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ESSAYS ON STOCK MARKETS IN SUB-SAHARAN AFRICA

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DECLARATION

I, ACHIAPO JESSICA LISETTE ATSIN (3580919), hereby declare that the thesis for DOCTOR OF PHILOSOPHY in ECONOMICS is my own work and that it has not previously been submitted to another university or for another qualification.

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ABSTRACT

The main objective of this thesis was to closely examine several financial and economic aspects of the stock markets in Sub-Saharan Africa. Thus, the objectives of this thesis were to explore the interdependence, the time-varying conditional correlation and the volatility linkages among Sub-Saharan African and developed stock markets; to investigate the relationship between financial liberalization and the development of stock markets; and to examine the patterns of the aggregate market liquidity and the relevance of the mainstream determinants of market liquidity in the chosen Sub-Saharan African stock markets. The study was composed of three standalone essays. The first essay, which investigated stock price co-movements and the volatility linkages between selected Sub-Saharan African markets and the key developed markets, used the Johansen cointegration test, the VECM and the GARCH models for the sample period 2 January 2009 – 31 December 2016. The second essay, examining the effect of financial liberalization on the development of stock markets in Sub-Saharan Africa, employed the Bayesian VAR for the sample period 1975Q1 – 2014Q4. Lastly, the third essay, which investigated the determinants of liquidity levels in Sub-Saharan African stock markets employed the Markov Switching Vector Autoregressive model for the sample period 2 January 2009 – 31 December 2016.This study aimed at contributing to the already existing literature by focusing on analysing four key stock markets in the region, namely the Nigerian Stock Exchange, the Kenyan Securities Exchange, The Johannesburg Stock Exchange, as well as the Bourse Regionale des Valeurs Mobilieres (BRVM), a regional stock exchange serving eight West African countries (i.e. Benin, Burkina Faso, Guinea Bissau, Cote d'Ivoire, Mali, Niger, Senegal and Togo).The results from the first analysis show the existence of cointegration and a long run relationship among the four African markets and between the African markets and two developed markets. There was also evidence bi-directional as well as uni-directional causality between market returns, as well as high positive correlations in volatility between five pairs of markets out of 14. These findings are crucial for investors as they will affect portfolio diversification. The results from the second investigation show a positive correlation between stock market development and the liberalization of stock markets and the financial sector in all four countries, which advocates for the opening of financial markets to foreign investors, as well as the deepening of the sector. Additionally, a positive long-run response of stock market development to all three forms of liberalization in all the markets considered suggested that greater focus should therefore be put on increasing financial openness by removing the restrictions in the financial sectors of the respective economies,

as this will promote effective delivering of credit to the private sector, efficiency in evaluating credit and surveilling the public sector, which is provided through the stock market. Finally, the analysis uncovered negative correlation between inflation and stock market development in all four markets, suggesting that policy makers in these countries should pay special attention to inflation targeting policies in order to positively contribute to enhancing these markets. The results from the third analysis showed that the four Sub-Saharan African stock markets are still relatively illiquid despite the efforts made to improve the markets' microstructure and functioning. The results also identified the discount rate, domestic market volatility and global investors' confidence as common determinants of stock market liquidity in the four markets. These findings suggest that maintaining macroeconomic stability as well as keeping an eye on global events could contribute to improving the level of liquidity in Sub-Saharan African countries.

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Chapter 1

INTRODUCTION

1.1 Background

The equity market sector in Africa has seen a considerable speedy evolution over a very short period of time. While the Sub-Saharan African region only housed 11 functioning stock markets by the end of 1996, the continent currently has around 20 operating exchanges, amongst which is one of very few regional exchanges in the world regrouping eight Francophone West African countries. These stock markets can be regrouped into four categories. The first one is comprised markets such as South Africa, dominating the region in terms of market size and development. In effect, the JSE which is ranked 16th in the world in terms of size, accounting for more than 80 percent of the regional total market capitalization (Farid, 2013: 4). The second group includes the medium sized markets, which in most cases have been operating for a long time. These are, for example, Nigeria and Zimbabwe. The third category could regroup small and recently established but rapidly growing markets such as Botswana, Ghana and Mauritius. Lastly, the fourth category of exchanges found in the region are the small new markets that are still taking off, such as Swaziland and Zambia (Farid, 2013: 4).

While African stock markets only account for less than two percent of the world market capitalization, there is still a growing interest in the Sub-Saharan African region resulting from its noticeably strong growth prospects, improved macroeconomic management, decreased political instability, and robust global commodity demand (Masetti, Mihr, Lanzeni, AG and Hoffmann, 2013). However, these markets are characterised by their small sizes, generally illiquid stocks and financial inefficiencies. The high degree of illiquidity characterising most Sub-Saharan African stock markets emerges from the fact that shares are infrequently traded, often limited to a small group of blue chip stocks, and turnover ratios are low compared to international standards (Masetti *et al.*, 2013). In the JSE, for example, there can be extreme differences in intra-market liquidity, going as high as 100 percent between the All Share index and the constituents of the Top 40 index. Nevertheless, these limitations of the African stock markets do not prevent them from recording solid performances with many of the small markets offering dramatic returns to investors. Additionally, the apparent lack of correlation between the African markets and developed ones makes them relatively immune to the global investor jitters which affect stock values in other parts of the world (Farid, 2013: 5). These markets then offer global investors considerable opportunities for portfolio and risk diversification.

As more developed capital markets are crucial to Sub-Saharan Africa for a more efficient mobilization of domestic corporate and individual resources, suggestions have been made to overcome these markets' limitations and improve their broader economic impact. One proposition was the promotion of financial integration in existing monetary unions and a harmonized approach to regulation in the region in order to increase financial market size, as well as the size of the economies (Farid, 2013: 4). Moreover, countries have been encouraged to increase and fortify the national exchanges' collaborations on a regional basis; and also, to consider the establishment of regional stock exchanges. Consequently, discussions have been undertaken with regard to the integration of national exchanges in Southern Africa, and the establishment of regional exchanges in Central and East Africa. However, very little progress has been made, which is mostly a reflection of broad economic restrictions such as exchange controls; as well as the differences in the countries' institutional legal and technical standards (Farid, 2013: 4). Therefore, it becomes crucial to dedicate greater attention to understanding the financial framework currently existing in the region in terms of inter-market linkages, financial regulations and excess profit prospects. Moreover, notwithstanding the size, liquidity and efficiency challenges of the region's stock markets, a considerable number of regional stock indices outperformed benchmark indices such as the S&P 500 and the MSCI Emerging Market index in 2012 (Masetti, *et al.*, 2013). This goes to show the rising potential that the Sub-Saharan African markets present.

Therefore, the research questions that emerge following the preceding discussions are as follows: are the key stock markets in Sub-Saharan Africa interdependent and are they related to the more developed stock markets in the world? What are the determinants of aggregate market liquidity in the region's stock markets? Do the changes in regulations affect stock prices, profitability and the development of the stock markets in the Sub-Saharan African region?

1.2 Objectives of the study

The objective of this study is to closely examine several financial and economic aspects of the stock markets in Sub-Saharan Africa.

However, the specific objectives are to:

i. Explore interdependence among Sub-Saharan African stock markets and developed stock markets;

ii. Examine the time-varying conditional correlation among Sub-Saharan African markets; and between developed and Sub-Saharan African markets;

iii. Analyse volatility regimes across Sub-Saharan African stock markets;

iv. Investigate the determining factors of liquidity levels in Sub-Saharan African stock markets;

v. Evaluate the degree of financial liberalization in selected Sub-Saharan Africa countries and;

vi. Examine the effects of liberalization on the development of the stock markets.

1.3 Relevance

The considerable improvement in the Sub-Saharan Africa region growth performance, due to a reduction in political conflict, promotion of good governance and ongoing economic reforms and policies targeted at poverty reduction, has drawn investors' attention to the region. The increase in foreign direct investment and portfolio investment resulting from this growing interest constitutes an important contribution to the development of the region's financial sector and economy as a whole. Therefore, investigating the stock markets in Sub-Saharan Africa could help in drawing a global picture of the profitability of the region in order to increase investors' confidence and attract more capital inflows. Although there are extensive studies on the contribution of the financial markets to economic growth in the region, as well as the financial sector's challenges and reforms, this study aims at contributing to the already existing literature by focusing on analysing four key stock markets in the region, namely the Nigerian Stock Exchange, the Kenyan Securities Exchange, The Johannesburg Stock Exchange, as well as the Bourse Regionale des Valeurs Mobilieres (BRVM), a regional securities market which serves eight West African countries, namely Benin, Burkina Faso, Guinea Bissau, Cote d'Ivoire, Mali, Niger, Senegal and Togo.

1.4 Structure of the thesis

The thesis will be composed of three standalone essays. The first essay investigates stock price co-movements and the volatility linkages between selected Sub-Saharan African markets and key developed markets. The second essay examines the effect of financial liberalization on the development of stock markets in Sub-Saharan Africa, while the third essay analyses stock returns predictability in the key financial markets in Sub-Saharan Africa and the opportunity of using arbitrage methods in order to make profits. The last chapter provides a conclusion presenting a summary and discussion of the overall findings of the thesis. The chapter also gives the policy implications, the limitations of the study and recommendations for further research.

Chapter 2

STOCK PRICE CO-MOVEMENTS AND VOLATILITY LINKAGES IN SUB-SAHARAN AFRICAN STOCK MARKETS

2.1 INTRODUCTION

2.1.1 Background and problem statement

It has been proven that financial markets that are efficient and well-regulated have the ability to effectively mobilize capital as well as channel resources into productive investments. Moreover, they assist in better managing and diversifying risk, raising savings and monitoring the corporate sector (Standley, 2010). Again, a well-developed financial sector also contributes to economic development. However, evidence shows that the size of a financial market in a country is linked to the size of its economy (Standley, 2010). That is, countries with small sized economies often have less developed financial markets. This is the case for the Sub-Saharan African economies in particular. In effect, most financial markets in Sub-Saharan Africa remain underdeveloped despite the national development strategies that have been adopted to develop and deepen them.

The African continent consists of 54 UN-recognized states and is generally divided into two main regions: the North African region and the Sub-Saharan African region. The North African region comprises five countries, namely Algeria, Egypt, Tunisia, Morocco and Libya; while the Sub-Saharan African region consists of the 49 remaining countries. According to Mobolaji (2008), the Sub-Saharan African region accounts for 34 underpriviledged countries in a total of 48 in the world, of which 24 have the lowest level of human development in the world. However, in recent years, Sub-Saharan Africa has attracted investors' interest leading to considerable capital inflows into the region. The growing interest in the region results from its noticeably strong growth prospects, improved macroeconomic management, decreased political instability, and robust global commodity demand (Masetti *et al.*, 2013). Although most Sub-Saharan African financial markets remain immature with dominant banking sectors, the character of the domestic financial sector varies across countries. With the exception of South Africa, the rest of the region has small and illiquid equity markets; a handful of countries in the region run viable domestic bond markets. Of the 29 stock exchanges on the continent, the Johannesburg Stock Exchange remains dominant, representing 38 percent of all listed companies and about 90 percent of total market capitalization (World Bank, 2013). The high degree of illiquidity characterizing most Sub-Saharan African stock markets emerges from the fact that shares are infrequently traded, often limited to a few stocks, and turnover ratios are low compared to international standards (Masetti *et al.*, 2013).

As deeper and more efficient financial markets are crucial to improve Sub-Saharan Africa's economic prospects, many countries from the region are trying to improve the operating environment through changes to the financial regulatory framework. One of the key priorities suggested consists of promoting financial integration in existing monetary unions and harmonized approach to regulation in the region in order to increase the sizes of the financial markets, as well as the sizes of the economies. Another one of those priorities advocates the use of alternative instruments of collateralization in an attempt to avoid slowing growth (Carey, Pattillo, Gulde, Wagh and Christensen, 2006). Consequently, it is relevant to dedicate greater attention to understanding the degree of financial integration currently existing in the region in terms of inter-market linkages and volatility spillovers. In effect, this will assist in efficiently implementing the above-mentioned strategies and encourage the contribution of the rest of the world to the development of the region's financial markets. Moreover, notwithstanding the size and liquidity challenges of the region's stock markets, a considerable number of regional stock indices outperformed benchmark indices such as the S&P 500 and the MSCI Emerging Market index in 2012 (Masetti *et al.*, 2013). This goes to show the rising potential of the Sub-Saharan African markets as investment vehicles.

Therefore, the research questions that emerge following the preceding discussions are as follows: are the key stock markets in Sub-Saharan Africa interdependent? Are they related to the more developed stock markets in the world? Do volatility spillovers exist across the aforementioned markets?

2.1.2 Objectives of the study

Thus, the objectives of this study are:

(i) To review the evolution of the major Sub-Saharan stock markets and trade linkages between the selected countries;

(ii) To examine the level of interdependence among the key Sub-Saharan African stock markets and developed stock markets;

(iii) To examine the time-varying conditional correlation among Sub-Saharan African markets; and between developed and Sub-Saharan African markets;

(iv) To analyse volatility regimes across Sub-Saharan African stock markets;

(v) To draw policy recommendations based on the outcomes.

2.1.3 Relevance of the study

The increase in foreign direct investment and portfolio investment resulting from the growing interest in Africa constitutes an important contribution to the development of the region's financial sector and economy as a whole. Therefore, an investigation into the major stock markets in Sub-Saharan Africa could help in ascertaining the profitability of the region's markets in relation to the major global markets, to increase investors' confidence and attract more capital inflows. Moreover, the implications that market price correlations and volatility spillovers have on asset pricing make this analysis crucial for investors as it can assist in international portfolio diversification. Although there are a considerable number of studies on whether African stock markets are correlated, this study aims at contributing to the already existing literature by focusing on analysing the three most commonly examined stock markets in the region, namely the Nigeria Stock Exchange, the Nairobi Securities Exchange, The Johannesburg Stock Exchange, and a market that is less examined despite its promising prospects, the Bourse Regionale des Valeurs Mobilieres (BRVM), which is one of the two regional stock exchanges on the continent and serves eight West African countries, namely Benin, Burkina Faso, Guinea Bissau, Cote d'Ivoire, Mali, Niger, Senegal and Togo. The analysis will also expand the literature by exploring the issue of interdependence between these Sub-Saharan African stock markets and two of the most developed ones, the New York Stock Exchange and the London Stock Exchange.

2.1.4 Structure of the chapter

The remainder of the chapter is organized as follows. Section 2.2 gives an overview of stock markets in Sub-Saharan Africa and discusses the potential source of linkages. Section 2.3 provides the theoretical and empirical literature review regarding the research theme. The choice of the methodology is justified by reviewing the different tools used in the existing literature. Section 2.4 discusses the methodology used in this analysis and provides a detailed description of the data used in the estimation. Section 2.5 presents the empirical analysis and discusses the findings; while Section 2.6 provides a conclusion to the study and recommendations for future research.

2.2 OVERVIEW OF THE MARKETS AND SOURCES OF LINKAGES

2.2.1 Evolution of key stock markets in Sub-Saharan Africa

Africa has seen a boom in the number of stock markets and the level of market capitalization over the last two decades. Twenty years ago, Africa only had eight bourses of which five were in Sub-Saharan African countries and three in North Africa. Presently, the continent is home to 29 stock exchanges from 38 countries. Of those 29 stock exchanges, 24 are located in Sub-Saharan Africa and 23 are members of the African Securities Exchange Association (ASEA).

Among the oldest exchanges in Sub-Saharan Africa are the Johannesburg Stock Exchange (JSE) founded in 1887, the Nairobi Securities Exchange (NSE) in 1954 and the Nigeria Stock Exchange in 1960. The youngest exchanges in the region are the Rwanda Stock Exchange (RSE) founded in 2008 and the Seychelles Securities Exchange (SSE) in 2012. In the following sections, the four Sub-Saharan African stock markets that are taken into consideration in this study are briefly examined.

The Johannesburg Stock Exchange

Established on the 8th of November 1887 by Benjamin Woolman, the JSE's initial mission was to enable the new mines and their investors to gather the capital necessary for the mining industry (Samkange, 2010). The development of the South African economy brought about a rise in the number of industrial enterprises joining the mining firms initially on the JSE's listings. The number of listed firms grew from only 151 industrial, financial and mining firms in 1932 to 402 firms as of May 30th 2014, eight decades later. The speedy surge of the JSE is also mirrored in the need to relocate to larger premises six times in nine decades (Moolman and Du Toit, 2005).

Subsequent to the 1947 legislation dealing with financial markets, in 1963 the JSE joined the World Federation of Exchanges (WFE) which speaks for a minimum of 97 percent of the world stock market capitalization. By its affiliation to such a federation, the exchange became part of a network of cooperation and trust among countries on an international sphere, and could take part in a forum dominated by the sharing of ideas and knowledge (Samkange, 2010). The mushrooming of listed companies worldwide during the 1980s did not fail to reach the JSE which gave birth to two new classes of stocks: the Development Capital Market (DCM) catering for small firms and with less requisites in terms of profits and company size; and the Venture Capital Market (VCM) listing companies engaging in greenfield ventures, provided that specific requirements are met (Moolman and Du Toit, 2005). In 1995, the JSE like the more mature markets such as those of the United States of America (USA) and London underwent a restructuring program aimed at deregulating the market. This initiative, by effectively eliminating the restriction of membership which was previously open only to natural persons holding South African citizenship and now opening the market to all including legal persona, increased liquidity and trade volume. Since then, foreign investors have been net buyers in excess of R9.3 billion, compared to only R0.185 billion in 1994 (Moolman and Du Toit, 2005). This demonstrates that foreign investment assumes a more critical role on the JSE, representing more than 20 percent of its market capitalization, and sometimes a far larger portion of its daily trading (Moolman and Du Toit, 2005). The bourse, following the global pattern, phased out floor trading in June 1996 and upgraded to electronic trading on the JET (JSE Equities Trading) System. In 2005, the exchange demutualized and listed on its own exchange (JSE, 2014).

The year 2003 saw the launch of the AltX, an alternative exchange for small and medium listings that do not essentially align with the prerequisites of the JSE main board. Subsequently, the launch of the YieldX, an exchange for interest rate and currency instruments, followed the AltX (JSE, 2014). In 2001, the South African Futures Exchange (SAFEX) was procured by the JSE, followed by the Bond Exchange of South Africa, obtained in 2009 (JSE, 2014).

Five financial markets, namely the Equities, Bonds, Financial, Commodities and Interest rate subsidiaries are now offered on the JSE. A partnership between the JSE and the FTSE Group led to the alignment of the JSE's equities trading model with that of Europe, as well as the reclassification of its instruments in accordance with the FTSE Global Classification framework. The FTSE/JSE Africa Index Series thus became the new designation for the JSE index series and its two benchmark indices became the FTSE/JSE All Share Index and the FTSE/JSE Top 40 Index. The FTSE/JSE All Share Index covers 99 percent of market capitalization, while the FTSE/JSE Top 40 Index tracks the top listings in a representative spread of sectors (JSE, 2014).

According to De Beer (2015), the reliance of the country's domestic gross fixed capital formation on international capital inflows has increased considerably over the years; and portfolio investment has been the major anchor in the country's international capital attraction. This is the case despite the country's strict capital controls which represent a threat to the attraction of international capital. South Africa has more than 50 years of experience with exchange controls on residents and non-residents, dating from the early 1960's. The South African Reserve Bank, the institution empowered to oversee and regulate the system of controls and capital inflows and outflows, has used these measures as tools to target rate of exchange and the domestic interest rates, through FX market interventions in the commercial foreign exchange market (Schating, 2009: 530). The responsibility to assist the Financial Surveillance Department in the administration of capital control is then delegated to local authorized dealers such as large commercial banks and currency trading companies. Although the South African exchange controls have been considerably relaxed over the last 20 years, they are still particularly restrictive with regards to offshore investments (Douglas, 2014). Noticeably, the rules apply to all exchanges, irrespective of the parties or amounts concerned. Moreover, legal entities, companies or individuals who resides in South Africa have to obtain prior approval from the SARB before performing a transfer. This process may take several weeks and is still subject to red tape. Besides, currency transfers can only be performed by authorized dealers and outward specific conditions outlined by the authorized dealers mandated by the SARB have to be mets before payments outside of the country can be made. In addition, specific limits are set on the permitted size of personal transfers and the SARB needs to be notified of any payment performed to a foreign entity. Although South African companies were allowed to make foreign investments of up to ZAR 500 million per annum into companies outside the Common Monetary Area, relaxation of exchange control regulations in 2013 allowed South African groups listed on the JSE to establish one subsidiary outside the country. This is to facilitate African and offshore investments of up to ZAR 750 million, without the constraint of establishing an offshore treasury company (Douglas, 2014). In addition, exchange control restrictions have been removed on foreign listed entities that inwardly list on the JSE.

