreover, the negative impact of oil price volatility on economic growth in selected African countries will be transmitted through exchange rates in the 4<sup>th</sup> period as weaker currencies crumble in the face of a volatile international commodity (oil) market. The results provides an empirical confirmation to the work of Chinzara (2011) who found that there is evidence of volatility transmission between the stock market and macroeconomic

factors particularly for the exchange rate and the Treasury bill rate. In the 5<sup>th</sup> period however, the dire impact of oil price fluctuations is transmitted through stock prices volatility since bad news are more destabilizing than good news of the same magnitude. Real interest rates will also increase in the 6<sup>th</sup> period, exerting a downward pressure on economic growth as the cost of borrowing surge beyond the reach of many investors.

As the exchange rates, stock prices volatility and real interest rates increases, inflation will creep in the 7<sup>th</sup> period further weakening the terms of trade and competitiveness of economies in the selected African countries. Beyond the 7<sup>th</sup> period, into the 8<sup>th</sup> and the 9<sup>th</sup> period, stock price volatility persists in response to oil price volatility causing economic growth to deteriorate further in the selected African countries as market capitalization and stock returns plunges. Finally, the circle begins again in the 10<sup>th</sup> period as real exchange rate come back to bite harder into the already depleted economies if the oil price volatility does not relent, its negative impact will be continuously transmitted to the economies of selected African countries through the aforementioned transmission channels.

#### 4.3.6 Pairwise Granger Causality or Block Exogeneity tests

Table 17: Pairwise Granger Causality or Block Exogeneity tests results

Excluded variables	Dependent variable (F-statistics)					
	D(LGDPG)	D(BPVOL)	D(LEXR)	D(LRIR)	D(LINF)	D(SPVOL)
D(LGDP)		0.13071	0.38527	0.42693	0.00462	12.8711
D(BPVOL)	-3.28284**		2.00264	2.00264	3.62345	2.35145**
D(LEXR)	-4.02506**	0.58901		1.50937	0.19086	0.12072
D(LRIR)	-3.00102**	0.00263	1.63751		0.00029**	0.20062
D(LINF)	-3.00275**	0.23243	0.70437	0.00515		0.01807
D(SPVOL)	-2.76773**	1.22099**	0.07201	0.87413	0.15332	

The results of the Pairwise Granger Causality or Block Exogeneity tests presented in Table 17 indicated that there is statistical evidence at 5% level that oil price volatility as measured by Brent crude price volatility (BPVOL) granger cause economic growth in selected African countries as measured by the logarithm of Gross Domestic Product growth rate (LGDPG). There is, however, no evidence that economic growth in selected African countries also granger causes oil price volatility leading to the conclusion that a uni-directional causality runs from later to the former. Moreover, the results above confirmed that a bi-directional causality exist between oil price volatility and stock prices volatility in the selected African countries due to the 'contagion effect' phenomenon in regional stock markets. The combined results of the Granger causality test, impulse response functions, variance decompositions and cointegration test findings, suggested that these recursive structures substantiate the fact that oil price volatility (BPVOL) contemporaneously influence the trends in economic growth in selected African countries (LGDPG).

## CHAPTER 5: SUMMARY, CONCLUSION AND POLICY RECOMMENDATION

### 5.1 Introduction

The current chapter presents and discusses findings found in the previous chapters as well as recommendations to the corporate world, the society and academia. Conclusions are drawn and areas for further research are also suggested in this chapter. The primary objectives of this study was to examine the relationship between oil price volatility and the stock price volatility of the selected African countries, examine the impact of oil price volatility on macroeconomic performance of the selected African countries and identify the transmission channels through which oil price volatility affect the economy of the selected African countries. The researcher reviewed and explored literature on the relationship between oil prices and stock prices movements in selected developing African countries as well as the relationship between oil price volatility, stock price volatility and the macro economy in developing countries.