The relaxation of these particularly restrictive exchange control regulations seems to have impacted foreign interest in the South African financial market. In fact, foreign ownership of rand denominated South African government bonds increased from just below 14 percent in 2009 to around 36 percent in 2014. Furthermore, 10 percent of the Global Markets Local Currency Bond Index (GEMEX) is attributed to South Africa and the country was included in the Citibank World Government Bond Index (WGBI) in September 2012 (De Beer, 2015).

The Nairobi Stock Exchange

Share trading began in the 1920s while Kenya was still a British colony and trades took place on a gentleman's agreement without a formal market, any rules or regulations governing stockbroking activities. Thus, standard commissions were charged and clients had the obligation to honour their contractual commitments of making good delivery and settling relevant costs (NSE, 2015).

In 1951, the earliest professional stock broking firm was established by an Estate Agent, Francis Drummond, who suggested the creation of a stock exchange in the East African region to the finance minister of Kenya at that time, Sir Ernest Vasey. In July 1953, after considering the proposal from the then finance minister of Kenya, Sir Ernest Vasey, and Francis Drummond, the London Stock Exchange officials allowed the establishment of the Nairobi Securities Exchange as a stock market overseas (Ngugi, 2003). As a result, the Nairobi Stock Exchange (NSE) was formally founded in 1954 as a voluntary association of stockbrokers registered under the Societies Act (1954). However, only the resident European communities were allowed to trade in shares, while Africans and Asians were not allowed to deal in equities.

With the uncertainty about the future of Kenya at the dawn of independence came the slump in stock market activity, although three years of calm and economic growth reassured investors about the market and a number of highly over-subscribed public issues were handled by the exchange. The oil crisis of 1972 brought inflationary pressures on the economy, effectively depressing share prices and stopping the growth. Moreover, the introduction of a 35 percent capital gains tax in 1975 further weakened the exchange, which also lost its regional character following the nationalizations, exchange controls and other inter-territorial restrictions introduced in neighbouring Tanzania and Uganda (NSE, 2015). Years later, as the Kenyan government recognized the need for policy reforms aimed at fostering sustainable economic development with an efficient and stable financial system, the Capital Market Authority (CMA) was formed in 1989 as a regulatory body to assist in the creation of an environment conducive to the growth and development of the country's capital market (ASEA, 2015).

The exchange concluded its first privatization in 1988 with the successful sale of the 20 percent stake of the Kenyan government in the Kenya Commercial Bank (KCB). After registering, under the Companies Act in 1991, a private company limited by shares, the exchange moved from the "Call Over" trading system to the floor-based "Open Outcry System". On February 18, 1994, the NSE 20-Share Index registered an all-record high of 5030 points, which contributed to the exchange being rated by the International Finance Corporation (IFC) as the best performing market in the world with a return of 179 percent in US dollar terms. Six months later, the

NSE relocated to more spacious premises with a new computerized delivery system (DASS). This upgrade was followed by the licensing of eight new stockbrokers, effectively increasing the number of stockbrokers for the first time since the NSE was founded (NSE, 2015).

In order to boost foreign portfolio investments, the Kenyan government put in place a series of incentives in 1995, including the loosening up of exchange control for domestically controlled companies by doubling the aggregate limit from 20 percent to 40 percent and the individual limit from 2.5 percent to five percent (NSE, 2015). In addition, while listed securities are exempted from stamp duty, capital gains tax and value added tax, the withholding tax on dividends only amounts to five percent for residents and 10 percent for non-residents. In December 1995, the exchange control act was abolished. The following year, the NSE concluded the largest share issue in its history through the privatization of Kenya Airways. The Kenyan government thus reduced its stake in the airline from 74 percent to 26 percent, offering the shares to more than 110 000 shareholders. As a result of the successful divestiture of that state-owned enterprise, the Kenya Airways Privatization team received the World Bank Award for Excellence for 1996 (NSE, 2015).

The Central Depository System (CDS) was passed by Parliament in 2000, together with the amendment of the Capital Markets Authority Act, which became the Capital Markets Act. In that same year, the CDS was sanctioned by the President and the first licensed dealer, namely the CFC Financial Services, launched its operations on the NSE. The Main Investment Market Segment (MIMS), the Alternative Investments Market Segment (AIMS), the Fixed Income Securities Market Segment (FISMS) and the Futures and Options Market Segment (FOMS) were the four independent market segments that ensued from the basic restructuring of the Kenyan capital market that was implemented in February 2001. Additionally, the new NSE trading and settlement rules were approved on the 17th April 2002, followed by the institution of New Foreign Investor Regulations, on the 26th July 2002, defining three categories of investors on the market, namely local East African and foreign investors. Moreover, a

Shareholder Agreement was signed, through the Capital Markets Challenge Fund, by the NSE, the CMA, the Association of Kenya Stockbrokers, the CMA Investor Compensation Fund and nine institutional investors on the 5th August 2002 for the establishment of the Central Depository and Settlement Corporation (CDSC). Finally, the exchange started live trading on its automated trading systems in September 2006 (NSE, 2015).

As part of the 2010-2014 strategic plan of the NSE to develop into a full-service securities exchange which supports trading, clearing and settlement of equities, debt derivatives and other associated instruments, the Nairobi Stock Exchange Limited became the Nairobi Securities Exchange Limited, in July 2011 and shifted its equity settlement cycle from T+4 to T+3 (NSE, 2015). The NSE All-Share Index (NASI), a market capitalization weighted index consisting of all the securities listed on the exchange, was introduced in 2008 with a base value of 100 as of January 2008. It was followed in 2011, by the FTSE NSE Kenya 15 index, a representation of the performance of the 15 largest stocks in terms of full market capitalization trading on the NSE, and the FTSE NSE Kenya 25 index, a representation of the performance of the 25 most liquid stocks trading on the NSE. Both indices were launched by the NSE in association with FTSE international. This association was also at the origin of FTSE NSE Kenyan Shilling Government Bond Index, the first instrument of its kind in the region whose aim is to give investors access to current information and depict the Kenyan Government Bond market's performance (NSE, 2015).

In 2013, the NSE was awarded the prize of the Most Innovative African Stock Exchange at the year's Africa Investor Index Series Awards in recognition of its efforts to increase company listings and diversify asset classes (NSE, 2015). The following year the exchange officially launched its IPO, after the CMA formally approved its request to operate as a demutualized entity and to self-list its stocks on the MIMS. Thus, the exchange offered 66,000,000 shares at a price of Ksh 9.50 per share in an attempt to raise a capital of Ksh 627,000,000. Strong from the success of this IPO, the NSE then self-listed its stocks on the MIMS under the Investment

Services sector. This move made the bourse the second African exchange to be listed, after the Johannesburg Stock Exchange. In October 2014, a MoU was signed with the Korea Exchange (KRX), effectively sealing the collaboration between capital markets in Kenya and Korea (NSE, 2015).

From an initial number of six at its formation in 1954, the NSE has seen its number of stockbrokers grow steadily to 20. However, from an initial rate of 2.5 percent, the commission rates have considerably fallen to between two percent and one percent on a sliding scale for equities and 0.05 percent for all fixed interest securities for every Shilling (NSE, 2015).

Although the Nairobi Securities exchange is one of the most developed markets among the Eastern and Central African countries, it remains relatively young and emerging by international standards. With a market capitalization of about USD 20 billion as of the 8th of October 2015, the Nairobi Securities Exchange was ranked the 67th largest exchange in the world and the 4th largest in Africa in terms of market capitalization (WFE, 2015). The NSE's market capitalization as a percentage of GDP is quite high compared to its counterparts from the region and reached more than 50 percent in 2013. The market has also reported an annual market turnover ratio of almost 10 percent in 2014. This increase from the 2009 turnover ratio of 4.59 percent depicts an improvement in the activity of the market.

Although an increasing number of companies are being listed on the exchange (65 listed companies in 2015 compared to 55 in 2009), it is still very insignificant considering the high number of companies involved in the country (310 000 registered companies as of November 2015) (ASEA, 2015). This testifies to the relative youth of the exchange and also of the lack of confidence of investors who may be discouraged by the low liquidity making them less willing to list on the NSE. The limited number of listings has a negative impact on the supply of new equities in the market, thus hindering the use of the equity market as a source of financing.

Despite all of the challenges facing the bourse, it is important to note that it is receiving more attention from local investors. In fact, between 2009 and 2014, the percentage of domestic investors to the total number of investors considerably improved with more than 65 percent of investment coming from domestic investors, while more that 50 percent of ownership of shares on the market belonged to foreign investors in 2009 (ASEA, 2014). However, the market is still unpopular with individual investors compared to institutions. In 2014, more than 80 percent of investors on the market were institutions (ASEA, 2014).

Presently the NSE faces the challenge of increasing its turnover ratio which is currently stagnant. In the near future, local investors are expected to take the reins of the exchange as they are currently the target of a public education program disseminated through an array of communication tools and channels (NSE, 2015).

The Nigeria Stock Exchange

Established in 1960 as the Lagos Stock Exchange, the Nigerian Stock Exchange received its new appellation in December 1977 and extended its coverage to major commercial cities in the country, with an actual total of six branches in the Nigerian territory (Nigeria Stock Exchange, 2015). With an initial number of 19 securities listed, the bourse started its operations in 1961 as a registered company limited by guarantee. Licensed under the Investments and Securities Act (ISA) and with the Securities and Exchange Commission (SEC) of Nigeria as its regulating body, the Nigeria Stock Exchange is committed to implement the highest levels of international standards in all its dealings with its stakeholders. For this reason, the Nigeria Stock Exchange holds membership in organizations such as the World Federation of Exchanges (WFE) of which it is a founding member, the International Organization of Securities Commissions (IOSCO), the Intermarket Surveillance Group (ISG), the SIIA's Financial Information Services Division (FISD), Financial Services Regulation Coordinating Committee (FSRCC) Nigeria and Sustainable Stock Exchanges (SSE); all international and regional entities supporting the development of standards and best practices in its operations. Moreover, together with other African exchanges, the Nigeria Stock Exchange founded the African Securities Exchanges Association (ASEA) in 1993 and is part of its executive committee (Nigeria Stock Exchange, 2015).

In November 1996, with the aim of facing the challenges of establishing itself at an international level and attaining a superior service delivery, an Internet System called CAPNET was initiated by the exchange (NSEPro, 2015). The Automatic Trading System was introduced in April 1999, as a replacement for the open outcry trading method. This new system represents a security trading arrangement by means of which stock market's transactions are done through a computer network operating automatically online. The efficiency of settlement on the market's transactions was then improved from T+2 weeks to T+3 days. In addition, electronic clearing, settlement and delivery services, as well as custodian services are handled by the Central Securities Clearing System Plc. (CSCS), a subsidiary of the exchange which was incorporated in 1992 (Osaze, 2011).

In May 2001, closing the month at a value of 10 153.8, the Nigeria Stock Exchange All Share Index broke its all-time record and crossed the 10 000-point mark (Osaze, 2011). With a total market capitalization of USD 80.16 billion, 184 listed companies and 261 listed securities as of March 2016, the exchange remains committed to satisfying the needs of its stakeholders and aiming for the highest level of competitiveness by keeping up with markets evolution trends. It is also dedicated to keeping its operations fair, its markets transparent and orderly in order to be the link between the best of African enterprise and the local as well as global communities of investors (Nigeria Stock Exchange, 2015). The exchange's listed equities are grouped into 11 industry sectors, comprising among others, agriculture, conglomerates, construction/real estate, consumer goods and financial services. A total of 12 indices, including among others the NSE All Share Index (ASI) and the NSE 30 Index are used to monitor market and sector performance (Nigeria Stock Exchange, 2016).

Since the capital market deregulation in 1993, issuing houses and stock brokers have been charged with determining the price of new issues, whereas only stockbrokers are in charge of the secondary market prices. The prices are published daily on a number of platforms such as the exchange intranet facility (CAPNET), the Stock Exchange Daily Official List and in some newspapers. The SEC, the apex regulatory institution of the exchange, has the directive of surveillance over the exchange in order to prevent breaches of market rules and to spot and dissuade any unfair trading practice. Hence, it was entrusted with the dual responsibilities of regulating the market in order to protect investors' interests as well as enhancing the efficiency of the capital market through development (SEC, 2016).

In a bid to attract foreign funds to Nigeria, legislations preventing the flow of foreign capital into the country were abolished. As a result, foreign brokers were allowed to register as dealers on the exchange and the market is open to all investors regardless of their nationalities. In effect, until 2014 foreign investors' participation in the Nigeria Stock Exchange exceeded domestic transactions. However, in 2015 due to the drop in the prices of crude oil which had a considerable effect on Nigeria's earnings, restrictions on foreign exchange controls were imposed by the Central Bank of Nigeria (CBN). These measures were taken in an attempt to ease the pressure on the country's foreign reserves and to protect the local currency. They consist of, among others, a ban on access to 41 pre-identified items to foreign exchange from the official forex windows, the introduction of a demand management strategy in the allocation of forex, as well as impediments to financial account items such as the accumulation of portfolio assets abroad (i.e. Eurobonds, foreign currency bonds and share purchases). Since 2015, foreign participation in the market has dropped to less than 50 percent of the total value of transactions, reaching 36.5 percent in February 2016 compared to 68.9 percent reported in February 2014 (Nigeria Stock Exchange, 2016).

The West African Stock Exchange (BRVM)

The BRVM is the regional stock exchange in French speaking West Africa, namely Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo. It was created to replace the old Ivorian Bourse des Valeurs d'Abidjan (BVA).

The necessity of creating a regional financial market dates back to the treaty of the West African Economic and Monetary Union (WAEMU) signed by the member states in 1973 and was reaffirmed through the 1980s reforms (Bio Tchane, 2011). In 1994, when the countries in the subregion experienced economic and financial difficulties, one of the solutions implemented was the devaluation of the CFA Franc in an attempt to reduce economic and financial imbalances of the WAEMU zone. For this, it was established that it was necessary to expand the actors in the financial environment, as well as diversify the instruments of financial intermediation. Thus, it is under this strategy that efforts aimed at the creation of the BRVM (Bio Tchane, 2011).

The Council of Ministers decided in 1992 on the establishment of the regional market, and this was entrusted to the West African Central Bank (BCEAO) in 1996. The different options chosen for the organization and operation of the regional financial market were reflected in the legal and regulatory framework. The draft agreement for the creation of the Regional Council for Public Savings and Financial Markets, the draft General Regulations of the Exchange, the draft general regulation of the Central Depository-Settlement Bank (DC/BR), the draft specification Companies Management and Intermediation were all affirmed in 1996 (Benga, 2007).

The closure of the Stock Exchange of Abidjan (BVA) actually began with the opening of the regional council of the Regional Stock Exchange (BRVM). After the establishment in December

1996 of the boards of directors of the BRVM and the DC / BR, the transfer of files took place in January 1997 and the dematerialization of values of the BVA began on 15 September 1997, that is, two months after the signing of the agreement in Dakar on the establishment the Regional Council for Public Savings and Financial Markets, which was instructed not only to organize and control the public offering savings but also to empower and control stakeholders on the regional financial market. The launch of the BRVM, however, did not take place within the promised time because of institutional problems such as the drafting of the general regulation, the establishment of a definitive rating system, the realization of the project of the BRVM national branches, the adoption of market operation rules and the establishment of the Central Depository/Settlement Bank. After many years, the BRVM finally began its activities through the centralized electronic quotation on the 16 September 1998 (Benga, 2007).

This specialized financial institution governed by the law of the Regional Council of Public Savings and Financial Markets is a private limited company and a public service concession. The BRVM is an electronic stock exchange built on the basis of the following architecture: a centralized location in Abidjan, Cote d'Ivoire is connected to National Stock Exchanges Branches (ANB) located in each WAEMU member states. This structure allows equal access to information in each country. Its main role is to centralize and process trading orders transmitted by the main organizers of the stock market that are the management and intermediation companies (Benga, 2007).

The Exchange began operations with 34 securities listed. The quoting system currently used is centralized electronic quotation by the orders transmitted by the SGI that are not captured at the central site. The settlement of transactions is also done centrally by the depository system. On the regional stock exchange, two indices represent the activity of the securities on the market. These are the BRVM Composite, which consists of all the securities listed, and the BRVM 10, which is composed of the ten most active companies on the market. The listing and the selection criteria for the BRVM Composite and BRVM 10 are based on the major stock indices in the world, especially the FCG index, from the International Financial Corporation (IFC), an affiliate of the World Bank. The formula takes into account market capitalization, trading volume per session and frequency of transactions. In addition, only ordinary shares are used to calculate the indices. Moreover, the liquidity factor is fundamental in selecting the BRVM 10 index component values. In effect, for each of them, the average transaction during the three months preceding the quarterly review should not be lower than the median average daily amount of transactions of all stocks; and the frequency of transactions must always be greater than 50 percent, with the stock traded at least half the time during the study period of three months (Benga, 2007).

The indexes are automatically generated by the system of negotiations of the BRVM and after each trading session. Moreover, the BRVM 10 is revised four times a year (the first Monday in January, April, July and October) and the BRVM Composite after registration of a new company for listing, so as to be adapted to the evolving regional financial market. With 39 listed companies in 2014, the BRVM had a market capitalization of USD 15 billion as of December 2015, which positioned it as the sixth largest African exchange (Lyudvig, 2016). It was the continent's best performing stock exchange in 2015, with an appreciation of almost 18 percent of its main index the BRVM Composite. Historically, foreign investors have constituted between 40 percent and 60 percent of the trading on the exchange. However, as domestic investors' turnover increased sharply in 2015 and led to a 48 percent increase in overall turnover, foreign investors participation fell to 25 percent.

In terms of capital control measures, The WAEMU zone keeps up restrictive measures on most capital exchanges with non-residents. In all WAEMU nations, comparable measures are in place and they are overseen jointly by the country's ministry of finance and the BCEAO. Despite the slight variations in the rules from country to country, a prior approval by the ministry of finance is generally required for nearly all outward capital flows, with the exception of the amortization of obligations and settlement of short-term loans. Specifically, this approval is needed in cases of capital outflows transactions from residents to non-residents such as a direct venture abroad by residents, including investment through foreign firms under direct or indirect control of residents; the acquisition of money market instruments; the purchase of foreign securities; financial credits and loans; the conceding of guarantees and sureties; the reinvestment of liquidation earnings; as well as gifts and any other transfer of assets. Moreover, an exchange authorization, subject to the approval of the central bank is required for outflows of funds needed for the servicing of credit facilities to non-residents (Kireyev, 2015: 8). Additionally, despite the more liberal regulation on inward capital transfers, there are still considerable restrictions. These include the surrender to the BCEAO of all assets denominated in euros and other currencies held by authorized forex dealers in their establishments. Furthermore, a declaration to the national ministry of finance must be made in case of sales of corporate securities to nonresidents leading to the foreign control of domestic establishments. Also, while nonresidents are not allowed to list on a regional securities exchange, securities and mutual funds that were issued outside the WAEMU region, they still require an authorization by the Regional Council on Public Savings and Financial markets in order to issue securities, real assets and money market instruments (Kireyev, 2015: 8).

2.2.2 Existing regional trade links

Regional trade linkages can be observed by examining the level of exports and imports between the countries in the region. When looking at the level of South African exports to African countries as a percentage of GDP, it can be seen that between 2002 and 2009, Nigeria and Kenya have grown to be the main recipients of the bulk of South Africa's exports to Africa. There is thus a possibility that the stock markets in Kenya and Nigeria are both linked to the South African stock market (Kambadza and Chinzara, 2012). South Africa's exports to Mauritius, which was the destination of most of SA's exports between 2000 and 2002, have fallen. But other African countries such as Botswana, Namibia, and Mozambique are now its top three trade partners in Africa (United Nations, 2014). This can be explained by the proximity as well as the existing trade agreements signed between the countries. In return, South Africa was ranked as Nigeria's 10th trading partner in terms of exports, receiving 3.3 percent of Nigeria's exports in 2013 (United Nations, 2014). Cote d'Ivoire, as a country and part of WAEMU, was Nigeria's 13th trading partner in terms of exports, receiving 1.83 percent of its exports in 2013. Additionally, the main African trading partners of the WAEMU zone countries in 2013, were Nigeria, South Africa, Ghana and Gabon, receiving 9.6 percent, 9.1 percent, 9 percent and 4.2 percent of its exports, respectively (WAEMU, 2014).

In terms of imports, Nigeria was South Africa's seventh trading partner in 2013 with a share of 3.5 percent of total imports coming from Nigeria; while South Africa was Nigeria's 11th trading partner with a share of about two percent of total imports coming from South Africa (United Nations, 2014). Moreover, 5.01 percent of Kenya's imports came from South Africa, its fifth trading partner. The WAEMU zone countries main African trading partners in 2013 were Nigeria (12.3 percent), Ghana (2.1 percent), Angola (1.7 percent) and South Africa (1.5 percent) (WAEMU, 2014).

Outside the continent, the United States and the United Kingdom are always among the top five trading partners of most African economies, though a stronger trading link is being created between China and Sub-Saharan Africa. For example, in 2013, the USA was the fourth non-African trading partner of the WAEMU zone in terms of exports with a 4.7 percent share, and the third one in terms of imports with a 5.7 percent share (WAEMU, 2014). Imports from the UK accounted for 1.4 percent of total imports to the Union in the same year. Similarly, the USA and the UK received 6.27 percent and 7.88 percent of Kenya's exports, respectively. The USA is Nigeria's top trading partner, receiving about 17 percent of its exports and 14 percent of its imports in 2013; while the UK is ranked 5th with 6.32 percent of exports and 6.58 percent of imports in the same year. The same is true for South Africa which received 6.35 percent of its imports and sent 7.24 percent of its exports to the USA. The UK received 3.46 percent of South African exports and accounted for 3.23 percent of South African imports that same year (United Nations, 2014).

In terms of intra-African trade in services, a number of African countries have succeeded in exporting services on the regional markets. This is the case for South Africa from which most investments are taking place in the service sector and whose companies have been present mostly on the financial and business services sector and the communication sector (Holmes, 2013). The telecommunication company, MTN is a well-known example of South Africa's export of ITC services. The MTN group which was ranked the sixth largest company on the JSE as of December 2015 has operations in 17 African countries including Nigeria, Benin, Cote d'Ivoire, Guinea-Bissau and Kenya (MTN, 2015). On the retail side, Shoprite was the first to succeed at establishing itself on the continent with 336 corporate and 39 franchise stores in 14 African countries including Nigeria (excluding South Africa). As at June 2016, the company employed 21000 people in its operations outside of South Africa (Shoprite, 2016). Other retailers such as Pick n Pay, Woolworths and Massmart are also working on expanding their footprints in Africa.

According to Dihel, Fernandes, Gicho, Kashangaki and Strychacz (2011), there are several world-class Kenyan firms providing and exporting higher value offshore services such as, R&D business ventures, product development and transformational sourcing. Being among the first countries to adopt the International Financial Reporting Standards (IFRS), a number of Kenyan accountants possess expertise and experience in IFRS. This presents an important export opportunity for Kenyan firms and accountants who often travel to provide services in countries that have recently adopted IFRS and have a deficit in skilled and experienced IRFS professionals. Kenya also has a number of success stories in the ICT services export with companies such as KenCall, Ushahidi and Safaricom. However, the outflow of Kenyan professional service firms is dominantly directed to the regional markets of the East African Community (EAC). Only a fifth of Kenyan service exporters have South African clients, while more than half have clients in Tanzania and/or Uganda. Almost a quarter of the clients are in Sudan and in European countries other than the UK. In the BPO sector, the most important markets for Kenyan exporters are the UK and the US (Dihel *et al.*, 2011).

In the WAEMU, exports of services consist of three main components, namely transport, travel and other services whose importance varies from one country to the other (BCEAO, 2014). Tourist activities (travel) are the primary source of revenue from export services of the Union and are essentially professional (business, conferences) and personal (leisure, culture and others). These revenues saw their share increase over the years, because of the renewed activity in tourism, especially in Burkina Faso, Mali and in Senegal. Many possibilities are offered by these countries in the Union, with regards to their historical and cultural heritage and geographical sites. Many tours are offered and the routes of the WAEMU countries have improved. Major cultural events are increasingly organized. Business tourism is also booming due to increased investment opportunities in the fields of mining and oil in most of these countries (BCEAO, 2014). In the transport sector, services provided to foreign ship owners and, to a lesser extent, those of land transport, mainly provided to residents of African countries constitute the main source of revenue for transportation services of WAEMU countries. In effect, the autonomous port of Abidjan (PAA) is West Africa's largest container port and the busiest port in francophone West Africa. It also serves the landlocked countries of the WAEMU, such as Mali, Burkina Faso and Niger, for the import and exports of their goods.

In the ITC and BPO sectors, Senegal is one of the major exporters of services to the rest of Sub-Saharan Africa. With companies such as ARC Informatique, Finetech, 2SI and GSIE, the country provides, among other things, software development and implementation services, web services, data processing and database services, business intelligence and data warehousing integration of enterprise applications, company security, application software and system integration services (Doumbouya, Ndiaye and Primack,2015: 171-173). In 2012, between 70 percent and 90 percent of these companies' revenues were derived from export activities and their main customer base is mainly located in Sub-Saharan Africa, and particularly in West and Central Africa. In addition, Sonatel which is the principal telecommunication provider of Senegal is involved in the construction of fiber optics networks in Africa. The company is a co-owner of several submarine fiber optic cables around the world and is the largest investor in the ACE cable, a 17000 km long cable with 22 underwater stations which connects 23 countries, including 16 African countries (Doumbouya *et al.*, 2015: 178).

The existence of these trade links between the countries thus suggests that a shock on one of the markets could affect the others. There is thus a possibility of linkages between the different stock markets.

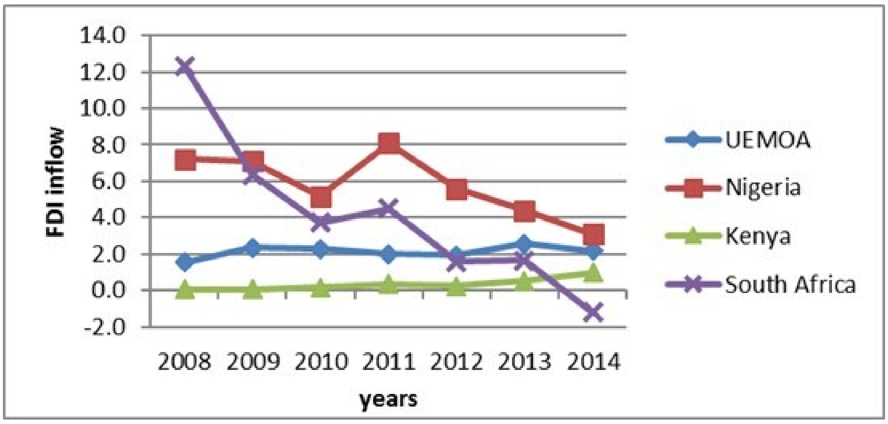
2.2.3 Financial linkages

Because of the unavailability of data on the specific direction of FDI flows among African countries, this section will focus on aggregate financial flows in the region. From Figure 2.1 below, it can be seen that the net FDI inflows have declined over the years for Nigeria and South Africa. The latter shows a particularly dramatic decrease between 2008 and 2014, depicting a reduction in the flow of foreign investment into the country. Interestingly, South Africa recorded a negative net inflow in 2014, suggesting that there was more FDI outflow than FDI inflow during that year. However, net FDI inflows to the WAEMU zone have been positive and almost constant between 2008 and 2014, varying between US$ 1.5 billion and US$ 2.5 billion. Hence, the union continuously received a considerable amount of capital during that period, though these inflows are still lower than the ones received by Nigeria during the same period. In effect, although net FDI inflow to Nigeria considerably decreased during these seven years, it was still the highest among the countries.

Figure 2.2 illustrates the net portfolio equity inflows to the countries and the Union, between 2008 and 2014. The net inflow is seen to be highly unstable in South Africa with the highest positive inflow recorded in 2009 and 2010.

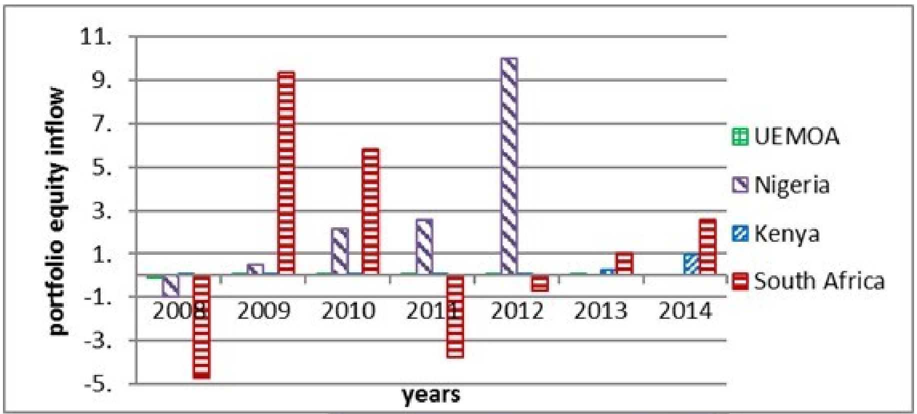
Portfolio equity inflows were very low in Kenya and the WAEMU zone during the seven years.

Figure 2.1: Net FDI inflows (in USD billion)



Source: UNCTAD, 2015 and Author's calculations

Figure 2.2: Net portfolio equity inflows (in USD billion)



No available data for WAEMU in 2014, as well as Nigeria in 2013 and 2014.

Source: WDI (2015)

In 2012, Nigeria recorded the highest net portfolio equity inflow among the countries since 2008, while the others recorded very low or negative net inflows. This suggests that there was a greater interest for the capital market in Nigeria that year, compared to the capital markets in the other countries under consideration. The low net portfolio equity inflows in Kenya and the WAEMU zone imply that only weak financial linkages exist between these countries and the rest of the world. However, Nigeria and South Africa exhibit stronger financial ties with the rest of the world.

Interestingly, the degree of financial linkages between countries may also be analysed through the existence of financial services exports among them. Nigeria is one of the successful exporters of banking services in Africa. Nigerian banks' external assets (proxy for exporters of banking services) increased significantly from N250 million in 1980 to N1 702 513 million in 2011 (Chaitoo and Bankole, 2015: 70). Among its 20 banks, 11 had operations in other African countries as of 2012, with Ecobank Nigeria operating in 35 other African countries including all eight countries of the WAEMU, as well as Kenya and South Africa. The United Bank for Africa (UBA) also has an important footprint on the continent with its presence in 19 countries, including Benin, Cote d'Ivoire, Mali, Senegal and Kenya (Chaitoo and Bankole, 2015: 100-101). It has been acknowledged as one of the fastest growing banks in Africa and has also been tagged the Pan African bank in recent times. Moreover, eight Nigerian banks also had international operations beyond Africa, including in London, Paris, New York, Dublin, Hong Kong and mainland China.

In 2012, the South African corporate private sector was undertaking far more new project investments into Africa relative to the state-owned companies. In the financial sector, the companies that are more actively investing in new projects in the rest of Africa are institutions such as Standard Bank, First Rand, Sanlam and Liberty Life (Holmes, 2013). Standard Bank has the biggest banking footprint in Africa with operations in 20 countries, including Nigeria, Kenya and Cote d'Ivoire. It is consolidating its focus on the continent by cutting its operations in other emerging markets such as Latin America. Nonetheless, the other retail banks have joined the race for market share. This is the case for Absa which spent R 18 billion in 2012 to buy up the Africa business of its parent company, Barclays, which has a presence in 14 countries, including Kenya and Nigeria (Holmes, 2013). Besides Absa, First Rand started operations in Ghana, and its investment banking franchise, RMB, has a presence in Nigeria. Nedbank has also taken a 20 percent stake in Ecobank. First Rand is one of the largest financial institutions in South Africa. The institution provides banking, insurance and investment products and services to retail, commercial, corporate and public sector customers (First Rand, 2016).

Additionally, the Sanlam Group, another one of the largest financial services groups in South Africa, has the most considerable Pan African footprint of insurance groups based on the number of countries and contribution to the overall consolidated group. It is present in 11 African countries including Kenya and Nigeria, as well as in Malaysia, India and with niche businesses in certain developed markets (Sanlam, 2015).

2.2.4 Conclusion

From the moment of their foundation, the Sub-Saharan African stock markets have strived to establish themselves in the image of their developed counterparts. The JSE which is one of the oldest markets on the continent has proven itself to be the best and the most promising among emerging markets. With a growing number of listed companies, these exchanges underwent major changes, have been daring in their restructuring endeavors and have exhibited a strong commitment to transforming their operations into the most technologically advanced on the continent. Despite the challenges that they face due to their low liquidity level, high volatility, contrasting microstructure and restrictive capital control measures, except in Kenya, they still attract considerable foreign interest. However, foreign participation has diminished in recent years in Nigeria and Kenya, following the repetitive crises that affected the countries' respective currencies.

South Africa, as one of the biggest economies in the region, shows strong trade ties with the rest of the continent. Between 2002 and 2009, Nigeria and Kenya received the bulk of South Africa's exports to the region. Although its top three trade partners in Africa are now Botswana, Namibia and Mozambique, it is still ranked high on the list of the African trading partners of Nigeria, Kenya and the WAEMU zone. Nigeria and the WAEMU zone also have strong trade links. Outside of the continent, the USA and the UK receive a considerable portion of African trade and always rank among the top five trading partners of South Africa, Kenya, Nigeria and the WAEMU zone.

Beside the merchandise import and export, the intra-regional trade in services is also important among these Sub-Saharan African countries. Telecommunication companies such as MTN and retailers such as Shoprite, continue to link South Africa to the rest of Africa with their continuously expanding network of operations on the continent. Similarly, Kenya has succeeded in exporting accounting services internationally by exploiting its strong expertise in IRFS. Moreover, Kenyan companies such as KenCall, Ushahidi and Safaricom represent some of success stories in the export of ICT services. Although most of its trade in services is directed to the EAC countries, Kenya also exports services to South Africa, the US and the UK. Additionally, the WAEMU zone's main exports of services are in the transport, travel and other services sectors, with travel being the main source of revenue from the export of services. From that region, Senegal dominates the exports of ITC services to the rest of Sub-Saharan Africa with companies like Sonatel which is involved in the construction of fibre optics networks in Africa and co-owns several fibre optic cables around the world.

In terms of financial linkages, net FDI inflows have declined in South Africa and Nigeria between 2008 and 2014. In the WAEMU zone, the net inflows have been positive and almost constant during the same period, though they were still lower than the amount received by Nigeria. The higher level of net portfolio equity inflow in Nigeria and South Africa between 2008 and 2014 suggests that there was a greater interest for the capital markets in both countries other than in Kenya and the WAEMU countries, where portfolio equity inflows were relatively low during the same period. This implies that Kenya and the WAEMU countries have weak financial ties with the rest of the world, while Nigeria and South Africa have stronger ties with the rest of the world.

Furthermore, the existence of stronger financial ties between Nigeria and South Africa and the rest of the world was confirmed by analysing financial linkages between the countries in terms of the exports of financial services. In effect, Nigeria which is one of the most successful exporters of banking services in Africa, had 11 of its 20 banks operating in other African countries in 2012 and eight of these banks were also operating outside of the continent. In South Africa, financial institutions such as Standard Bank, Sanlam have the biggest Pan African footprints among all South African financial institutions, with operations in 20 countries and 11 countries respectively.

2.3 LITERATURE REVIEW

2.3.1 Introduction

This section seeks to examine the literature on co-movements in prices and volatility linkages among asset markets. The chapter is structured as follows. Section 2.3.2 discusses the theoretical literature and the empirical studies previously conducted on the topic of price co-movement between markets. This is followed by Section 2.3.3 which presents the theoretical and empirical literature pertaining to volatility linkages. Finally, Section 2.3.4 provides a conclusion to the chapter identifying the gaps in the reviewed literature and the measures taken to counter the identified weaknesses.

2.3.2 Stock Price co-movements

Theoretical literature

Barberis, Shleifer and Wurgler (2005) distinguish between three theories of return co-movement namely, the fundamentals-based co-movement, category-based co-movement and habitat based co-movement. The economy in all three models assumes that there is a perfectly elastic supply of a riskless asset with a zero rate of return, as well as a fixed supply of risky assets denoted as $2n$.

According to the fundamentals view, which is the more traditional view, the co-movements in fundamental values constitute the basis for co-movement in prices. This view is derived from frictionless economies with rational investors where the prices are a direct reflection of the appropriate risk-adjusted discounted sum of an asset's rationally forecasted cash flows (Barberis *et al.*, 2005: 1). From the assumption of rational investors, stems the existence of "fundamental traders" who have a Constant Absolute Risk Aversion (CARA) utility over the value of their invested wealth in the following period, and who also consider that price changes are normally distributed. Thus, for an asset's fundamental value to change there should be a revision of the investors' expectations of future cash flows; or there should be a change in the discount rate applied to those cash flows. The fundamentals view then suggests that correlation in returns occurs as a result of correlated changes in rationally expected cash flows, or as result of correlated changes in rationally applied discount rates. In turn, news about interest rates or risk aversion, affecting all discount rates at the same time, can be the cause of correlated discount rates. The latter can also occur due to correlated changes in investors' rational perception of the assets' risk (Barberis *et al.*, 2005: 1). However, with the assumption of a constant riskless rate, constant investors' risk aversion and their constant perception of risk, the discount rate is also considered constant. Therefore, the co-movement in news about fundamental values which is reflected in the return co-movement is simply the co-movement in news about future cash flows. Barberis *et al.* (2005: 7) then concluded that the fundamental-based view can conveniently explain cases of common factors in returns, such as the strong market and industry factors. The existence of these factors could partly be the result of market-level and industry-level factors in cash flow news.

This fundamental-based theory is similar to the standard textbook theory of stock price movements over long period of time, which stipulates that stock prices are determined by expected real dividends discounted by a constant discount rate (Engsted and Tanggaard, 2004: 1). That is, present stock prices are equal to the present discounted value of the expected future earnings. However, based on yearly data collected over many decades, this simple present value model presents limitations due to the absence of a theory of discount rates. In effect, as discount rates do not remain constant over time, the standard models in finance theory have failed to effectively explain this time variation (Engsted and Tanggaard, 2004: 1). In many tests of the model making use of a constant discount rate was rejected because most general equilibrium models involve changes in discount rates and the discount rates are expected to depend on a variety of macroeconomic variables (Pindyck and Rotemberg, 1993: 1073). Hence Pindyck and Rotemberg (1993: 1073) explain that all present value models in which discount rates depend only on macroeconomic variables commonly imply that the prices of different stocks can only move together as a response to common movements in earnings, or as a reaction to common effects of changes in current or expected future macroeconomic conditions. Hence, if companies' earnings are uncorrelated due to unrelated industries, the price of their stocks will only move together in cases of changes in current or expected future macroeconomic conditions. However, Pindyck and Rotemberg (1993) rejected this hypothesis casting doubt on the important distributional effects of macroeconomic variables. They concluded that it is more accurate to pursue the hypothesis that stock price co-movement happens as a result of market segmentation and the existence of group wide sentiments.

The second theory discussed by Barberis *et al.* (2005), the category-based co-movement, suggests that co-movement is not determined simply by the fundamentals, but also by the investors trading patterns. More specifically, the authors argue that investors are attracted to thinking about investments in terms of categories. This is particularly the case for institutional investors who as fiduciaries, are bound by systematic rules when making portfolio allocation. In that process, then, assets are first grouped into categories based on some characteristic, and funds are allocated by categories rather than at the level of individual securities. Some common examples of categories include oil industry stocks, large stocks, small-cap stocks, value stocks, growth stocks and junk bonds. By allocating funds in that manner, the investment process is simplified, and a consistent way of evaluating the performance of portfolio managers is provided (Barberis *et al.*, 2005: 7). One assumption of the model is that some of these investors may be noise traders with correlated views. A change in sentiment will lead them to reallocate the funds between the various categories. In the event that prices are affected by their trading, this reallocation of funds between categories will produce common factors in the returns of assets belonging to the same category, even if there is no correlation between these assets' cash flows (Barberis *et al.*, 2005: 8).