### 5.2 Summary of main findings and Conclusion

This study investigated the interlinkages between oil prices, stock prices and the economy by examining volatility transmission in developing African countries using monthly panel data from June 2003 to November 2019. The primary purpose of the investigation was to explore relationship between oil price volatility and the stock price volatility across the selected African countries. The current study also examined the impact of oil price volatility on macroeconomic performance of the selected African countries and sought to identify the transmission channels through which oil price volatility affect the economy. The consequences of oil price volatility on stock prices and economic growth, measured by the GDP growth rate of selected African countries was analyzed by using a range of time series and panel data estimation techniques including Multivariate BEKK (1,1) model, Panel Generalized Method of Moments, Johansen cointegration and Vector Error Correction (VECM). The results of the current study reveal the following:

- The Diagonal BEKK Model exhibits very large GARCH and relatively low ARCH effects which suggests that co-movement between oil price volatility and stock price volatility in selected African countries does not appear to be directly linked to geography or economic relations between the countries due to financial globalization and integration. Moreover, the results show that correlations between the stock indices and oil price returns are highly volatile throughout the period and the volatility is particularly more pronounced after the



2007–2008 financial crisis. In all cases, there is an increase in volatility during and after the crisis. These results are consistent with the findings presented by (Dutta, Nikkinen, & Rothovius 2017).

- The GMM results suggests that oil price volatility and stock prices volatility have negative impacts on the level of economic growth in selected African countries consistent with the findings by (Van Eyden et al., 2019)
- Finally, the VECM model results also suggests a significant negative long run relationship between oil price volatility and economic growth in selected African countries. The results also indicate that oil price volatility is transmitted to the economy through the exchange rates, real interest rates, consumer price indices (rate of inflation) and the volatility of stock market returns. These findings support the findings presented by (Maina, 2015).
- Finally, the pairwise Granger causality or block erogeneity test uncovered a uni-directional cause and effect that runs from oil price volatility to economic growth through stock price volatility in selected African countries over the sample period.

### 5.3 Policy implications

Since the study revealed that economic growth in selected African countries is influenced by oil prices volatility and stock price volatility as well as other macroeconomic factors such as exchange rates, inflation, real interest rates and public debt, investors across the globe should monitor developments in these variables before they invest their money in emerging or developing markets, particularly the selected African countries used as unit of analysis in the current research. Regarding oil prices volatility, international investors should not turn a blind eye to fluctuations in oil prices since their persistence is associated with risk and uncertainty in stock markets and the economy at large. Investors should continue with their quest for investment in equities across the globe even in developing nations since no investment haven is immune to risk and uncertainty but what differs is the degrees of vulnerability to risk. Therefore, the implications of this study are that, in the case where the risk premium is higher, careful modelling and forecasting of oil prices volatility is a prerequisite for proper and informed investment decisions.

One important implication of this study is that adding stocks only from these selected African countries' financial markets is not enough to diversify risk. Investors should not put all their eggs in one basket, but they should diversify their portfolios by investing in more stable and mature markets in developed countries. The results of the current study also imply that correlations and volatility spillover effects between oil markets and emerging stock markets must be studied and

considered. Policy makers in the emerging world must now design policies not only looking at domestic estimates, but also consider the fact that emerging markets are now highly linked both among each other and with co-movements in oil or commodity prices globally. Hence, global financial landscape has changed, and the emerging markets is no exception.

#### 5.4 Priorities going forward

The study conclude that oil prices volatility have significant negative impacts on economic growth in selected African countries. Policymakers in these economies, and in general, should aim to respond by appropriate design of expansionary (monetary) policies in the wake of heightened oil market uncertainty. The fact that the negative influence of oil market volatility on economic activity is more pronounced in the selected African countries, improved monetary policy is useful to counter the negative impact of oil price volatility. In attempts to enhance economic growth outcomes, policy efforts should also be directed towards minimizing oil market volatility.

#### 5.5 Further research

This research cannot exhaustively envelop all the rudiments of the relationship between oil price volatility and the level of economic growth in emerging markets. The composition of the research should be taken as a roadmap rather than a comprehensive treatment of all the facets and dynamic linkages between the aforesaid variables. Further research may seek to characterize oil prices volatility using the conditional variance computed from dynamic non-linear multivariate extensions of GARCH model such as Dynamic Conditional Correlation Multivariate models to give more plausible results. Of course, the current research cannot exhaustively explore all the possible state variables, but future work should try to examine the long run relationship between oil prices volatility and economic growth using powerful methodologies such as Autoregressive Distributed Lag (ARDL) models and Markov regime switching models. Finally, further research may seek to examine the relationship between oil price volatility and economic growth at a sector level.