To formally illustrate this model, the authors considered two categories named X and Y, with risky assets 1 through n belonging to category X, and risky assets $n+1$ through $2n$ belonging to category Y. Their mathematical deductions suggest that the returns of a group of stocks can possess a common factor basically for the reason that these stocks are in the same category. In effect, after $\Delta u_{X,t+1}$ (i.e. a positive sentiment shock about category X) is experienced by noise traders, the latter will increase their investments in all stocks in category X. This will effectively lead to a simultaneous increase in the prices of all assets belonging to X. Moreover, there is another less obvious reason for the effect of the positive sentiment shock $\Delta u_{X,t+1}$ on the returns on all stocks. Presume that there is an increase in the prices of stocks in category Y after the noise traders grow bullish about the stocks in that category. The reaction from fundamental traders to the overvaluation will be to short sell securities in Y, and buy more stocks in X in an attempt to hedge themselves against adverse fundamental news. Hence, there is also a transmission of the sentiment shock about Y, $\Delta u_{Y,t+1}$, to the securities in category X (Barberis *et al.*, 2005: 10). Furthermore, the effect of noise traders' transactions on prices and patterns of comovement shown in this model, rests on the assumption that fundamental traders have a one-period horizon (i.e. horizons ending ahead of the resolution of cash-flow uncertainty at time T). In the case that they only worried about wealth at time T, they would attempt to counter the effect of noise traders more aggressively. However, due to their one-period horizon, the fundamental traders have to care about future demand by noise traders and make their investments less aggressive. High risk aversion or perceived stock volatility increases the effect of the sentiment shocks to return, as they become more disinclined to bet against the noise traders (Barberis *et al.*, 2005: 10). In order to find evidence of category-based comovement, Barberis *et al.* (2005: 11) identify three predictions unique to the economy examined. The first two predictions describe the result from a reclassification of risky asset j from category Y into category X[1] , assuming there is a fixed cash-flow covariance matrix Σ_D and that the number of assets n tends to infinity. In the case of the first prediction with the following univariate regression:

$$\Delta P_{j,t} = \alpha_j + \beta_j \Delta P_{X,t} + v_{j,t} \tag{2.1}$$

Where, $\Delta P_{X,t} = \frac{1}{n}\Sigma_{l\in X}\Delta P_{l,t}$,

[1]For example, a considerable decline in the market capitalization of a large-cap stock may send it to the small-cap category.

the reclassification leads to not just an increase in the covariance of asset j with the return on category X (i.e. $\Delta P_{X,t}$), but also its beta loading on that return which is the OLS estimate of the parameter β_j. More generally, the increase in beta is greater than can be described by any increase in cash-flow correlation (Barberis *et al.*, 2005: 11). In the case of the second proposition using the following bivariate regression:

$$\Delta P_{j,t} = \alpha_j + \beta_{j,X} \Delta P_{X,t} + \beta j, Y \Delta P_{Y,t} + \upsilon_{j,t}, \tag{2.2}$$

the reclassification leads to an increase in the OLS estimate of the parameter $\beta_{j,X}$ and a fall in the estimate of $\beta_{j,Y}$. This prediction detects a potentially more powerful test than the first one, concluding that the re-categorization of a stock from one category into the other is followed by an increased sensitivity of the other category's sentiment shock (i.e. $\Delta u_{X,t}$). Again, in order for the above-mentioned propositions to hold, there need to be, either noise traders with identical demands functions for all assets within a category, or fundamental traders who are capable of offsetting their effect. If not, correlation in fundamental news will be the sole determinant of return correlation, and the correlation structure of returns (i.e. β_j and R^2 in the first proposition, and $\beta_{j,X}$ and $\beta_{j,Y}$ in the second proposition) will remain unchanged after the reclassification (Barberis *et al.*, 2005: 12).

Finally, the last proposition of the category view suggests that, as the number of risky assets approaches infinity, corr$(\Delta P_{X,t}, \Delta P_{Y,t})$ is lower in an economy containing noise traders with identical demands functions for all assets within a category, than it would be in the presence of fundamental traders only (Barberis *et al.*, 2005: 12). In the latter case, the correlation of the fundamentals of the categories X and Y is the sole determinant of corr$(\Delta P_{X,t}, \Delta P_{Y,t})$. When noise traders are introduced in the economy, imperfectly correlated shocks are added to the returns of X and Y; which lowers the correlation between both categories. In time series, it is possible to test for this proposition when the portion of noise traders with the indicated demand functions increases over time (Barberis *et al.*, 2005: 12).

The habitat-based co-movement, which is the third theory discussed by Barberis *et al.* (2005), stems from the argument that due to international trading restriction, lack of information or transaction costs, a great number of investors deal only part of all available stocks. Assuming that, for example, set X including securities 1 through *n* is only traded by one group of investors referred to as habitat X; while set Y including securities *n+1* through *2n*, is only traded by another group referred to as habitat Y investors. It is important to note that, contrary to the category-based view, X and Y do not refer to categories of assets that some investors do not differentiate between when redistributing their funds. They rather denote groups of assets that are solely held by some investors. Set X could, for example, be thought of as U.S stocks, and set Y as U.K. stocks, with many investors in these respective countries restricting their trading solely to domestic securities. In the event that habitat X investors become more risk averse, and subsequently decrease their positions in all risky assets in their possession, the habitat theory of co-movement argues that a common factor in the returns of securities in set X (i.e. the primary holdings of habitat X investors) will be generated. This will happen even if there is no correlation between those risky assets' fundamental values (Barberis *et al.*, 2005: 13). Although, the demand functions for habitat investors are motivated differently to those in the category view of co-movement, the price functions remain the same. This implies that the three propositions (i.e. Proposition one through three) highlighted in the category based theory, would also hold for this economy, with X and Y representing investors habitats instead of categories. In this case, Proposition one would now be construed as proposing that the inclusion of a stock to the habitat of a certain group of investors will lead to a higher degree of co-movement between this stock and the other assets in that habitat. Notably, similarly to the category based theory, the habitat based theory is dependent on limits to arbitrage. That is, even when they have similar cash flows, habitat X and Y can trade at different prices since some investors trade only certain securities. This will then open up conceivably interesting prospects for unconstrained arbitrageurs. However, these opportunities cannot be aggressively exploited by fundamental traders who have short horizons in this model (Barberis *et al.*, 2005: 13).

Interestingly, Canto (2004) developed a theoretical model aimed at explaining the link between stock market integration and the international transmission of shocks across countries, using the New Open Economy Models (NEOM), pioneered by Obstfeld and Rogoff (1995). The author develops a NEOM that introduces international equity trading and describes the role of international portfolio diversification on the transmission of supply shocks (Canto, 2004: 9). This was the first attempt at introducing stock market integration into a theoretical NEOM. Thus, in this benchmark model, shares were introduced, as well as concave transaction costs on the holdings of foreign shares, in the attempt to model stock market integration. The model simulated predicts that domestic and foreign stock returns are positively correlated when there is a response of stock markets to supply shocks (Canto, 2004: 63).

When there is a shock to home productivity, there is automatically an increase in the dividends paid by domestic stocks, linked to an increase in domestic stock returns. Subsequently, the temporary increase in wealth experienced by domestic agents informs their optimal decision to demand more foreign shares, increasing the foreign shares prices and returns, and signaling the existence of positive international spillovers between markets. This does not only highlight the importance of supply shocks in attempting to describe the dynamic behaviour of international equity returns, but also shows dividends and profits as representing an extra channel of the international transmission of shocks.

After the introduction of imperfect international stock market integration into the model using adjustment costs, there is a dramatic fall in international stock returns correlations. Thus, Canto (2004) argues that in the case of imperfectly integrated markets, the ability of investors to take optimal decisions is limited by the barriers to portfolio diversification and the imperfect capital mobility. The dynamic response of variables to international spillovers and technology shocks will in turn be affected. Naturally, there will be a fall in the contemporaneous correlations of stock prices, stock returns and consumption, resulting from the rise in the transaction costs of investing in foreign shares (Canto, 2004: 64).

Moreover, when introducing various degrees of stock market integration, the new model proposes that the level of the transaction cost of investing in the international portfolio determines the expected relationship between foreign and domestic stock returns. Stock prices are equally simultaneously affected by this transaction cost (Canto, 2004: 64). Furthermore, there is also a dramatic change in the length of the dynamic response of the stock returns to supply shocks, when initial asymmetric holdings of foreign shares are introduced in the model. Although the effect of the shocks on stock returns turns out to last longer, the initial volume of foreign assets held does not determine the dynamic response of real variables to supply shocks. Similarly, the initial level of foreign assets' holdings is hardly a determinant of the dynamic response of the foreign stocks holdings; while the latter is considerably dependent on the level of transaction costs in the foreign markets (Canto, 2004: 64). This model being the first attempt at introducing stock market integration within a NOEM framework, presents some limitations. One of these limitations is the fact that the model does not consider the accumulation of capital. This confines the importance of stock markets in the transmission mechanism.

Besides the NOEM framework, Canto (2004) highlighted two other theories predicting and explaining the existence of stock market spillovers. Firstly, the author argues that with the growing international economic integration, the globalization and deregulation of financial markets, economic as well as corporate news released in one country may not disclose information solely concerning that particular country, but may hold global factors impacting the world economy. Also, in an environment where the equity market behaves efficiently, there should be an immediate adjustment of stock prices to the inflow of relevant information, thus reflecting at any point in time all relevant information that can impact the stock prices. Subsequently, the movement of stock prices in other markets around the world constitutes a possible source of information that can influence stock prices in one country. Canto (2004: 68) called it the global factor hypothesis. More formally, this hypothesis asserts that a portion of the movements in foreign stock returns is credited to comprising global information. For that reason, stock price innovation in international markets represents a source of learning for domestic market traders. In fact, the latter extract the imperceptible information from prior foreign returns and integrate the valuation information into their ensuing domestic trading. Thus, with the presence of a global factor in stock pricing, traders may track the changes in price in international markets, as they provide valuable information about this global pricing factor. This exhibits the financial globalization process worldwide, and accentuates the value of foreign stock market developments in the investment decision making process domestically (Canto, 2004: 108).

Public Information hypothesis

Finally, Canto (2004) presents a second hypothesis to explain the existence of international stock return co-movements. That is the public information hypothesis. The hypothesis argues that macroeconomic news may represent a source of market return co-movements. In effect, with the presence of common factors in business cycles, the macroeconomic news emerging from one country may not only reveal information about futures cash flows or discount rates in the home country, but also in many other countries. According to Canto (2004: 149), instead of domestic investors waiting and following the foreign market's response to foreign news, they react directly to the content of the news itself. Finally, the author underlines the importance of the use of high frequency datasets in the analysis, as it improves the understanding of dynamic interactions between different stock exchanges (Canto, 2004: 149).

Empirical literature

Like Pindyck and Rotemberg (1993), Engsted and Tanggaard (2004), and Barberis *et al.* (2005) also reject the standard hypothesis of the simple present value model. The Engsted and Tanggaard (2004) study analysed the co-movement of USA and UK stock markets by decomposing stock return innovations in the two countries into various news components (i.e. dividend news, real interest rate news, and stock return news).To this end, they used quarterly data from the USA and the UK, covering the period 1918 to 1999. The news components were then analysed, using a VAR-based variance decomposition, to see how they move together across countries. It was found that the main determinant of stock market volatility in both the USA and the UK is the news about the risk premia (future excess returns) and that this component is highly cross-country correlated, effectively explaining the high degree of co-movement of USA and UK stock markets (Engsted and Tanggaard, 2004).

Similarly, Bonfiglioli and Favero (2005) attempted to explain the co-movements between US and German stock markets by highlighting the difference between interdependence and contagion. Within the framework of an explicit structural model, they evaluated the relative significance of contagion and interdependence, employing cointegration analysis to isolate long-run equilibria from short-run dynamics. A long-run equilibrium was constructed by testing distinctive possible specification and favouring the hypothesis of cointegration between the (log of) US earning-price ratio and long-term interest rates (Bonfiglioli and Favero, 2005: 1313). The analysis failed to reject the hypothesis of no long-run interdependence between the US and the German markets. Thus, a Vector Error Correction Model was used as a baseline reduced form and a structural model was built to evaluate the relative significance of interdependence and contagion in the identification of the short-run dynamics of the two markets. That structural model demonstrated that the impact of fluctuations of the US stock market on the German stock market is represented by a non-linear specification. While common fluctuations in the US exchange have practically no impact on the German market, such impact becomes sizeable and significant for abnormal fluctuations (Bonfiglioli and Favero, 2005: 1314).

The notion of contagion was also analysed by Canto (2004) through the global factor hypothesis. In testing that hypothesis, the author conducts an empirical analysis of the intra-day spillovers between the FTSE 100 and the Dow Jones Industrial Average returns. The use of the intra-day data set was motivated by an attempt to specify and separately estimate the market spillovers in three cases, namely: the first one looks at the effects of New York stock prices on next morning London stock prices, considering that the New York stock exchange closes later than the London Stock Exchange. In reverse, the second case considers the fact that the London Stock Exchange opens earlier than the New York Stock Exchange and thus analyses the effects of London stock prices on New York stock prices. Lastly, the third case examines the situation where the London and the New York stock exchanges trade simultaneously and news is incorporated simultaneously in both stock prices (Canto, 2004: 68). With the intra-day stock prices for the FTSE 100 and the Dow Jones Industrial Average, the author was able to compute intra-day stock indices returns for the period 4 January 1999 through to 28 March 2003. The two-stage EGARCH approach was then used to investigate the three cases mentioned above. The results from the estimation in case one and two showed evidence in favour of the global factor hypothesis as a considerable source of stock returns correlations. In effect, subsequent domestic returns are significantly affected by foreign returns. Based on the significant parameters estimated, the author infers that innovations in foreign stock exchanges can partially explain the movements in stock markets, as domestic traders learn from these innovations. Thus, there is significant evidence of increasing international stock market linkages between the New York and the London Stock Exchanges, which supports the globalization of financial markets around the world (Canto, 2004: 97). As for the third case examined, the results present a significant bi-directional relationship between the New York and the London Stock Exchanges in terms of returns interactions during the common trading hours.

In trying to answer the question: "why does stock price synchronicity exist in emerging markets?", Morck, Yeung and Yu (2000) consider the information content of stock markets highlighting that the relative amounts of firm-level and market-level information exploited into stock prices determines the degree of synchronicity among stock. Using weekly and bi-weekly stock return data from 40 countries between 1993 and 1997, they run a number of multivariate OLS regressions in order to test for three hypotheses (Morck *et al.*, 2000: 2). The first hypothesis states that fundamentals might be more correlated for firms operating in low-income countries, which might be the reason for their stock prices moving more synchronously. Secondly, they hypothesize that protection of private property right is usually poor and uncertain in low-income economies. Hence, the occurrence of political events as well as rumours in these countries alone could lead to market-wide stock price swings. Also, informed trading could become less attractive when the protection of protective rights is inadequate; leading to an increase in market-wide noise trader risk which will be observed as an increase in market-wide stock price fluctuation distinct from fundamental. Finally, the third hypothesis states that when there is poorer protection from corporate insiders for public investors, firm-specific information could become less useful to risk arbitrageurs due to difficulties such as intercorporate income shifting. These problems could therefore, hinder the capitalization of firm-specific information into stock prices. This could result in the reduction of firm-specific stock price variation, and an increase in stock return synchronicity (Morck *et al.*, 2000: 2). Their empirical analysis showed that there is more synchronicity between stock returns in emerging economies than the ones in developed economies. Moreover, they argued that economies with higher per capita GDP tend to have better property rights protections and better investors protections, compared to economies with lower per capita GDP. This contribution to information transparency explains the cross-country difference in stock price co-movement and justifies the fact that stock prices move in a more synchronous way in poor economies than in rich economies (Morck *et al.*, 2000). However, the study fails to address the fact that information transparency is constituted of both market-level information transparency and firm-level information transparency. Instead, they are under the assumption that the fluctuations in stock prices motivated by market-level information do not vary much across firms and across countries. This is a limitation that Wang and Zou (2013) attempt to address in their study of stock price co-movement of ADRs.

Contrary to Morck *et al.* (2000), Wang and Zou's (2013) investigation of how different types of information affect stock price co-movement focuses on non-US firms in the setting that both non-US stocks and US stocks trade together. The ownership of the shares of non-US companies that trade in the US financial markets is represented by American Depositary Receipts (ADRs). The authors mention that stock price co-movement can be driven by market-level information, industry-wide information as well as firm specific information. They emphasized that since the R-squared of the market regression (i.e. the percentage of market level volatility in the total volatility of stock prices) is commonly used to measure stock price co-movement, a firm's stock prices incorporating relatively more market-level information compared to average firms' stock prices, will tend to co-move more with the market (Wang and Zou, 2013: 39). Thus, the hypothesis was that, if stock prices of ADRs are informative, ADRs have lower stock price co-movement with the US markets than US stocks. In effect, it was argued that the relative amount of market-level information (i.e. information of the US market movement incorporated in stock prices) against firm-specific information (i.e. the portion of ADRs' home country information that is not correlated with the U.S capital markets) incorporated in the stock price, will determine the co-movement of ADRs' stock prices. However, the empirical analysis conducted using a series of OLS regressions concluded that the returns of ADRs co-move more with the US markets than similar US firms do (Wang and Zou, 2013: 40). In effect, in an efficient market, ADRs should have lower synchronicity and their prices should be more influenced by their home economies. However, the study shows that they are inefficient and inappropriately record information from outside the U.S market.

By introducing macroeconomic news as another source of information that could create interactions between international markets, Canto (2004) investigates the public information hypothesis in three major European futures markets, namely, the British, the German and the Pan-European markets. Using intra-day prices on futures contracts for the Dow Jones Eurostoxx 50, the DAX and the FTSE 100 indices, the author estimated a series of VAR models to examine the dynamic spillovers between the three markets and whether or not the co-movements can be ascribed to the flow of public information, which is measured by news on macroeconomic fundamentals. The results from the estimations show strong dynamic interactions between the three futures markets. However, no profit opportunities are discovered when the futures on these indices are traded. Moreover, no clear dynamic pattern was identified, such as the FTSE index leading the futures fluctuations and the continental indices futures following its movements. Furthermore, consistent with the public information hypothesis is the finding that shocks at the domestic macroeconomic level impact both the foreign and the domestic stock returns in the short-run. In effect, there is a quick response of the returns to both domestic and foreign information, which is characterized by an immediate jump and little movement afterwards (Canto, 2004: 148). Additionally, although there is visible strengthening of the dynamic cross market linkages between the DAX, the Eurostoxx 50 and the FTSE 100 futures, there is an increase in the contemporaneous correlation between the three futures returns in the minutes following the release of macroeconomic data. Lastly, the short-run stock market interactions are affected around announcement periods by the fact that official Euro-Zone and British news releases have pre-scheduled times or that German news announcements have non-pre-determined times (Canto, 2004: 149).

In order to test the three models of co-movement, presented by Barberis *et al.* (2005), the authors collected data on S&P 500 index inclusions between 22 September 1976 and 31 December 2000 as well as S&P 500 deletions between 1 January 1979 and 31 December 2000. The difference in the sample period between the inclusions and the deletions is due to the fact that Standard & Poor's only started recording announcement dates of index changes in September 1976 and data on deletions before 1979 was unobtainable. Barberis *et al.* (2005: 15) examine three propositions (i.e. Proposition one through three). In effect, in Proposition one, they test whether there is an increase (or decrease) in a stock's beta with the S&P and the portion of its variance explained by the index, following the stock's inclusion in (or removal from) the index. Regarding Proposition two, the test consists of finding out whether, when taking into account the return of non-S&P stocks, there is an increase (a fall) in a stock's beta with S&P, after inclusion (or deletion). Lastly, with regards to Proposition three, the aim is to test whether the cross-category correlation stock has decreased after the S&P has grown in importance as a category. Barberis *et al.* (2005: 15) define the null hypothesis as being that return co-movement is mainly a function of co-movement in news about fundamentals, such that the betas, the R^2 and the cross-category correlation (i.e. of S&P and non-S&P stocks) remain unchanged. This hypothesis is tested against the alternative which is that trading flows indeed produce co-movement, and the betas, R^2 and cross-category correlation change as predicted. After running a series of univariate and bivariate regressions, it was found that with the inclusion of stocks into the index, there is an increase in co-movement between these stocks and other stocks already in the index, and a decrease in co-movement between the newly included stocks and stocks that are not part of the index. The situation happens in reverse when considering deletions. However, the fact that no news about fundamentals comes with including stocks into the S&P 500 index, it is difficult to reconcile these findings with the fundamentals view of co-movement. Yet, this evidence supports the category-based and the habitat-based theories (Barberis *et al.*, 2005: 23).

When investigating co-movements between emerging and developed stock markets, Ali, Butt and Rehman (2011), as well as Gupta and Guidi (2012) focused on the Asian markets. Gupta and Guidi (2012) investigated the links between the Indian stock market (as an emerging market) and the Hong Kong, Japan, Singapore and U.S stock markets (as the developed markets); while Ali *et al.* (2011) expanded the analysis to four more Asian markets and one more western market by including the UK market in the investigation of co-movements of the Pakistani Equity Market with the stock markets in China, India, Indonesia, Japan, Malaysia, Singapore, Taiwan and USA. Using a series of cointegration tests, namely the Engle Granger cointegration test, the Johansen cointegration test, and the Gregory and Hansen cointegration test; as well as the Granger causality test, Gupta and Guidi (2012: 14-17) explored interdependence between the markets. The data sample consisted of daily closing index prices of the 5 markets covering the period 31 August 1999 – 17 June 2009. It was found that there is no stable long-term relationship among the markets. Hence, this presents an opportunity for international investors looking to access the Indian stock market. Moreover, the existence of a cointegration relationship although unstable over time, may be due to the strengthening of trade relations between the countries under consideration.