## BIBLIOGRAPHY

- Abbas, G., McMillan, D. G., & Wang, S. (2018). Conditional volatility nexus between stock markets and macroeconomic variables: Empirical evidence of G-7 countries. *Journal of Economic Studies*, 45(1), 77-99.
- Acikalin, S., Aktas, R., & Unal, S. (2008). Relationships between stock markets and macroeconomic variables: an empirical analysis of the Istanbul Stock Exchange. *Investment Management and Financial Innovations*, 5(1), 8-16.
- Adenikinju, O., Adetunji Babatunde, M., & Adenikinju, A. F. (2013). Oil price shocks and stock market behaviour in Nigeria. *Journal of Economic Studies*, 40(2), 180-202.
- Akinlo, T., & Apanisile, O. T. (2015). The impact of volatility of oil price on the economic growth in Sub-Saharan Africa. *Journal of Economics, Management and Trade*, 338-349.
- Akoum, I., Graham, M., Kivihaho, J., Nikkinen, J., & Omran, M. (2012). Co-movement of oil and stock prices in the GCC region: A wavelet analysis. *The Quarterly Review of Economics and Finance*, 52(4), 385-394.
- Alfred, M. Evaluating the impact of global oil prices on the SADC and the potential for increased trade in biofuels and natural gas within the region. In (Vol. 2019). Helsinki, Finland: UNU-WIDER.
- Allen, F., Otchere, I., & Senbet, L. W. (2011). African financial systems: A review. *Review of development finance*, 1(2), 79-113.
- Aloui, C., Nguyen, D. K., & Njeh, H. (2012). Assessing the impacts of oil price fluctuations on stock returns in emerging markets. *Economic Modelling*, 29(6), 2686-2695.
- Anderson, M., & Subbaraman, R. (1996). *Share prices and investment*. Reserve Bank of Australia.
- Arouri, M. E. H., & Fouquau, J. (2009). On the short-term influence of oil price changes on stock markets in GCC countries: linear and nonlinear analyses. *arXiv preprint arXiv:0905.3870*.
- Asari, F., Baharuddin, N. S., Jusoh, N., Mohamad, Z., Shamsudin, N., & Jusoff, K. (2011). A vector error correction model (VECM) approach in explaining the relationship between interest rate and inflation towards exchange rate volatility in Malaysia. *World Applied Sciences Journal*, 12(3), 49-56.
- Asteriou, D., & Bashmakova, Y. (2013). Assessing the impact of oil returns on emerging stock markets: A panel data approach for ten Central and Eastern European Countries. *Energy Economics*, 38, 204-211.
- Awartani, B., Javed, F., Maghyereh, A., & Virk, N. (2018). Time-varying transmission between oil and equities in the MENA region: New evidence from DCC-MIDAS analyses. *Review of development finance*, 8(2), 116-126.
- Bagirov, M., & Mateus, C. (2019). Oil prices, stock markets and firm performance: Evidence from Europe. *International Review of Economics & Finance*, 61, 270-288.
- Bashar, O. H., Wadud, I. M., & Ahmed, H. J. A. (2013). Oil price uncertainty, monetary policy and the macroeconomy: The Canadian perspective. *Economic Modelling*, 35, 249-259.
- Basher, S. A., & Sadorsky, P. (2006). Oil price risk and emerging stock markets. *Global finance journal*, 17(2), 224-251.
- Bastianin, A., Conti, F., & Manera, M. (2016). The impacts of oil price shocks on stock market volatility: Evidence from the G7 countries. *Energy Policy*, 98, 160-169.
- Bauwens, L., Laurent, S., & Rombouts, J. V. (2006). Multivariate GARCH models: a survey. *Journal of applied econometrics*, 21(1), 79-109.
- Beetsma, R., & Giuliodori, M. (2012). The changing macroeconomic response to stock market volatility shocks. *Journal of Macroeconomics*, 34(2), 281-293.