Likewise, Ali *et al.* (2011) used the Johansen cointegration method as well as the Granger causality test, with a data sample consisting of monthly stock prices of the 10 markets' main indices for the period of July 1998 to June 2008. The results from the analysis showed that there is no cointegration relationship between the Pakistani stock market and the UK, USA, Taiwan, Malaysia and Singapore stock markets. This represents an attractive opportunity for international portfolio managers from these countries to diversify with Pakistani stocks. However, the same opportunity does not exist for international investors from India, Japan, China and Indonesia; the Pakistani stock market was found to be cointegrated with these markets. Furthermore, a short-term relationship was found between the Pakistani stock market and the ones in the Japan, Taiwan and Malaysia. Thus, policy making about the Pakistani stock market should take into account any development in the three markets. Additionally, the co-movement of Pakistani stocks with the markets under consideration is not influenced by the structure of the exchange (Ali *et al.*, 2011: 401).

On the African sphere, according to Kambadza and Chinzara (2012), economic linkages existing between the economies constitute the basis of fundamental linkages between nations. In other words, the amount of close investment, trade and any other form of economic ties existing between two countries can define their degree of connection. Thus, the effects of an economic shock in one country could affect the other countries with which it shares strong economic ties, through its export companies for example. Moreover, should those companies be listed, the shock is likely to affect their returns in the same direction, which will produce then a co-movement of the related countries' stock markets (Kambadza and Chinzara, 2012: 4). However, the stock markets' co-movements may not only occur between countries that have direct economic ties. In effect, if the concerned countries share strong economic ties with a third party country, a slowdown in demand for exports, for example, from the third party country may result in a co-movement of the concerned countries' stock markets (Kambadza and Chinzara, 2012: 4). Furthermore, the co-movement in stock markets may also be the result of contagion which is not explained by economic factors but rather by the positions taken by investors in anticipation of an expected crisis in one country, affecting the other related countries (Kambadza and Chinzara, 2012: 4).

Kambadza and Chinzara (2012) investigated the existence of returns co-movements and volatility linkages among eight African stock markets, namely, South Africa, Nigeria, Namibia, Morocco, Mauritius, Kenya, Ghana and Egypt. The data sample included daily closing indices and covered the period 31 January 2000 – 28 July 2010. Using factor analysis in order to examine the structure of correlation among the chosen market returns, the authors found that, generally, African markets share limited returns interactions, unless the countries are close trading partners or have big economies (Kambadza and Chinzara, 2012: 20). In effect, there is evidence of patterns of correlation between the following sets of countries: Morocco and Egypt; Namibia and South Africa; Mauritius and Kenya; and Morocco, Egypt, South Africa and Nigeria. Likewise, the VAR, block exogeneity, impulse response functions as well as variance decomposition, used by the authors to further investigate the dynamic interactions among the return, confirmed the results presented above. In addition, there is evidence of the greater importance of domestic innovations compared to foreign innovations, when explaining current returns. However, in cases where a stock market appeared to be responsive to foreign innovations, it was a quick response, consistent with the weak informational efficiency hypothesis. Also, South Africa was found to be more endogenous and dominant than the other countries, in terms of returns and volatility influence (Kambadza and Chinzara, 2012: 20).

Collins and Biekpe (2003) employed the narrow definition of contagion in order to paint a picture of the relationships and interdependencies among African stock markets returns, as well as between African markets and other emerging stock market returns. They postulated that contagion is narrowly defined as a considerable rise in correlation coefficients over a period of financial instability (Collins and Biekpe, 2003: 186). For the eight African countries considered in the study (i.e. Egypt, Kenya, Mauritius, Morocco, Namibia, Nigeria, South Africa and Zimbabwe), the study used daily data on the local benchmark index to calculate rolling two-day averages of daily returns allowing for differences in open market times. Focusing on the 1997 Asian crisis and the Hong Kong crash of the 17th October 1997, the sample period was divided into two: 2nd January 1997 to 17 October 1997 was defined as the tranquil period, while the crisis period was identified from 20 October 1997 to 28 November 1997 (Collins and Biekpe, 2003: 187). The unadjusted and adjusted correlations were calculated using Forbes and Rigobon's (2002) method and the sample correlation coeeficients were used to run exact t-tests. Collins and Biekpe (2003: 188) measured contagion by recording the significance of rises in correlations during the turmoil period as opposed to the tranquil period. Finally, Granger causality tests were conducted to identify causal relationships.

The analysis of the unadjusted correlation coefficients identified evidence of contagion from Hong Kong in some African markets, including Namibia and Mauritius. In contrast, the results of the analysis using adjusted correlation coefficients showed evidence of contagion only in Egypt and South Africa (Collins and Biekpe, 2003: 190). The results also found fourteen significant correlation coefficients among African markets, with the strongest relationships uncovered within the Southern African region; that is between Botswana and South Africa, Namibia and Botswana, and South Africa and Namibia. A strong inter-regional relationship was also found between South Africa and Egypt. Additionally, only two causal relationships were found with return in Egypt Granger causing returns in Morocco, and returns in South Africa Granger causing returns in Zimbabwe. Collins and Biekpe (2003: 193) argued that the existence of contagion between South Africa and Egypt could be due to the fact that they give global emerging market managers an opportunity to diversify their portfolios. Moreover, the authors explained that the strong relationships between the Southern African markets may be due to their fundamental trade and economic links, instead of investor behavior links (Collins and Biekpe, 2003: 193).

The extent of integration between the three largest markets of the Southern African Custom Union (SACU) (i.e. Botswana, Namibia and South Africa) was examined by Hearn and Piesse (2002) using a cointegration approach. The data sample included monthly values of each markets all-share index denominated in local currency for the period August 1993 - January 2000. The methodology followed four stages: firstly, the authors conducted a unit root test on the data in levels and in first differences with the aim of identifying the order of integration of the time-series. Secondly, a multivariate VAR system was then built after the number of cointegrating vectors were determined using the Johansen and Juselius (1991) framework. The corresponding VECM was also estimated. Thirdly, the Granger causality test was conducted for cointegrated models, while the block Granger non-causality was applied to the non-cointegrated models in order to test the mutual dependency on each of the variables' lag structures. Lastly, the autoregressive distributed lag (ARDL) method was employed to examine the error correction analysis in cases of short-term temporal deviations from the initial trend (Hearn and Piesse, 2002: 9).

The results from the pairwise cointegration analysis showed the existence of one cointegrating vector between Namibia and South Africa, suggesting the presence of a single long-run structural relationship between these markets' indices. No evidence of long-term cointegrating relationship was found between the other two pairs (Hearn and Piesse, 2002: 17). From the results of the Granger causality test, the authors deduced that price changes on the Namibia market granger cause price changes on the South African market. They argued that although this result is unexpected, an explanation could be that South Africa might be affected by a common component of African emerging markets that has a stronger influence on Namibia. Since the South African market is much larger and is more accessible to global capital markets, it would not be as strongly influenced by local or regional factors as Namibia would be. However, there may still be a spillover of the effect of such factor to the South African market, due to the degree of integration between the countries (Hearn and Piesse, 2002: 19).

Mohanasundaram and Parthasarathy (2015) investigated the existence of stock market interdependence and cointegration between South Africa, India and the USA. The authors examined the possibility of short-run as well as long-run relationships between these markets by employing the Johansen-Juselius multivariate cointegration approach. Using monthly values of the markets' stock indices (i.e. the JSE Africa All Share index, the Indian National Stock Exchange CNX NIFTY 50, and the NASDAQ Composite) for the period from April 2004 to March 2014, the correlation test uncovered high degrees of correlation between the markets, with the highest correlation between the JSE All Share index and the Indian NIFTY 50 at 92.11 percent (Mohanasundaram and Parthasarathy, 2015: 481). Further verification of the correlation found involved running the Granger causality test in order to identify the direction of influence. The results showed that there is a unidirectional causality relationship between the JSE All Share index and the NIFTY 50. This led Mohanasundaram and Parthasarathy (2015: 482) to infer that the JSE ALL Share index can be used while forecasting the NIFTY 50 index. The Johansen cointegration test was then used to examine the long-run relationship between the three markets. Since the results of the test indicated the absence of a long-run relationship between the market indices, unrestricted VARs were estimated to test the short-run relationship between the markets. The authors finally found that the South African and US indices are only affected by their own past lags, while the Indian index can be predicted by its own lags as well as the past lags of the South African index (Mohanasundaram and Parthasarathy, 2015: 483). Hence, Mohanasundaram and Parthasarathy (2015: 483) concluded that, despite the strong correlation existing between the markets, the markets are independent in the long-run.

The degree of integration between selected African stock markets and the rest of the world was examined by Alagidede, Panagiotidis and Zhang (2010) using parametric and non-parametric cointegration methods. The study focused on four African markets (i.e. South Africa, Egypt, Nigeria and Kenya), three emerging markets (i.e. Brazil, Mexico and India) and three developed markets (i.e. The UK, US and Japan). The data sample consisted of the monthly value in US dollars of the MSCI for Brazil, Egypt, India, Mexico and South Africa; the S&P and IFCG indices for Kenya and Nigeria; as well Nikkei 225, FTSE 100 and S&P 500 for Japan, the UK and US, respectively. The authors argued that using the data in a monthly frequency allows to solve the problem of non-synchronous trading that is commonly encountered in emerging markets, as well as prevent the possible impacts of autocorrelation in volatility which is a characteristic of higher frequency data (Alagidede *et al.*, 2010: 3). The common trends between pairs of the markets considered was examined by running bivariate cointegration tests. The results showed the existence of a long-run relationship between Egypt and Japan, Kenya and Japan, and South Africa and Brazil. However, no cointegration was found among African markets. The authors posited that the geographical proximity of these markets is neither necessary nor sufficient for them to be cointegrated (Alagidede *et al.*, 2010: 6).

Alagidede *et al.* (2010: 6) then employed the non-parametric Breitung cointegration test to conduct another bivariate analysis, allowing to consider the existence of a non-linear relationship between the markets. In contrast to the results found with the Johansen cointegration test, the Breitung test found that there is cointegration only between Egypt and South Africa, and Egypt and Brazil. The results imply the existence of a non-linear relationship between the two pairs of markets (Alagidede *et al.*, 2010: 6). These results, coupled with the low correlation found between African countries and the rest of the world, led the authors to conclude that investors could achieve stronger risk diversification by including African assets into their global investment portfolio (Alagidede *et al.*, 2010: 7).

Adjasi and Biekpe (2006) also explored the existence of dynamic cointegrating relationships among seven African markets, namely Egypt, Ghana, Kenya, Mauritius, Nigeria, South Africa and Tunisia. The choice of these countries was informed by the fact that they were among the earliest established on the continent. Moreover, reliable and consistent data on these markets' stock prices was easily accessible; and value weighted indexes were constructed and available for these markets (Adjasi and Biekpe, 2006: 106). The data sample included monthly values of the markets' indices for the period November 1997 to August 2005. Using the Johansen and Juselius methodology, the authors conducted a cointegration test that uncovered the existence of two cointegrating equation implying cointegration of structural and technological endowments between the countries considered; and dynamic long-run causalities between these stock markets (Adjasi and Biekpe, 2006: 108). Following the intuition that these long-run relationships will rest on a larger market being influence by a smaller market, and a larger market influencing a smaller one; Adjasi and Biekpe (2006: 108) derived two long-run equations with the first one being normalized on the JSE (i.e. the largest and most active market in the sample) and the second one being normalized on Ghana (i.e. the smallest and less developed market in the sample). Restrictions were put on the equations' β and α and the results showed a positive influence of the Kenyan, Nigerian and Tunisian markets on the South African market. However, the Mauritian and Ghanaian stock markets were found to negatively influence the South African market in the long-run. Similarly, the Ghanaian stock market was found to be positively affected by all of the stock markets except the Mauritian market (Adjasi and Biekpe, 2006: 110).

The short run relationships were then analysed using the VECM framework. Adjasi and Biekpe (2006: 115) found that the Ghanaian and South African stock markets are affected in the short run by dynamic short-run responses and feedbacks from the other African exchanges. Moreover, the Ghanaian model records a slower equilibrium correction than the South African model; while the short run dynamics in the South African market are not significantly influenced by the disturbances stemming from disequilibrium in the Ghanaian stock returns error-correction in the short-run. In contrast, short-run dynamics in the Ghanaian stock market are influenced by short-run disequilibrium in the South African market (Adjasi and Biekpe, 2006: 115). Adjasi and Biekpe (2006: 115) concluded that both long-run interdependence as well as bi-directional dynamic causality exist among African stock markets, with the South African having a dominating impact on the Ghanaian market which is younger and relatively inactive.

2.3.3 Volatility Linkages

Theoretical Literature

In general, most theories used to explain integration between markets and co-movements in stock price can also be relevant in the examination of volatility linkages. Akhtar, Jahromi, John and Moise (2016: 5) explain that it would be accurate to model volatility linkages as the information linkages among markets built on the proportional relationship between volatility and the flow of information. That is, the set of common information constitutes the first source of volatility linkages with information and macroeconomic news simultaneously affecting investors' expectations in any markets (Akhtar *et al.*, 2016: 5). This is consistent with both the global factor hypothesis and the public information hypothesis mentioned earlier in Section 2.3.2. Another source of volatility linkages can be attributed to information spillover which happens as a result of cross-market hedging. Effectively this will arise if investors trade in many asset classes and a news event impacts one asset class. Investors will thus react to the news by cross-hedging their activities and re-balancing their portfolio. This second source of linkages is in line with the category based view and habitat-based view of co-movement presented by Barberis *et al.* (2005) as it shows that the news event does not affect the demand for the corresponding asset class, but also alters the demand for the other asset classes as well.

Empirical Literature

Canto (2004) used the global factor hypothesis to also examine volatility spillovers between the FTSE 100 and the Dow Jones Industrial Average (representing the London Stock Exchange and the New York Stock exchange, respectively). With the same sample period (i.e. 4 January 1999 – 28 March 2003), the author chose to use an EGARCH as it permits an asymmetrical response of market volatility to positive or negative news. This refers to the leverage effects, which is the tendency of the correlation between changes in stock prices and changes in stock volatility to be negative. The results show that the EGARCH models are a reasonable representation of the return volatility processes, since all the coefficients estimated in the volatility equations were found to be significant. This is in support of the leverage effects. Particularly, there is a larger impact of negative innovations on volatility than positive innovations (Canto, 2004: 108). In the three specified cases defined by whether both exchanges were open simultaneously or only one of them was open at a time, it was found that there is significant bi-directionality in volatility spillovers between the New York and London stock indices (Canto, 2004: 108).

In their analysis of volatility linkages between the stock markets in Hong Kong, India and Singapore, Sariannidis, Konteos and Drimbetas (2009) also use a multivariate GARCH model, similar to Canto (2004). However, instead of the EGARCH, the study employed the BEKK-GARCH, which the authors' argued, is a highly appropriate choice to model the volatility transmission among the chosen markets. Then, making use of daily closing stock index data covering the period from 1 July 1997 to 31 October 2005 for the three Asian markets, it was found that all three of the markets considered have a high level of integration, as they react to common news derived mostly from the U.S. market. Moreover, the Hong Kong market was found to be the most efficient of the three, the Indian market the second most efficient, followed by the Singapore market. Also, Sariannidis *et al.* (2009: 13) argue that dated information has greater effect on conditional volatility than recent news. This is seen through the magnitude and persistence of the coefficient of the variance-covariance equations which show there are solid GARCH effects in the three markets. The implication is that there is inefficiency in the markets, and they slowly absorb the shocks. Additionally, the volatility formation is underlying in commonly available information which is indicated by the magnitude and the statistical significance of the covariances. This validates the point that stock markets are growingly integrated (Sariannidis *et al.*, 2009: 13).

The return linkages and volatility spillovers between the commodity price indices for beverages, food, energy and gold and the S&P 500 were examined by Mensi, Beljid, Boubaker and Managi (2013). Their data sample was constituted of daily returns of the S&P 500, beverage price, wheat price, gold indexes, and the Cushing West Texas Intermediate (WTI) crude oil price and the Europe Brent crude oil price for the period 3 January 2000 - 31 December 2011; the sample period chosen because it allows the examination of the sensitivity of the commodity market returns to the effects of the September 11 2001 terrorist attacks, the Gulf War which started in 2003 and the US subprime mortgage crisis of 2007 - 2008. To investigate the transmission of shocks, the dynamics of conditional volatility and volatility linkages between the series, Mensi *et al.* (2013:4) employed the VAR-GARCH model, which, as they argue, has less computational complications in providing meaningful estimates of the unknown parameters in comparison to various other multivariate models, like the full-factor multivariate GARCH model, for example. Thus, the results of the empirical analysis showed that, in the case of volatility spillovers, there is significant transmission between the stock exchange and the commodity markets. In addition, previous shocks and volatility in the S&P 500 have a strong influence on the oil and gold markets (Mensi *et al.*, 2013:4).

Also investigating the conditional correlations and volatility linkages between commodities and financial markets, Chang, McAleer and Tansuchat (2011) focused on the crude oil returns and stock index returns from the US and UK markets. Covering the period from 2 January 1998 to 4 November 2009 with a sample of daily returns of the crude oil spot, forward and futures prices from the WTI and Brent markets, and the S&P 500, Dow Jones, NYSE and FTSE 100 stock index returns, they chose to employ three multivariate conditional volatility models which assume constant conditional correlations. These models, namely the VARMA-AGARCH model of McAleer, Hoti and Chan (2009), the VARMA-GARCH model of Ling and McAleer

(2003), and the CCC model of Bollerslev (1990), do not have high dimensionality. They also make use of the DCC model of Engle (2002) in order to include time dependency in the conditional correlations (Chang *et al.*, 2011: 7). After empirical analysis, it was found that the use of dynamic models is consequential for consistency in the estimation of variances, covariances and volatility spillovers. The results produced from VARMA-GARCH and VARMA-AGARCH models showed that there is negligible indication of dependence of volatility spillovers among the financial markets and the crude oil markets. The authors also agreed to the superiority of the VARMA-AGARCH over the CCC and VARMA-GARCH models based on the evidence of asymmetric effects of positive and negative shocks of similar magnitude on conditional covariance (Chang *et al.*, 2011: 7).

The G-7 countries and nine prominent emerging markets, namely Argentina, Brazil, China, Hong Kong, India, Indonesia, Korea, Mexico and Taiwan, were the focus of Bhuyan, Elian, Bagnied and Al-Deehani's (2015) investigation of returns and volatility spillover effects. A data sample comprised of closing stock market indices for the 17 markets considered was used, covering a twelve-year period from 30 December 1995 to 28 February 2007. In the examination of volatility transmission between the markets, each market's volatility was initially tested by running the GARCH, EGARCH and GJR GARCH models. After selecting the most appropriate model, the latter was used to generate conditional variance series serving as proxy for volatility in each market. A VAR model, impulse response functions and variance decomposition were then employed to analyse transmission between markets. Bhuyan *et al.* (2015: 162-163) found that the leverage effects as well as asymmetry in volatility exist in all markets, except in the Chinese market. Furthermore, the examination of the volatility transmission among the stock markets indicated that there are significant volatility interactions among them. Finally, the authors also noted the evidence that stock markets located on the same continent are more influential in that region with the exception of the UK stock market which is linked to the US market (Bhuyan *et al.*, 2015: 162-163).

A similar study conducted by Balli, Basher, Ghassan and Hajhoh (2015) examined the returns and volatility spillovers from developed markets in Europe, the US and Japan, into 20 selected emerging markets in Asia and the MENA (Middle East and North Africa) region for the sample period 2000 - 2013. The study also contributed to the literature by investigating the potential underlying determinants of spillovers. To reach these objectives, the data sample included variables such as weekly stock return data, the level of stock investments by developed countries in emerging markets, bilateral trade volumes between emerging markets and their developed counterparts, holding by developed countries of emerging markets' debt securities, and the geographic distance between the capital cities of the countries considered (Balli *et al.*, 2015: 3).

The authors started their empirical analysis by modeling return and volatility for each market via a standard GARCH (1,1) process. This yielded the extent of the spillovers of global shocks on the emerging markets volatilities. Then, a constant spillover model as well as a trend spillover model was used to estimate shock spillovers among the markets. According to Balli *et al.* (2015: 3), while the time-varying characteristic of integration among markets is captured through the trend spillover model; the constant spillover model, on the other hand, keeps constant the degree of spillover effects, presenting a general picture of the effects. An additional step was taken by employing variance ratios to evaluate the effects of shocks from different origins as opposed to individual market's own shocks. Lastly, the authors used a cross-section model to investigate the potential factors determining shock spillovers from developed to emerging markets. The empirical findings from the constant spillover and trend spillover models reveal the presence of volatility spillover effects from major developed markets to the emerging markets. However, these effects are found to be heterogeneous, as there is a wide variation of the magnitude of the shocks across the countries considered in the study (Balli *et al.*, 2015: 8). Finally, the cross-section model identified distance, past colonial ties, domestic market capitalization, foreign portfolio investment and bilateral trade as important factors in the explanation of spillovers from developed to emerging countries (Balli *et al.*, 2015: 8).

Another interesting study was the analysis of the time-varying properties of the return volatility dynamics in the BRICS (i.e. Brazil, Russia, India, China and South Africa) markets, as well as the possible spillover effects between them and the US stock markets. The study which was conducted by Syriopoulos, Makram and Boubaker (2015), used a VAR(1)-GARCH (1,1) framework with a sample consisting of daily returns of representative stock market sector indices acting as proxies for two crucial economic sectors in each of the BRICS markets and the US. These are the financial and industrial sectors. Because the study covers the period 3 January 2005-31 December 2013, it allows the examination of the reaction of markets and the sensitivity of sectoral return and volatility spillovers effects, to the 2008 global financial crisis. Evidence was found of shocks and volatility spillover effects between the BRICS and the US markets. With the exception of China, industrial sector volatility in all of the BRICS markets was found to be affected by previous US industrial sector volatility. Similar results were found in the case of the financial sectors with evidence of shocks and volatility transmission from the US to BRICS. Brazil and India were the most affected by the US market.

Akhtar *et al.* (2016) analysed the intensity of volatility linkages between Islamic and conventional stock, bonds and bills. With a data sample consisting of daily return data on conventional bond stock, and money market indices for nine Islamic countries, 37 non-Islamic countries and a world index, the study covered the period from 31 May 2007 to 8 June 2010 for the main analysis. It was then extended to cover the period 31 May 2005 – 8 June 2010, to conduct the robustness tests, for only a subset of countries according to the availability of Islamic indices prior to 2007 (Akhtar *et al.*, 2016: 12).

Firstly, to examine linkages between money and stock markets, as well as between bonds and stock markets within each country, the study used two approaches which are the Pearson correlation and estimates from a stochastic volatility model with restrictions in GMM. Secondly, univariate and multivariate analyses are run to test the suggested hypothesis that volatility linkages between conventional assets are higher that volatility linkages between Islamic assets.

The estimates of volatility linkages across all the sample period are the basis of the univariate analysis, while the changes in volatility linkages across time is captured by the multivariate tests, which controls the other factors susceptible in affecting the intensity of volatility linkages (Akhtar *et al.*, 2016: 9-10).

The results from the empirical analysis found a smaller set of common information and lower cross-market hedging activity in Islamic markets, implying weaker linkages in Islamic markets compared to non-Islamic markets (Akhtar *et al.*, 2016: 25). When volatility linkages involving at least one Islamic asset are compared to volatility linkages between two conventional assets, the difference ranges between 3.36 and 13.53 percentage points. Yet, the difference becomes higher and ranges from 12.72 to 20.19 percentage points, when comparing linkages between two conventional assets and linkages between two Islamic assets. In addition, from the investigation of the extent of the difference in the above results between Islamic and non-Islamic countries, it can be seen that the difference in volatility linkages between non-Islamic assets and Islamic ones is greater in Islamic countries. This may be due to the existence of Islamic rules and regulations that are only addressed to Islamic countries (Akhtar *et al.*, 2016: 25). However, the authors argue that the weak effect in non-Islamic countries should be considered as a composition effect, since certain industries or firms that not conform to the Islamic law are excluded from Islamic stock indices in non-Islamic countries (Akhtar *et al.*, 2016: 25).

Most recently, Sclip, Dreassi, Miani and Paltrinieri (2016) investigated the dynamic correlations and volatility linkages between stocks and sukuk (i.e. Islamic bonds) using daily values of the 68 most liquid sukuk listed on Nasdaq Dubai, Bursa Malaysia and the London Stock Exchange, for the period 1 January 2010 to 31 December 2014. The data sample also included daily returns data of five global (i.e. Europe, U.S, Emerging markets, Frontier Markets and Asia Pacific) and five emerging MSCI indices (i.e. Turkey, Qatar, United Arab Emirates, Malaysia and Indonesia). Implementing their chosen methodology, the DCC model in three steps, the authors started by selecting the appropriate univariate volatilities using the Bayesian Information Criterion to compare the GARCH, EGARCH and GJR-GARCH. The correlation and persistence parameters were then estimated using the standardized residuals; and the asymmetric DCC model was implemented in an attempt to account for the asymmetric return volatility of equity time series. Sclip *et al.* (2016:9) found that there are higher correlations between sukuk and US and EU indices during times of high volatility. However, sukuk does not experience flight to quality phenomenon that occurs in the case of conventional bonds. In addition, the linkages in volatility between sukuk and regional indices are stronger during crisis periods.

Some studies analysing volatility regimes and spillovers between African stock markets can also be cited. One of them is the study by Mattes (2012) which aimed at investigating African stock market volatility during the period from 1 January 1997 to 22 October 2010. More specifically, the author seeks to find out the behaviour of the African markets volatility during five crisis periods between 1997 and 2010. The study ran a rolling bivariate diagonal BEKK-GARCH using daily closing index values for five African stock markets, namely Egypt, Kenya, Mauritius, Nigeria and South Africa, as well as four international equity markets, namely Brazil, Hong Kong, Russia and the U.S. These international markets were selected because they were considered the origin of the five crises considered. These are the Asian crisis of 1997, the Russian and Brazilian crises of 1998, the Bursting of the Dot Com Bubble in 2000-2002 and the Credit crisis of 2007-2009 (Mattes, 2012: 23).

The results from the empirical analysis showed that volatility persistence, although strong during both crisis and non-crisis periods, is more significant during non-crisis periods. This is true even in the case of the Credit crisis where volatility persistence was the highest. The same results were found for unconditional volatility, though the Credit crisis period showed higher unconditional volatility than during the non-crisis period. Thus, the crises, other than the Credit crisis, are found not to have a strong impact on volatility persistence and unconditional volatility (Mattes, 2012: 59).

Moreover, there are recurrently larger cross-volatility spillovers during non-crisis periods than during crisis periods, especially in the case of the cross-GARCH effect for almost all the markets. Although this occurs for cross-volatility innovation during crisis periods, cross-volatility innovation was found to be stronger than it is during non-crisis periods across all crises and for almost all of the markets. This shows a stronger short-run impact of the crises and a weak long-term impact, as there is a generally smaller impact of shocks to volatility in foreign equity markets on the five African markets during crisis periods than during non-crisis periods (Mattes, 2012: 59). Furthermore, the Credit crisis was found to have the strongest impact on African volatility. Additionally, home influences on volatility seem to be more important for African markets, even though they still have volatility linkages with emerging as well as developed stock markets (Mattes, 2012: 59).

Similarly, Lamba and Otchere (2001) investigate volatility linkages among seven African markets, namely Zimbabwe, South Africa, Namibia, Mauritius, Kenya, Ghana and Botswana; and nine developed stock markets, namely the US, UK, Netherlands, Japan, Germany, France, Canada, Belgium and Australia. The sample period covered is from January 1988 to May 2000, which coincides with the deregulation of the capital markets and the foundation of exchanges in most African countries. Using a VAR model, the authors found that the markets belonging to the SADC are the most integrated of all the African markets considered (Lamba and Otchere, 2001). That is, there exist significant linkages between Zimbabwe, South Africa and Namibia. Furthermore, the results from the investigation of the effect of the international stock markets on the volatility of African equity markets showed the strong influence of the US market on South Africa and Namibia, as it accounts for around 10 percent of their forecast error variance. The South African market is the only African market that is considerably affected by the UK markets as it accounts for around six percent of its forecast error variance (Lamba and Otchere, 2001).

In their analysis of volatility and volatility transmission across African markets, Kambadza and Chinzara (2012) set out to estimate and compare three different volatility models, which are the GARCH, EGARCH and GJR-GARCH model, in order to determine the most appropriate one for each market that will be used to estimate conditional volatility series. These series would then be analysed within a VAR framework to study the extent of volatility co-movement. Based on the results from the estimation using daily closing indices covering the period 31 January 2000 to 28 July 2010, for eight African equity markets, namely South Africa, Nigeria, Namibia, Morocco, Mauritius, Kenya and Ghana, the GJR-GARCH was found to be more stationary and had lower information criteria across all the markets. Thus, that model was chosen as the most suitable one for the remainder of the study (Kambadza and Chinzara, 2012: 20). After the volatility series were examined within a VAR framework, it was found that, similarly to returns co-movements, volatility interactions are limited between the African markets apart from the markets that are close trading partners and also large economies. Moreover, domestic innovations are more significant in explaining current volatility than foreign innovations. In most of the markets, volatility was found to be fundamentally persistent and asymmetric, although it was found to be explosive in Morocco and Nigeria. The evidence also suggests a significant increase in volatility in most markets during the 2008 financial crisis (Kambadza and Chinzara, 2012: 20).

For their analysis of volatility linkages among return structures of Sub-Saharan African stock markets indices, Piesse and Hearn (2005) constructed a comprehensive dataset that scrutinizes the entire Sub-Saharan African region. They identified ten national exchanges that collectively are the most dominant in the region. These countries are: Botswana, Ghana, Kenya, Malawi, Mauritius, Namibia, Nigeria, South Africa, Zambia, Zimbabwe. The data sample consisted of mostly weekly closing values of a comprehensive set of indices for all the markets under consideration, for the period January 1993 to January 2000. In order to capture a common feature of the studied countries that is the asymmetry in volatility such that bad news and good news have a different effect on future volatility, the study employed the EGARCH (Piesse and Hearn, 2005: 42). Piesse and Hearn (2005: 49) posited that volatility spillovers are more likely to occur between countries that have close links in terms of linked stock exchange trading systems, membership to a common currency area or trading relationships.

The results of the analysis confirmed this hypothesis as evidence of volatility spillovers was found from Botswana and Zimbabwe to South Africa. In effect, this was attributed to their trade and macroeconomic linkages, resulting from their integration within the SADC and their mutual focus on exporting to the European Union (Piesse and Hearn, 2005: 49). Although the South African market's dominance should be sufficient to prevent any volatility spillover from the smaller markets, it is probable that the strong localised trading interdependencies existing between the three markets constitutes the transmission channel for the bi-directional volatility links between them. Piesse and Hearn (2005: 49) also found the existence of regional patterns in volatility the West African markets (i.e. Ghana and Nigeria) and Kenya and the SADC countries. Finally, a bi-directional volatility relationship was found between Mauritius and Zimbabwe, while volatility in Mauritius was found to uni-directionally affect both the East African market and the Southern African markets, at the exception of South Africa (Piesse and Hearn, 2005: 50).

Lastly, a study conducted by Agyei-Ampomah (2011) focused on the nature and extent of linkages among African equity markets, and their relationships with other regional and global indices. The sample of countries consisted of four African countries from the IFC Global category, namely South Africa, Egypt, Nigeria and Morocco, and six countries classified as frontier economies (i.e. Botswana, Ghana, Ivory Coast, Kenya, Mauritius and Tunisia). By using monthly returns of the markets' all share indices for the period January 1998 - December 2007, the author attempted to address a number of microstructural biases existing in these markets such as stale pricing and nonsynchronous trading (Agyei-Ampomah, 2011: 5). The proxies for the global and regional benchmarks used in the study were the S&P Global 1200 Index and the S&P/IFCG Middle East and Africa Index, respectively. Following the Barari (2004) methodology, the study found persistently low levels of correlation between African stock markets, as well as between them and the global and regional markets. Moreover, no evidence of integration was found between the stock markets and the global stock market, except in the case of South Africa. Additionally, total volatility of the local indices was found to primarily country-specific as a considerably dominant proportion of the total volatility is attributed to the residual term, rather than to the global and regional indices. Finally, Time varying integration was uncovered in these markets, with a diminishing level of integration over time (Agyei-Ampomah, 2011: 12). Agyei-Ampomah (2011: 12) argued that integration of African markets even at a regional level seems to still be far from being achieved, despite the development of sub-regional blocs. In case there is any existing relationship between economies belonging to the same regional blocs, it does not appear in the way their stock markets behave (Agyei-Ampomah, 2011: 12).

2.3.4 Conclusion

In conclusion, many theories explain the existence of co-movement in stock prices as well as volatility spillovers among international markets. However, most researchers agreed on the fact that price co-movement and volatility linkages among stock markets mainly occur as a result of information spillover or contagion. Empirically, although many studies, for example those of Lamba and Otchere (2001); Kambadza and Chinzara (2012) and Mattes (2012)) have examined interdependence and volatility spillovers among African markets, very few have been found, which examined the West African Stock Exchange (BRVM) in conjunction with other African stock markets.

As can be seen from the variety of models used in the literature of return co-movements, there is no consensus on the best analytical framework to investigate this phenomenon. Hence, cointegration analysis, an effective tool in the estimation of long-run models from actual time-series data, is selected to conduct this study, for its ability to prevent spurious results in the presence of non-stationarity, which is a common characteristic of financial time series data. Among the various cointegration tests that have been developed, the Johansen cointegration test will be used, as its system-based approach gives it a theoretical advantage and superiority over the single equation-based procedures such as the Engle-Granger and Philips-Ouliaris cointegration methods.

In addition, almost all of the existing studies have used multivariate models from the GARCH family to test volatility linkages; the GJR-GARCH was identified as the most suited in the case of African stock markets by Kambadza and Chinzara (2012). However, one weakness commonly identified in the literature is the limitation of volatility modelling to the use of only one or a few GARCH models, namely the GARCH, EGARCH and GJR-GARCH. Therefore, this study intends to correct this flaw by testing, in conjunction with the three mentioned models, other existing multivariate GARCH models to improve robustness.

In the following section, the methodology framework as well as the data used in this study will be described.

2.4 METHODOLOGY

2.4.1 Introduction

A number of tools have been historically used in order to investigate price movement correlation among stock markets. Drawing on Canto (2004), Bonfiglioli and Favero (2005) and Gupta and Guidi (2012), the technique that will be used to analyse the interdependence among the selected Sub-Saharan African and developed stock markets is the Johansen cointegration test. To test the time-varying conditional correlation among the selected markets, the DCC-GARCH will be used as suggested by Gupta and Guidi (2012). Finally, to investigate the existence of volatility linkages among the selected markets, a series of multivariate GARCH models will be tested to identify the most appropriate on which to model volatility in the markets considered. The conditional variance series generated by the appropriate model will be used to run Granger causality, impulse response functions as well as variance decompositions.

The choice of modeling is informed by the public information hypothesis. In effect, the study will examine the hypothesis that there is co-movement in prices and volatility linkages between the stock markets, which can be attributed to the flow of public information and is measured by the news on macroeconomic fundamentals. The study follows a microstructure approach as it will focus on the short-term effects drawing on microstructure information which can be found in high frequency data sets.

2.4.2 Analytical Framework

Johansen Cointegration test

The Johansen cointegration test is a procedure that, rather than relying on OLS estimation, uses maximum likelihood estimation to build cointegrated variables (Ssekuma, 2011: 12). In effect, the OLS regression approach can be used to test for cointegration using the residuals of a model (cf. Engle-Granger cointegration method; and Philips – Ouliaris cointegration method).

That method is, however, capable of detecting at most one cointegrating relationship, regardless of the number of variables included in the system. This presents a limitation since there may be for more than two variables in a system, and thus there may be more than one cointegrating relationship. For instance, in the situation where a system includes k variables (not including any constant terms), there may exist up to$r$ linearly independent cointegrating relationships, with $r \leq k - 1$. In this case, using an OLS regression will lead to only the minimum variance stationary linear combination of the variables being found. Yet, additional linear combinations of the variables may exist with more inherent appeal. The Johansen procedure is therefore an attempt to correct this limitation, by using a system approach to cointegration, which permits all r cointegrating relationships to be determined. The procedure leans heavily on the relationship between the rank of a matrix and its characteristic roots. The maximum likelihood estimation is derived using a series of tests aimed at determining the number of cointegrating vectors.

This approach starts by finding out whether all the variables are of the same order of non-stationarity. This implies that a unit root test is run. Although a number of tests, such as the Dickey Fuller (DF) test, Augmented Dickey Fuller test and Philips-Perron (PP) test, are available for testing the presence or otherwise of a unit root, the preference is for the ADF test, for its superiority when it comes to time series with autoregressive structure, as well as its reliability for ensuring white noise residuals (Ali *et al.*, 2011).

The Johansen procedure takes its point of departure in the Vector Autoregressive (VAR) of order p, which can be written as:

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + ... + \beta_p y_{t-p} + u_t \tag{2.3}$$

where y_t is an $n \times 1$ vector of variables integrated of order 1 (i.e $I(1)$); u_t is an $n \times 1$ vector of innovations; and β_1 through β_p are $n \times n$ coefficient matrices.

Equation 2.3 is then reparameterized, by substracting y_{t-1} on both side of the equation, turning it into a vector error correction model (VECM) of the form:

$$\Delta y_t = \Pi y_{t-p} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + ... + \Gamma_{p-1} \Delta y_{t-(p+1)} + u_t \tag{2.4}$$

where $\Pi = (\sum_{i=1}^{p} \beta_i) - I$ and $\Gamma_i = (\sum_{j=1}^{i} \beta_j) - I$.

The rank of the Π matrix is the centre of the Johansen cointegration test. If Π is of rank zero, which means that all the eigenvalues are not significantly different from zero, it is concluded that there is no cointegration. However, if the rank of the Π is greater than zero, there is cointegration and the number of distinct cointegrating vectors is given by the row rank of Π (Johansen, 1988). The order of the matrix Π is $m \times m$. However, Π cannot be of m (i.e. full rank) since that would only mean that the original y_t is$I(0)$. Hence, Π which is of rank $r <m$, may be written as:

$$\Pi = \alpha\beta'$$

for the correct $m \times r$ matrices β' and α, with

$$\alpha = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ . \\ . \\ . \\ \alpha_r \end{bmatrix}$$

$$\beta' = \begin{bmatrix} \beta'_1 & \beta'_2 & . & . & . & \beta'_r \end{bmatrix}$$

The matrix β' provides the cointegrating vectors, and the matrix α provides the number of each cointegrating vector entering each equation of the VECM, referred to as the adjustment parameters. Hence, subject to $\Pi = \alpha\beta'$ for various values of r, the VAR is estimated by the Johansen's procedure using the maximum likelihood estimator which assumes $u_t \sim iidN(0, \Sigma)$.

The two likelihood ratio tests used by Johansen to detect the number of cointegrating vectors are the trace test (λ_{trace}) and the maximum eigenvalue (λ_{max}) test with the formulas:

$$\lambda_{trace} = -T \sum_{j=r+1}^{n} ln(1 - \widehat{\lambda}_j) \tag{2.5}$$

and

$$\lambda_{max} = -Tln(1 - \widehat{\lambda}_{r+1}) \tag{2.6}$$

where T is the sample size, and $\widehat{\lambda}_j$ and $\widehat{\lambda}_{r+1}$ are the estimated values of the characteristics roots obtained from the matrix.

In the case of the trace test, the null hypothesis is that there are r cointegrating vectors and the alternative hypothesis is that there are n cointegrating vectors. However, for the maximum eigenvalue test, the null is that there exist r cointegrating vectors while the alternative hypothesis is that there are *r+1* cointegrating vectors (Gupta and Guidi, 2012). The test statistics in both cases possess a non-standard distribution. Simulation is employed to find the critical values and they are provided in Johansen and Juselius (1990).

Note that, since the lag length used in the VECM can impact the Johansen test, it is important to optimally determine the lag length.

Multivariate GARCH models

The multivariate GARCH models stemmed from the evolution of Autoregressive Conditional Heteroskedasticity (ARCH) models initially developed by Engle (1982), in an attempt to investigate volatility in economic and financial time series. The GARCH which is a generalized version of Engle's (1982) model was later developed by Bollerslev (1986) and Taylor (1986), independently. This was done by modeling the conditional variance as an autoregressive moving average (ARMA) process. A GARCH (p,q) can be written as:

$$\varepsilon_t = \nu_t \sqrt{h_t} \tag{2.7}$$

where $\sigma_\nu^2 = 1$ and $h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i}$.

A simple example would be a GARCH (1,1) where,

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}. \tag{2.8}$$

In this case, h_t which is the current fitted variance is represented as a function of a long-run average value (lying on α_0), the information about volatility only one period ahead ($\alpha_1 \varepsilon_{t-1}^2$), and the fitted variance from the model one period ahead, also called the volatility persistence ($\beta_1 h_{t-1}$).