- Beltratti, A., & Morana, C. (2006). Breaks and persistency: macroeconomic causes of stock market volatility. *Journal of econometrics*, 131(1), 151-177.
- Berument, M. H., Ceylan, N. B., & Dogan, N. (2010). The impact of oil price shocks on the economic growth of selected MENA1 countries. *The Energy Journal*, 31(1).
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, 87(1), 115-143.
- Borjigin, S., Yang, Y., Yang, X., & Sun, L. (2018). Econometric testing on linear and nonlinear dynamic relation between stock prices and macroeconomy in China. *Physica A: Statistical mechanics and its Applications*, 493, 107-115.
- Brooks, C. (2004). *Introductory Econometrics for Finance*. The United Kingdom. In: Cambridge University Press. Available at: <http://hdl.handle.net/10.1002/ijfe>.
- Brown, S. P., & Yücel, M. K. (2002). Energy prices and aggregate economic activity: an interpretative survey. *The Quarterly Review of Economics and Finance*, 42(2), 193-208.
- Buddelmeyer, H., Jensen, P. H., Oguzoglu, U., & Webster, E. (2008). Fixed effects bias in panel data estimators. Available at SSRN 1136288.
- Bundoo, S. K. (2017). Stock market development and integration in SADC (Southern African Development Community). *Review of development finance*, 7(1), 64-72.
- Burakov, D. (2017). Oil prices, economic growth and emigration: An empirical study of transmission channel. *International Journal of Energy Economics and Policy*, 7(1), 90-98.
- Chauvet, M., Senyuz, Z., & Yoldas, E. (2015). What does financial volatility tell us about macroeconomic fluctuations? *Journal of Economic Dynamics and Control*, 52, 340-360.
- Chen, Y., Li, W., & Jin, X. (2018). Volatility spillovers between crude oil prices and new energy stock price in China. *Romanian Journal of Economic Forecasting*, 21(2), 43-62.
- Chinzara, Z. (2011). Macroeconomic Uncertainty and Conditional Stock Market Volatility in South Africa. *South African Journal of Economics*, 79(1), 27-49.
- Chowdhury, S. S. H., & Rahman, M. (2004). On the Empirical Relation between Macroeconomic Volatility and Stock Market Volatility in Bangladesh. *The Global Journal of Finance and Economics*, 1(2), 209-225.
- Christopher, G., Minsoo, L., Hua Hwa Au, Y., & Jun, Z. (2006). Macroeconomic Variables and Stock Market Interactions: New Zealand Evidence. *Investment Management & Financial Innovations*(4).
- Chuku, C., Effiong, E., & Sam, N. (2010). Oil price distortions and their short-and long-run impacts on the Nigerian economy.
- Creti, A., Ftiti, Z., & Guesmi, K. (2014). Oil price and financial markets: Multivariate dynamic frequency analysis. *Energy Policy*, 73, 245-258.
- Darby, M. R. (1982). The price of oil and world inflation and recession. *The American Economic Review*, 72(4), 738-751.
- Degiannakis, S., Filis, G., & Arora, V. (2017). Oil prices and stock markets.
- Dutta, A., Nikkinen, J., & Rothovius, T. (2017). Impact of oil price uncertainty on Middle East and African stock markets. *Energy*, 123, 189-197.
- Dutta, P., Noor, M. H., & Dutta, A. (2017). Impact of oil volatility shocks on global emerging market stock returns. *International Journal of Managerial Finance*, 13(5), 578-591.
- Engle, R. F., & Kroner, K. F. (1995). Multivariate simultaneous generalized ARCH. *Econometric theory*, 11(1), 122-150.
- Filis, G. (2010). Macro economy, stock market and oil prices: Do meaningful relationships exist among their cyclical fluctuations? *Energy Economics*, 32(4), 877-886.
- Foudeh, M. (2017). The long run effects of oil prices on economic growth: The case of Saudi Arabia. *International Journal of Energy Economics and Policy*, 7(6), 171-192.

- Fowowe, B. (2013). Jump dynamics in the relationship between oil prices and the stock market: Evidence from Nigeria. *Energy*, 56, 31-38.
- Gil-Alana, L. A., & Yaya, O. S. (2014). The relationship between oil prices and the Nigerian stock market. An analysis based on fractional integration and cointegration. *Energy Economics*, 46, 328-333.
- Goodness, C. A. (2015). Does oil price uncertainty matter for stock returns in South Africa? *Investment Management & Financial Innovations*(1), 179.
- Gourène, G. A. Z., & Mendy, P. (2018). Oil prices and African stock markets co-movement: A time and frequency analysis. *Journal of African Trade*, 5(1), 55-67.
- Guesmi, K., & Fattoum, S. (2014). Return and volatility transmission between oil prices and oil-exporting and oil-importing countries. *Economic Modelling*, 38, 305-310.
- Gujarati, D. (2004). Basic Econometrics.(4 th edtn) The McGraw– Hill Companies.
- Gupta, R., & Modise, M. P. (2013). Does the source of oil price shocks matter for South African stock returns? A structural VAR approach. *Energy Economics*, 40, 825-831.
- Hamdi, B., Aloui, M., Alqahtani, F., & Tiwari, A. (2019). Relationship between the oil price volatility and sectoral stock markets in oil-exporting economies: Evidence from wavelet nonlinear denoised based quantile and Granger-causality analysis. *Energy Economics*, 80, 536-552.
- Hamma, W., Jarboui, A., & Ghorbel, A. (2014). Effect of Oil Price Volatility on Tunisian Stock Market at Sector-level and Effectiveness of Hedging Strategy. *Procedia Economics and Finance*, 13, 109-127.
- Hsiao, C. (2014). *Analysis of panel data*: Cambridge university press.
- Huang, R. D., Masulis, R. W., & Stoll, H. R. (1996). Energy shocks and financial markets. *Journal of Futures Markets: Futures, Options, and Other Derivative Products*, 16(1), 1-27.
- Huang, S., An, H., Gao, X., & Huang, X. (2015). Identifying the multiscale impacts of crude oil price shocks on the stock market in China at the sector level. *Physica A: Statistical mechanics and its Applications*, 434, 13-24.
- Kamel Si, M., Benhabib, A., & Maliki, S. (2016). The impact of oil prices on macroeconomic fundamentals, monetary policy and stock market for eight Middle East and North African countries. *Topics in Middle Eastern & North African Economies: Proceedings of the Middle East Economic Association*, 18(2), 26.
- Kang, W., Ratti, R. A., & Vespignani, J. (2016). The impact of oil price shocks on the U.S. stock market: A note on the roles of U.S. and non-U.S. oil production. *Economics letters*, 145, 176-181.
- Kilian, L., & Park, C. (2009). THE IMPACT OF OIL PRICE SHOCKS ON THE U.S. STOCK MARKET. *International Economic Review*, 50(4), 1267-1287.
- Kumari, J., & Mahakud, J. (2015). Does investor sentiment predict the asset volatility? Evidence from emerging stock market India. *Journal of Behavioral and Experimental Finance*, 8, 25-39.
- Liljeblom, E., & Stenius, M. (1997). Macroeconomic Volatility and Stock Market Volatility: Empirical Evidence on Finnish Data. *Applied Financial Economics*, 7(4), 419-426.
- Mademlis, D. K., & Dritsakis, N. (2018). *Volatility between oil prices and stock returns of dow jones index: a bivariate GARCH (BEKK) approach*. Paper presented at the International Conference on Applied Economics.
- Maghyereh, A. (2004). *Oil Price Shocks and Emerging Stock Markets: A Generalized VAR Approach* (Vol. 1).
- Maina, G. P. (2015). Transmission channels of crude oil price shocks on Kenya's economy. *Unpublished Master of Economics Project, Nairobi, Kenyatta University.*[Retrieved from].
- Miller, J., & Ratti, R. (2009). *Crude oil and stock markets: Stability, instability, and bubbles* (Vol. 31).
- Mohammadi, H., & Tan, Y. (2015). Return and volatility spillovers across equity markets in mainland China, Hong Kong and the United States. *Econometrics*, 3(2), 215-232.