Because the univariate GARCH only catered for the analysis of individual time series, the multivariate GARCH models were developed to allow the simultaneous analysis of multiple time series. These models are defined as:

$$r_t = \mu_t + a_t \tag{2.9}$$

and

$$a_t = H_t^{1/2} z_t \tag{2.10}$$

where r_t is a $n \times 1$ vector of log returns of n assets at times t;a_t is a $n \times 1$ vector of mean-corrected returns of n assets at times t such that $E[a_t] = 0$ and $Cov[a_t] = H_t$; μ_t is a $n \times 1$ vector of the expected value of the conditional r_t; H_t is a $n \times n$ matrix of conditional variances of a_t at times t; and z_t is a $n \times 1$ vector of iid errors such that $E[z_t] = 0$ and $E[z_t z_t^T] = I$.

Note that, $H_t^{1/2}$ may be found by doing a Cholesky factorization of H_t and μ_t may be modeled either as a constant vector, or as a time series model. The only remaining specification is the one for H_t which is different for the various specifications of MGARCH.

Dynamic Conditional Correlation GARCH (DCC-GARCH)

The DCC-GARCH is a multivariate model in nature, developed by Engle (2002). It is a generalization of Bollerslev's (1990) CCC model which assumes constant correlation processes in financial asset returns. In effect, for the models of conditional variances and correlations, the conditional covariance matrix is divided into two components that are the conditional standard deviations and correlation matrix. It is written as:

$$H_t = D_t R_t D_t \tag{2.11}$$

where, $D_t = diag(h_{1t}^{1/2}, ..., h_{nt}^{1/2})$ is the conditional standard deviation, and R_t is the correlation matrix.

However, since the CCC-GARCH assumes that the correlation matrix is time invariant,H_t becomes:

$$H_t = D_t R D_t \tag{2.12}$$

Although the estimation of such a model looks computationally attractive due to constant correlation matrix, it may become too restrictive in certain cases, especially in the case of financial assets returns. Therefore, the DCC model enables correlations to vary over time, by isolating the dynamic correlation process through the use of a robust two-step procedure. The first step focuses on the conditional heteroskedasticity. In this case, the conditional covariance matrix is the same as presented in Equation 2.12. The elements of the diagonal matrix are represented by standard deviations (i.e. conditional volatilities) from univariate GARCH models such that:

$$D_t = \begin{bmatrix} h_{1t}^{1/2} & 0 & \dots & 0 \\ 0 & h_{2t}^{1/2} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & h_{nt}^{1/2} \end{bmatrix}$$

where, $h_{it} = \alpha_{i0} + \sum_{q=1}^{Q_i} \alpha_{iq} a_{i,t-q}^2 + \sum_{p=1}^{P_i} \beta_{ip} h_{i,t-p}$

The standardized disturbances are then given by:

$$\epsilon_t = D_t^{-1} a_t \sim N(0, R_t) \tag{2.13}$$

Note that these residuals have a unit conditional volatility. Since R_t is a correlation matrix, it is symmetric and it is then defined by:

$$\overline{R} = \frac{1}{T} \sum_{t=1}^{T} \epsilon_t \epsilon_t' \tag{2.14}$$

This is the constant conditional correlation estimator. The second step of the DCC-GARCH, then consists in generalizing the CCC estimator to capture dynamics in correlation. The DCC correlation structure, given by a $n \times n$ symmetric positive definite matrix, is written as:

$$Q_t = \overline{R} + \alpha(\epsilon_{t-1}\epsilon_{t-1}' - \overline{R}) + \beta(Q_{t-1} - \overline{R}) \tag{2.15}$$

where $Q_t^{i,j}$ is the correlation between r_t^i and r_t^j at time t. The maximum likelihood method is used in this second step to estimate the non-negative scalar parameters α and β simultaneously. It is assumed that the standardized disturbances are jointly Gaussian.

Correlation clustering, which is a stylized fact in financial time series, is effectively captured by the DCC-GARCH. That is, if correlation was high at time $t-1$, it is very likely to also be high at time t. In the case where $\alpha + \beta < 1$, there is a mean reverting correlation, which fluctuates around the unconditional correlation $\overline{R}$. The restriction that is usually put on the parameters α and β is that they have to be positive and different from zero.It is thus possible to have $\alpha + \beta = 1$, in which case the conditional correlation is an integrated process.

GARCH-in-Mean (GARCH-M)

This is a variation of the GARCH which includes the conditional variance or the standard deviation in the mean equation in order to test their impact on the mean of future returns. It is thus written as:

$$r_t = \mu_t + a_t + \lambda h_t \tag{2.16}$$

or in the case of the conditional standard deviation:

$$r_t = \mu_t + a_t + \lambda h_t^{1/2} \tag{2.17}$$

In the case where $\lambda \neq 0$, the model would imply that there is serial correlation in returns, as they depend on the variance which is serially correlated.

Integrated GARCH (IGARCH)

Originally developed by Engle and Bollerslev (1986), this model is characterized by a conditional variance equation of the form:

$$h_t = \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \tag{2.18}$$

such that

$$\sum_{i=1}^{p} \alpha_i + \sum_{j=1}^{q} \beta_j = 1 \tag{2.19}$$

In this model, the constant term is dropped and the parameters of the GARCH model are restricted to sum to one.

Glosten-Jagannathan-Runkle GARCH (GJR-GARCH)

Developed by Glosten, Jagannathan and Runkle (1993), the GJR GARCH is a simple extension of the GARCH model to which an additional term is added to factor in possible asymmetries. It is formulated as follows:

$$r_t = \mu_i + \sum_{i=1}^{k} a_i r_{t-i} + \varepsilon_t \quad , \varepsilon_t / I_{t-i} \sim N(0, h_t) \tag{2.20}$$

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{k=1}^{r} \gamma_k \varepsilon_{t-k}^2 I_{t-k} + \sum_{i=1}^{q} \beta_i h_{t-i} \tag{2.21}$$

where, $I_{t-1} = 1$ if $\varepsilon_{t-i} < 0$, and $I_{t-1} = 0$, if otherwise.

Equation 2.20 is a mean equation. Its current innovation, ε_t, which relies on a past information set I_{t-i}, is serially correlated, with a zero mean and a variance h_t.

Equation 2.21 represents the variance equation for a Threshold GARCH (p,r,q).Its conditional variance is represented by h_t.The coefficient of lagged squared residuals from the mean equation (i.e.ε_{t-i}^2) is given by the parameter α_i, while the parameter β_i is the coefficient of the lagged conditional variance, and ω is a constant. It is crucial that $\alpha_i + \beta_i < 1$, in order to guarantee the stationarity of the equation.

The asymmetry component of the equation is provided by I_{t-i}. If its coefficient γ_k is found to be positive and statistically significant, it can be inferred that there exists asymmetry in volatility in the data. The approach suspects that positive information (i.e. $\varepsilon_{t-i} \geq 0$) and negative information (i.e. $\varepsilon_{t-i} < 0$) have different impacts on volatility. Thus, the impact of positive information is measured by α_i, while $\alpha_i + \gamma_k$ measures the response to negative information. In the case where γ_k is positive and statistically significant, it can be inferred that negative information has a greater effect on volatility than positive information.

It is assumed that the residuals are conditionally normal, and a log-likelihood function is maximized in order to estimate the univariate GARCH models. The function is written as:

$$l = -\frac{T}{2} log(2\pi) - \frac{1}{2} \sum_{t=1}^{T} log(\sigma_t^2) - \frac{1}{2} \sum_{t=1}^{T} (r_t - \mu - \phi r_{t-1})^2 / \sigma_t^2 \tag{2.22}$$

where T is the number of observations.

Although the setting of the initial parameters is necessary in the maximum likelihood method, in the case of the software employed for this study (i.e. Eviews), the initial parameters are provided by the software for the ARCH procedures using the OLS regression for the mean equation. Alterations could be made manually at a later stage if there is no convergence or in case the parameter estimates are unrealistic.

Exponential GARCH (EGARCH)

This model was developed by Nelson (1991) in order to capture the asymmetry effect. In this model, the conditional variance is taken into its natural logarithm form and can vary over time as a function of the lagged error terms, instead of the lagged squared error terms. Hence, the specification for the conditional variance of the EGARCH(p,q) model can be written as follows:

$$ln(h_t) = \omega + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{t-i}}{h_{t-i}^{1/2}} \right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{h_{t-k}^{1/2}} + \sum_{i=1}^{q} \beta_i ln(h_{t-i}) \qquad (2.23)$$

The use of the log of the conditional variance implies the exponential property of the leverage effect, instead of quadratic like in the GJR-GARCH. To ascertain the presence of leverage effects, the hypothesis that $\gamma_i < 0$ can be tested. If γ_i is found to be statistically different from 0, then the impact is said to be asymmetric.

Asymmetric Power ARCH (APARCH)

This is another useful development of the GARCH model, in which instead of imposing the asymmetric specifications based on conventional measures of model fit or assessment of parameter significance, these specifications are nested in the model and determined by the data. Generalized by Ding, Granger and Engle (1993), the model stemmed from Taylor (1986) and Schwert (1989) the standard deviation GARCH model in which the standard deviation is modeled instead of the variance. Moreover, the parameters γ are included in the model to capture asymmetry of up to order r. The conditional variance equation in the APARCH model is of the form:

$$h_t^{\delta/2} = \omega + \sum_{i=1}^{p} \alpha_i(|\varepsilon_{t-i}| - \gamma_i \varepsilon_{t-i})^{\delta} + \sum_{j=1}^{q} \beta_j h_{t-j}^{\delta/2} \tag{2.24}$$

where $\delta > 0$ and $|\gamma_i| \leq 1$ for i=1,...,r,$\gamma_i = 0$ for all $i > r$, and $r \leq p$.

Thus, for all i, if $\delta = 2$, $\gamma_i = 0$ and $\beta_j = 0$, the APARCH model is simply a standard ARCH model. Also, if $\delta = 2$, $\gamma_i = 0$, the model is just a conventional GARCH model. Similar to the models described previously, the presence of asymmetry is determined by γ being statistically different from zero.

Component GARCH (CGARCH)

In the GARCH (1,1) model, the conditional variance exhibit mean reversion to the parameter $\bar{\omega}$, which remains constant. This is written as:

$$h_t = \bar{\omega} + \alpha(\varepsilon_{t-1}^2 - \bar{\omega}) + \beta(h_{t-1} - \bar{\omega}) \tag{2.25}$$

However, in the CGARCH, the mean reversion is allowed to vary to a level m_t. Hence, the model is written as:

$$h_t - m_t = \alpha(\varepsilon_{t-1}^2 - m_{t-1}) + \beta(h_{t-1} - mt - 1) \tag{2.26}$$

and

$$m_t = \omega + \rho(m_{t-1} - \omega) + \phi(\varepsilon_{t-1}^2 - h_{t-1}). \tag{2.27}$$

In this case, h_t still represents volatility, while ω is replaced by m_t which is the time varying long-run volatility.

Equation 2.26 shows the transitory component $(h_t - m_t)$ converging to zero with powers of $(\alpha + \beta)$, while equation 2.27 presents the long run component m_t converging to ω with powers of ρ. Generally, ρ belongs to the interval (0.99; 1), making m_t approach ω very slowly. Equation 2.26 and 2.27 may be combined to form:

$$h_t = (1-\alpha-\beta)(1-\rho)\omega+(\alpha+\phi)\varepsilon_{t-1}^2-(\alpha\rho+(\alpha+\beta)\phi)\varepsilon_{t-2}^2+(\beta-\phi)h_{t-1}-(\beta\rho-(\alpha+\beta)\phi)h_{t-2} \quad (2.28)$$

This equation reveals that the CGARCH model is simply a nonlinear restricted GARCH (2,2) model.

An asymmetric version of the model can also be estimated by including asymmetric effects in the transitory equation. In that case, the estimated models are of the form:

$$\begin{aligned} y_t &= x'\pi + \varepsilon_t \\ m_t &= \omega + \rho(mt - 1 - \omega) + \phi(\varepsilon_{t-1}^2 - h_{t-1}) + \Theta_1 z_{1t} \\ h_t - m_t &= \alpha(\varepsilon_{t-1}^2 - m_{t-1}) + \gamma(\varepsilon 2_{t-1} - m_{t-1})d_{t-1} + \beta(h_{t-1} - m_{t-1}) + \Theta_2 z_{2t} \end{aligned} \quad (2.29)$$

where z are the endogenous variables; d is the dummy variable indicating negative shocks; and $\gamma > 0$ shows the presence of leverage effects in the conditional variance.

2.4.3 Model Specification

The variables included in the model are daily stock returns of the Nigeria Stock Exchange all share index (NGSE), the Nairobi Stock Exchange all share index (NSE), the Bourse Regionale des Valeurs Mobiliere composite index (BRVM), the Johannesburg Stock Exchange all share index (JSE), the New York Stock Exchange composite index (NYSE) and the London Stock Exchange FTSE all share index (FTSE).

When examining return co-movements between the six selected markets using the Johansen cointegration framework, the VECM estimated can be written as a system of six equations or in a compact form when expressed as a matrix. Since there is no constant included in the cointegrating space, there are at most five cointegrating vectors and loading matrices as follows:

$$\begin{bmatrix} \Delta NGSE_t \\ \Delta NSE_t \\ \Delta BRVM_t \\ \Delta JSE_t \\ \Delta NYSE_t \\ \Delta FTSE_t \end{bmatrix} = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} & \gamma_{15} & \gamma_{16} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} & \gamma_{24} & \gamma_{25} & \gamma_{26} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} & \gamma_{34} & \gamma_{35} & \gamma_{36} \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & \gamma_{44} & \gamma_{45} & \gamma_{46} \\ \gamma_{51} & \gamma_{52} & \gamma_{53} & \gamma_{54} & \gamma_{55} & \gamma_{56} \\ \gamma_{61} & \gamma_{62} & \gamma_{63} & \gamma_{64} & \gamma_{65} & \gamma_{66} \end{bmatrix} \begin{bmatrix} \Delta NGSE_{t-1} \\ \Delta NSE_{t-1} \\ \Delta BRVM_{t-1} \\ \Delta JSE_{t-1} \\ \Delta NYSE_{t-1} \\ \Delta FTSE_{t-1} \end{bmatrix}$$
$$+ \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{15} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} & \alpha_{25} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} & \alpha_{35} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} & \alpha_{45} \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & \alpha_{55} \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} & \beta_{51} & \beta_{61} \\ \beta_{12} & \beta_{22} & \beta_{32} & \beta_{42} & \beta_{52} & \beta_{62} \\ \beta_{13} & \beta_{23} & \beta_{33} & \beta_{43} & \beta_{53} & \beta_{63} \\ \beta_{14} & \beta_{24} & \beta_{34} & \beta_{44} & \beta_{54} & \beta_{64} \\ \beta_{15} & \beta_{25} & \beta_{35} & \beta_{45} & \beta_{55} & \beta_{65} \end{bmatrix} \begin{bmatrix} NGSE_{t-1} \\ NSE_{t-1} \\ BRVM_{t-1} \\ JSE_{t-1} \\ NYSE_{t-1} \\ FTSE_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \\ u_{4t} \\ u_{5t} \\ u_{6t} \end{bmatrix} \quad (2.30)$$

This test ignores the first component which is the matrix of short-run coefficients as well as the disturbance term, and focus on finding the rank of the Π matrix, that is the matrix of β coefficients.

When analysing the time varying dynamic correlation between the six markets, the first step of the DCC model framework involves fitting the most appropriate univariate GARCH specifications to each series. The models for each market can be written in terms of the general representation of the univariate GARCH model with the following equations:

$$\begin{aligned} NGSE_t &= \alpha_0 + \alpha_1 NGSE_{t-1} + \varepsilon_{1t} \\ \varepsilon_{1t} &= \nu_{1t}\sqrt{h_{1t}}, \quad \nu_{1t} \sim N(0,1) \end{aligned} \quad (2.31)$$

$$\begin{aligned} NSE_t &= \alpha_0 + \alpha_1 NSE_{t-1} + \varepsilon_{2t} \\ \varepsilon_{2t} &= \nu_{2t}\sqrt{h_{2t}}, \quad \nu_{2t} \sim N(0,1) \end{aligned} \quad (2.32)$$

$$\begin{aligned} BRVM_t &= \alpha_0 + \alpha_1 BRVM_{t-1} + \varepsilon_{3t} \\ \varepsilon_{3t} &= \nu_{3t}\sqrt{h_{3t}}, \quad \nu_{3t} \sim N(0,1) \end{aligned} \tag{2.33}$$

$$\begin{aligned} JSE_t &= \alpha_0 + \alpha_1 JSE_{t-1} + \varepsilon_{4t} \\ \varepsilon_{4t} &= \nu_{4t}\sqrt{h_{4t}}, \quad \nu_{4t} \sim N(0,1) \end{aligned} \tag{2.34}$$

$$\begin{aligned} NYSE_t &= \alpha_0 + \alpha_1 NYSE_{t-1} + \varepsilon_{5t} \\ \varepsilon_{5t} &= \nu_{5t}\sqrt{h_{2t}}, \quad \nu_{5t} \sim N(0,1) \end{aligned} \tag{2.35}$$

$$\begin{aligned} FTSE_t &= \alpha_0 + \alpha_1 FTSE_{t-1} + \varepsilon_{6t} \\ \varepsilon_{6t} &= \nu_{6t}\sqrt{h_{6t}}, \quad \nu_{6t} \sim N(0,1) \end{aligned} \tag{2.36}$$

2.4.4 Data and descriptive statistics

The data sample consists of daily closing stock index prices of the Nigeria Stock Exchange (NGSE-ASI), the Nairobi Securities Exchange (NSE-ASI), the Johannesburg Stock Exchange (JSE-ASI), the Bourse Regionale des Valeurs Mobilieres (BRVM-C), the New York Stock Exchange (NYSE-C) and the London Stock Exchange (FTSE-ASI), for the sample period 2 January 2009 – 30 December 2016. The values for the Nigeria All Share index, the BRVM Composite and the Nairobi All Share index were obtained from the Investing.com website. The values for the JSE All Share index and the FTSE All share index were obtained from the JSE and the LSE websites respectively, while the NYSE Composite index values where obtained from Yahoo Finance.

A relevant issue arising in the data when examining stock markets from different countries is the missing observations that result from the differences in the holidays observed by the countries. Thus, to overcome this issue, the method of Occam's razor was used (Ali *et al.*, 2011). This method implies filling in the missing dates with the previous day value, the logic being that since there is no information generated on bank holidays, the following days carry the information from the previous day, implying no change in the price. However, observations were dropped in cases when the holidays occurred in at least four out of the six countries considered in the study.

All the time series are expressed in logarithmic form and the daily closing prices are used to compute the daily return for each index. The equation is as follows:

$$R_d^I = 100 \times ln\frac{I_d}{I_{d-1}} \tag{2.37}$$

where R_d^I is the continuously compounded rate of change in the price of index I on day d and I_d is the closing price of index I on day d.

Table 2.1 below, summarizes the descriptive statistics of log daily stock prices at level on the indices considered. The table shows statistics such as the mean, standard deviation, kurtosis, skewness, Jarque-bera and the number of observations for all of the six data sets under consideration. The standard deviation values show that of all the six indices under consideration, the

Table 2.1: Descriptive statistics of daily returns, 2 January 2009 – 30 December 2016

Statistics	NGSE	NSE	JSE	BRVM	NYSE	FTSE
Mean	- 0.008	0.029	0.041	0.025	0.031	0.025
Minimum	-4.353	-33.724	-3.695	-6.913	-7.312	-5.174
Maximum	7.985	32.007	5.601	8.242	7.065	5.026
Standard Deviation	1.049	1.377	1.061	0.801	1.167	1.039
Kurtosis	6.98	344.89	4.547	14.938	7.784	5.488
Skewness	0.239	-1.005	-0.056	0.227	-0.338	-0.202
Jarque-Bera	1365.26	9926659	204.44	12118.89	1982.58	538.65
Probability	0.000	0.000	0.000	0.000	0.000	0.000
Observations	2038	2038	2038	2038	2038	2038

Source: Author's estimations

Note: NGSE is the Nigerian Stock Exchange All Share index; NSE is the Nairobi Stock Exchange All Share index; JSE is the JSE all Share index; BRVM is the BRVM Composite index; NYSE is the NYSE Composite index; FTSE is the FTSE All share index.

NSE appears to be more volatile than the others with a standard deviation of 1.377. However, this index also records the second highest mean of daily return, after the JSE, for the sample period covered.