- Mokni, K., & Youssef, M. (2019). Measuring persistence of dependence between crude oil prices and GCC stock markets: A copula approach. *The Quarterly Review of Economics and Finance*.
- Morelli, D. (2002). The relationship between conditional stock market volatility and conditional macroeconomic volatility: empirical evidence based on UK data. *International Review of Financial Analysis*, 11(1), 101-110.
- Mukhtarov, S., Aliyev, S., & Zeynalov, J. (2020). The Effects of Oil Prices on Macroeconomic Variables: Evidence from Azerbaijan. *International Journal of Energy Economics and Policy*, 10(1), 72.
- Naifar, N., & Al Dohaiman, M. S. (2013). Nonlinear analysis among crude oil prices, stock markets' return and macroeconomic variables. *International Review of Economics & Finance*, 27, 416-431.
- Narayan, P. K., & Narayan, S. (2010). Modelling the impact of oil prices on Vietnam's stock prices. *Applied energy*, 87(1), 356-361.
- Nasir, M. A., Naidoo, L., Shahbaz, M., & Amoo, N. (2018). Implications of oil prices shocks for the major emerging economies: A comparative analysis of BRICS. *Energy Economics*, 76, 76-88.
- Nejad, M. K., Jahantigh, F., & Rahbari, H. (2016). The Long Run Relationship between Oil Price Risk and Tehran Stock Exchange Returns in Presence of Structural Breaks. *Procedia Economics and Finance*, 36, 201-209.
- Nortey, E. N., Ngoh, D. D., Doku-Amponsah, K., & Ofori-Boateng, K. (2015). Modeling inflation rates and exchange rates in Ghana: application of multivariate GARCH models. *SpringerPlus*, 4(1), 86.
- Olufisayo Akinlo, O. (2014). *Oil Price and Stock Market: Empirical Evidence from Nigeria* (Vol. 3).
- Omojolaibi, J. A., & Egwaikhide, F. O. (2013). A panel analysis of oil price dynamics, fiscal stance and macroeconomic effects: the case of some selected African countries. *Central Bank of Nigeria Economic and Financial Review*, 51(1), 61-91.
- OPEC, O. (2016). Annual Statistical Bulletin 2016. *Organization of Petroleum Exporting*.
- Oseni, I. O., & Nwosa, P. I. (2011). Stock market volatility and macroeconomic variables volatility in Nigeria: An exponential GARCH approach. *Journal of Economics and Sustainable Development*, 2(10), 28-42.
- Pierce, J. L., Enzler, J. J., Fand, D. I., & Gordon, R. (1974). The effects of external inflationary shocks. *Brookings Papers on Economic Activity*, 1974(1), 13-61.
- Polbin, A. (2017). Econometric estimation of the impact of oil prices shock on the Russian economy in VECM model. *VOPROSY ECONOMIKI*, 10.
- Ratanapakorn, O., & Sharma, S. C. (2007). Dynamic analysis between the US stock returns and the macroeconomic variables. *Applied Financial Economics*, 17(5), 369-377.
- Reboredo, J. C., & Rivera-Castro, M. A. (2014). Wavelet-based evidence of the impact of oil prices on stock returns. *International Review of Economics & Finance*, 29, 145-176.
- Rotimi, M. E., & Ngalawa, H. (2017). Oil price shocks and economic performance in Africa's oil exporting countries. *Acta Universitatis Danubius. Œconomica*, 13(5).
- Sauter, R., & Awerbuch, S. (2003). Oil price volatility and economic activity: a survey and literature review. *IEA research paper*, 28, 550-577.
- Schwert, G. W. (1989). Why does stock market volatility change over time? *The journal of finance*, 44(5), 1115-1153.
- Sezgin, A., Rafet, A., & Seyfettin, U. (2008). Relationships Between Stock Markets and Macroeconomic Variables: an Empirical Analysis of the Istanbul Stock Exchange. *Investment Management & Financial Innovations*(1).
- Sibanda, K., Gonesse, D., Mukarumbwa, P., & Hove-Sibanda, P. (2018). The impact of oil price on sectorial output in South Africa. *International Journal*, 74(4/1).
- Silvapulle, P., Smyth, R., Zhang, X., & Fenech, J.-P. (2017). *Nonparametric panel data model for crude oil and stock market prices in net oil importing countries* (Vol. 67).

- Silvennoinen, A., & Teräsvirta, T. (2009). Multivariate GARCH models. In *Handbook of financial time series* (pp. 201-229): Springer.
- Singh, T., Mehta, S., & Varsha, M. (2011). Macroeconomic factors and stock returns: Evidence from Taiwan. *Journal of economics and international finance*, 3(4), 217-227.
- Stavros Degiannakis, G. F., & Vipin, A. (2018). Oil Prices and Stock Markets: A Review of the Theory and Empirical Evidence. *The Energy Journal*, Volume 39(Number 5).
- Sui, L., & Sun, L. (2016). Spillover effects between exchange rates and stock prices: Evidence from BRICS around the recent global financial crisis. *Research in International Business and Finance*, 36, 459-471.
- Suleiman, M. (2013). Oil demand, oil prices, economic growth and the resource curse: An empirical analysis. *Surrey Energy Economics Centre (SEEC) School of Economics University of Surrey*.
- Van Eyden, R., Difeto, M., Gupta, R., & Wohar, M. E. (2019). Oil price volatility and economic growth: Evidence from advanced economies using more than a century's data. *Applied energy*, 233, 612-621.
- Wakeford, J. (2006). *The impact of oil price shocks on the South African macroeconomy: History and prospects*. Paper presented at the Accelerated and Shared Growth in South Africa: Determinants, Constraints and Opportunities,(18-20 October 2006). The Birchwood Hotel and Conference Centre, Johannesburg, South Africa.
- Wooldridge, J. M. (2010). Economic analysis of cross section panel. In: The MIT Press Cambridge.
- Zaabouti, K., Ben Mohamed, E., & Bouri, A. (2016). Does oil price affect the value of firms? Evidence from Tunisian listed firms. *Frontiers in Energy*, 10(1), 1-13.
- Zaki, F., Elgammal, M., & Hussainey, K. Macro economy, stock market and oil prices relationships before and after the Egyptian Revolution Era.