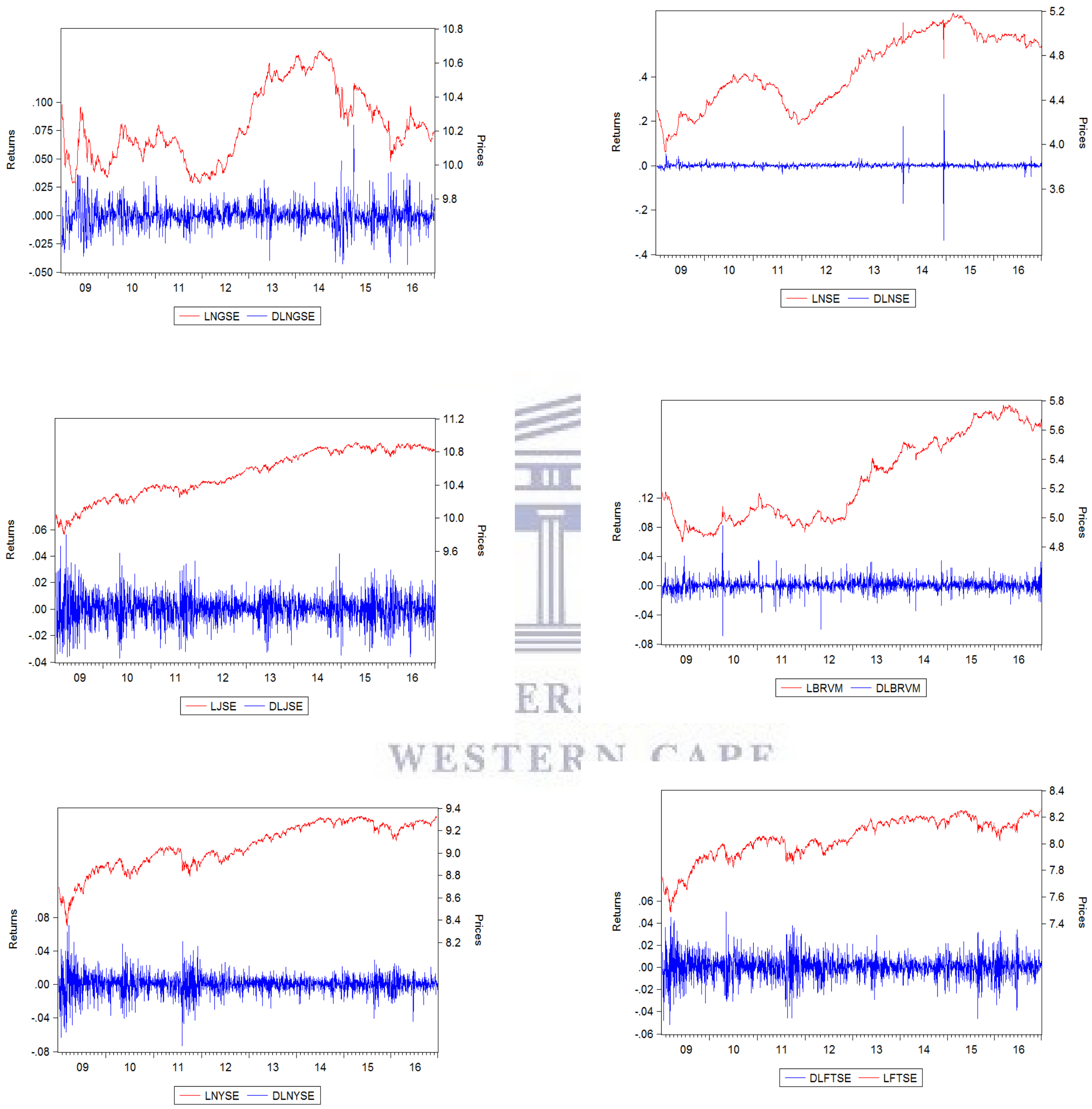
The distribution of daily returns is seen to be negatively skewed for the NSE, JSE, NYSE and FTSE, although the skewness in the NSE daily returns is more pronounced than it is for the other three indices. This means that for these indices, there are more negative than positive returns observations. The reverse is true for the remaining two indices.

For all indices, the kurtosis is above three (the expected value for a normal distribution), meaning that the daily return distributions are leptokurtic. In other words, the daily returns have higher peaks and fatter tails (i.e. a higher probability of extreme values), relative to normal distributions. This shows the non-normality of the daily returns in the six indices. This is especially true for the NSE-ASI which has the highest kurtosis value (344.89), showing the highest probability of extreme values. The Jarque-Bera test shows that none of the returns of the stock markets are normally distributed for the sample period covered in this study.

Figure 2.3 represents a plot of both the index values and the returns for all six markets considered. While the JSE, NYSE and FTSE indices showed a common upward trend between 2009 and 2016, the BRVM and the NGSE indices observed a fall between 2009 and 2013. The period from the end of 2014 up to 2016 was characterized by a fall in the NGSE and the NSE indices. The developing markets, as well as the developed markets all show evidence of volatility clustering. In effect, low returns are followed by low returns, while high returns are followed by even higher returns. However, among all six indices, the NSE index shows the lowest level of volatility, even in 2009 and 2010 where volatility is highest in almost all of the other markets as a result of a loss of confidence created by the 2008-2009 financial crisis.

The next section will present the empirical analysis conducted and the interpretation of the findings will be given.

Figure 2.3: Daily prices and returns of stock indices (2 January 2009 - 30 December 2016)



Source: Author's estimations

2.5 EMPIRICAL ANALYSIS AND FINDINGS

2.5.1 Stock price co-movements

Since it is standard practice to pretest all variables included in the model to assess their order of integration (Engle and Granger, 1991), the ADF and the PP tests for unit roots are run using Eviews. The results are presented in Table 2.2.

Table 2.2: Results of the unit root tests

Variables in log level				
	Augmented Dickey-Fuller (ADF)		Philips-Perron (PP)	
	Test statistics	p-value*	Test statistic	p-value*
NGSE	-1.665	0.449	- 1.655	0.454
NSE	- 1.035	0.742	- 1.115	0.712
JSE	- 1.594	0.485	-1.600	0.4823
BRVM	0.180	0.971	0.055	0.962
NYSE	- 1.583	0.491	- 1.558	0.504
FTSE	- 1.797	0.382	- 1.727	0.417
Variables in first log difference				
	Test statistics	p-value*	Test statistic	p-value*
NGSE	- 25.591	0.000	- 27.688	0.000
NSE	- 39.648	0.000	- 43.899	0.000
JSE	- 44.621	0.000	-45.062	0.000
BRVM	- 46.798	0.000	-46.994	0.000
NYSE	- 48.513	0.000	- 48.647	0.000
FTSE	- 43.762	0.000	- 43.835	0.000

Source: Author's estimations
Note: The critical value for both the ADF and PP are -3.430, -2.860 and -2.570 at 1%, 5% and 10% level of significance, respectively.
* MacKinnon (1996) one sided p-values

Table 2.2 contains the z test statistics as well as the MacKinnon (1996) one-sided p-values collected from the ADF and PP unit root tests on all six time series in log level and in first log difference. When the variables are tested in their log level form, the p-value is greater than 0.05, implying that the null hypothesis of a unit root cannot be rejected for all indices. This is the case when running both the ADF and the PP tests. However, when both tests are run on the variables in first log difference form, the p-value for each index is smaller than 0.05. The null hypothesis is therefore rejected at the five percent level of significance and it is concluded that there is no unit root in all six time series in their first log differences (i.e. stock returns).

Even though the Johansen procedure is usually employed in settings where all variables in the system are non-stationary, it is theoretically not an issue to have *I(0)* variables in the system. In fact, Johansen (1995) asserts that it is not necessary to pre-test the variables in the system to establish their order of integration. However, in a case where a single variable is *I(0)* instead of *I(1)*, a cointegrating vector will be found in the system which is only the result of the stationary variable i the model. As explained in the methodology, if all n variables in the system are *I(0)*, then the matrix Π will have a full rank. It is therefore imperative to keep in mind that the presence of stationary variables in the system introduces restricted cointegrated vectors, and the results of the analysis must be interpreted with caution.

Johansen cointegration test

The Johansen's procedure requires the estimation of a VAR (p). In order to determine the optimal lag length p of the VAR, we run the tests using some of the information criteria procedures and the results of the test using daily return series of the six stock indices are summarized in the table below.

As reported in the table, the AIC and the FPE select three lags as optimal while the SIC and HQ select two lags as optimal. The autocorrelation LM test is conducted on the VAR (2) and VAR (3) in order to check for serial correlation in the residuals. The null hypothesis of no serial correlation is rejected at the five percent level of significance in both cases. The appropriate lag length chosen will then be the one that expunges serial correlation in the residuals. That is the 7^{th} lag order. Therefore, a VAR of order seven will be estimated with all six return series.

The same lag selection procedure is applied to the bivariate VAR with every pair of stock indices and the results are summarized in Table 2.4 below.

After estimating the VAR models with the optimal number of lags, the Johansen cointegration

Table 2.3: Optimal lag order selection

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-16505.94	NA	0.654	16.603	16.620	16.609
1	-16072.47	863.891	0.439	16.204	16.322	16.247
2	-15922.87	297.228	0.391	16.089	**16.309***	**16.170***
3	-15877.24	90.406	**0.388***	**16.080***	16.400	16.197
4	-15844.23	65.189	0.389	16.083	16.505	16.238
5	-15809.29	68.781	0.389	16.084	16.607	16.276
6	-15775.95	65.438	0.390	16.086	16.711	16.316
7	-15753.44	44.055	0.396	16.100	16.826	16.367
8	-15734.71	36.528	0.403	16.117	16.944	16.421
9	-15716.52	35.374	0.410	16.135	17.064	16.476
10	-15688.35	**54.625***	0.413	16.143	17.173	16.521
11	-15670.83	33.858	0.421	16.162	17.293	16.577
12	-15646.85	46.201	0.426	16.174	17.406	16.626
13	-15620.53	50.547	0.430	16.183	17.517	16.673

* indicates lag order selected by the criterion;
Note - LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwartz information criterion; HQ: Hannan-Quinn information criterion.
Source: Author's estimations

Table 2.4: Optimal lag order selected for bivariate VAR in co-movement analysis

Pair of Stock indices	Chosen lag length
NGSE and NSE	2
NGSE and JSE	4
NGSE and BRVM	7
NGSE and NYSE	7
NGSE and FTSE	6
NSE and JSE	2
NSE and BRVM	5
NSE and NYSE	6
NSE and FTSE	2
BRVM and JSE	5
BRVM and NYSE	5
BRVM and FTSE	5
JSE and NYSE	7
JSE and FTSE	5
NYSE and FTSE	5

Source: Author's estimations

test is run on the variables as a group, as well as in pairs. Note that the models are assumed to have an intercept but no trend. The results of the Johansen procedure on the variables as a group are presented in the table below.

Table 2.5: Johansen cointegration results for all variables as a group

	λ_{trace}	**0.05 Critical value**	**p-value***	λ_{max}	**0.05 Critical value**	**p-value***
$r = 0$	1625.035	95.754	1.000	353.022	40.078	0.000
$r \leq 1$	1272.013	69.819	1.000	345.658	33.877	0.000
$r \leq 2$	926.354	47.856	0.000	276.270	27.584	0.000
$r \leq 3$	650.084	29.797	0.000	253.828	21.132	0.000
$r \leq 4$	396.256	15.495	0.000	204.508	14.265	0.000
$r \leq 5$	191.749	3.841	0.000	191.749	3.841	0.000

Source: Author's estimations
*MacKinnon-Haug-Michelis (1999) p-values

The empirical findings presented in Table 2.5 show that there are six cointegrating vectors in the system. In effect, both the trace and the maximum eigenvalues tests reject the null hypothesis of up to five cointegrating vectors at the five percent level of significance. However, as previously discussed, this result was to be anticipated since the time series used were *I(0)*, leading to Π having a full rank.

Next, the Johansen cointegration test is conducted on each pair of variables and the results are summarized in Table 2.6.

The results of the test on each pair are similar to the ones found in the group cointegration test. It can be seen that there are at least two cointegrating vectors between each pairs of stock markets at the five percent level of significance.

The evidence of cointegration that was found implies that there are some dynamic long run causal relationships between the six stock markets under consideration. This justifies the use of further tools to verify the relationship among the markets. In this study, the short-run relationship between the markets will now be run in a VECM framework. Finally, the Granger causality test, impulse response functions and variance decomposition will be run to verify the relationship among the markets.

VECM models

Tables 2.7 to 2.12 present the structure of the error correction model for the six markets

Table 2.6: Johansen cointegration results for the variables in pairs

	λ_{trace}	**0.05 Critical value**	**p-value***	λ_{max}	**0.05 Critical value**	**p-value***
NGSE and NSE						
$r = 0$	1207.182	15.495	1.000	738.951	14.265	0.000
$r = 1$	468.230	3.841	0.000	468.230	3.841	0.000
NGSE and JSE						
$r = 0$	723.906	15.495	0.000	450.997	14.265	0.000
$r = 1$	272.910	3.841	0.000	272.910	3.841	0.000
NGSE and BRVM						
$r = 0$	441.396	15.495	0.000	243.363	14.265	0.000
$r = 1$	198.033	3.841	0.000	198.033	3.841	0.000
NGSE and NYSE						
$r = 0$	508.592	15.495	0.000	296.774	14.265	0.000
$r = 1$	211.817	3.841	0.000	211.817	3.841	0.000
NGSE and FTSE						
$r = 0$	565.299	15.495	0.000	319.554	14.265	0.000
$r = 1$	245.746	3.841	0.000	245.746	3.841	0.000
NSE and JSE						
$r = 0$	1397.483	15.495	1.000	781.877	14.265	0.000
$r = 1$	615.606	3.841	0.000	615.606	3.841	0.000
NSE and BRVM						
$r = 0$	626.046	15.495	0.000	370.764	14.265	0.000
$r = 1$	255.282	3.841	0.000	255.282	3.841	0.000
NSE and NYSE						
$r = 0$	608.522	15.495	0.000	360.598	14.265	0.000
$r = 1$	247.924	3.841	0.000	247.924	3.841	0.000
NSE and FTSE						
$r = 0$	1350.504	15.495	1.000	759.189	14.265	0.000
$r = 1$	591.315	3.841	0.000	591.315	3.841	0.000
BRVM and JSE						
$r = 0$	636.271	15.495	0.000	375.233	14.265	0.000
$r = 1$	261.039	3.841	0.000	261.039	3.841	0.000
BRVM and NYSE						
$r = 0$	592.829	15.495	0.000	334.075	14.265	0.000
$r = 1$	258.754	3.841	0.000	258.754	3.841	0.000
BRVM and FTSE						
$r = 0$	602.077	15.495	0.000	341.082	14.265	0.000
$r = 1$	260.995	3.841	0.000	260.995	3.841	0.0000
JSE and NYSE						
$r = 0$	581.370	15.495	0.000	324.808	14.265	0.0001
$r = 1$	256.562	3.841	0.000	256.562	3.841	0.000
JSE and FTSE						
$r = 0$	711.763	15.495	0.000	378.641	14.265	0.000
$r = 1$	333.122	3.841	0.000	333.122	3.841	0.000
NYSE and FTSE						
$r = 0$	769.719	15.495	0.000	449.108	14.265	0.0001
$r = 1$	320.610	3.841	0.000	320.610	3.841	0.000

Source: Author's estimations

*MacKinnon-Haug-Michelis (1999) p-values

** denotes rejection of the hypothesis at the 5% level of significance.

under consideration. The ordinary least squares (OLS) was used to estimate the VECM with the optimal lag length of 7 based on the test for lag length criteria conducted at the beginning of the empirical analysis. The model diagnostics summarized in Table 2.13 shows that the model is congruent and does not present any serious misspecification.

The significance of the error correction term ($ect1_{t-1}$) for the BRVM, NGSE and NSE validate the structure of the error-correction model for these three markets. These terms indicate significant corrections of approximately 86 percent, 19 percent and 33 percent from short-run disequilibrium to the long run equilibrium in the BRVM, NGSE and NSE, respectively.

In the BRVM, changes in the first four lagged stock returns in the JSE and the NYSE, the first and sixth lagged stock returns in the NGSE, the first six lagged stock returns in the NSE significantly lead to a depression in stock returns. In the FTSE, changes in the seventh lagged stock returns in the JSE, the first three and the sixth lagged stock returns in the NGSE, the first three lagged stock returns in the NSE and the first lagged returns in the NYSE create a depression in stock returns. Similarly to the FTSE, stock returns in the JSE are significantly affected by lagged stock returns in the all of the other markets except the BRVM. Interestingly, while these lagged returns lead to a depression of stock returns in the JSE, the lagged stock returns in the FTSE lead to an increase in stock returns in the JSE. In the NGSE, however, only changes in the lagged stock returns in the African stock markets significantly affect the stock returns. They also lead to a depression of the stock returns in the NGSE. While stock returns in the NSE are significantly depressed by lagged stock returns in all of the other markets except the FTSE; stock returns in the NYSE are significantly depressed by changes in lagged stock returns in all of the other markets except the BRVM and the FTSE. While changes in lagged returns in the BRVM do not significantly affect the stock returns in the NYSE, changes in lagged returns in the FTSE increase stock returns in the NYSE.

Granger causality test

The results from the Granger causality test, presented in Table 2.14, show that there is a bi-

Table 2.7: General short run model (BRVM)

Dependent Variable: $\Delta BRVM_t$				
Variable	Coefficient	Std Error	t-statistic	p-value
$ect1_{t-1}$	-0.855	0.059	-14.501	0.000***
$ect2_{t-1}$	0.221	0.112	1.974	0.048**
$ect3_{t-1}$	0.217	0.085	2.531	0.0114**
$ect4_{t-1}$	0.106	0.032	3.360	0.001***
$ect5_{t-1}$	0.159	0.043	3.713	0.000***
$\Delta BRVM_{t-1}$	-0.187	0.056	-3.336	0.000***
$\Delta BRVM_{t-2}$	-0.167	0.053	-3.169	0.002***
$\Delta BRVM_{t-3}$	-0.093	0.049	-1.898	0.058*
$\Delta BRVM_{t-4}$	-0.099	0.045	-2.225	0.026**
$\Delta BRVM_{t-5}$	-0.022	0.039	-0.552	0.581
$\Delta BRVM_{t-6}$	-0.006	0.032	-0.181	0.856
$\Delta BRVM_{t-7}$	0.005	0.023	0.212	0.832
$\Delta FTSE_{t-1}$	-0.180	0.104	-1.723	0.085*
$\Delta FTSE_{t-2}$	-0.157	0.096	-1.636	0.101
$\Delta FTSE_{t-3}$	-0.107	0.085	-1.249	0.211
$\Delta FTSE_{t-4}$	-0.079	0.074	-1.068	0.285
$\Delta FTSE_{t-5}$	-0.064	0.060	-1.065	0.287
$\Delta FTSE_{t-6}$	-0.006	0.045	-0.122	0.903
$\Delta FTSE_{t-7}$	-0.007	0.028	-0.234	0.815
ΔJSE_{t-1}	-0.215	0.079	-2.693	0.007***
ΔJSE_{t-2}	-0.179	0.073	-2.463	0.014**
ΔJSE_{t-3}	-0.156	0.065	-2.389	0.017**
ΔJSE_{t-4}	-0.119	0.058	-2.109	0.035**
ΔJSE_{t-5}	-0.075	0.047	-1.597	0.110
ΔJSE_{t-6}	-0.052	0.036	-1.438	0.151
ΔJSE_{t-7}	-0.020	0.024	-0.863	0.388
$\Delta NGSE_{t-1}$	-0.067	0.031	-2.152	0.031**
$\Delta NGSE_{t-2}$	-0.035	0.029	-1.190	0.234
$\Delta NGSE_{t-3}$	-0.046	0.028	-1.649	0.099*
$\Delta NGSE_{t-4}$	-0.019	0.026	-0.732	0.464
$\Delta NGSE_{t-5}$	0.004	0.024	0.177	0.859
$\Delta NGSE_{t-6}$	-0.056	0.021	-2.632	0.008***
$\Delta NGSE_{t-7}$	-0.004	0.019	-0.231	0.817
ΔNSE_{t-1}	-0.147	0.040	-3.666	0.000***
ΔNSE_{t-2}	-0.128	0.037	-3.479	0.000***
ΔNSE_{t-3}	-0.099	0.033	-2.985	0.003***
ΔNSE_{t-4}	-0.076	0.029	-2.610	0.009***
ΔNSE_{t-5}	-0.053	0.024	-2.188	0.029**
ΔNSE_{t-6}	-0.041	0.018	-2.208	0.027**
ΔNSE_{t-7}	-0.018	0.013	-1.359	0.174
$\Delta NYSE_{t-1}$	0.276	0.098	2.808	0.005***
$\Delta NYSE_{t-2}$	0.248	0.089	2.787	0.005***
$\Delta NYSE_{t-3}$	0.193	0.078	2.463	0.014**
$\Delta NYSE_{t-4}$	0.135	0.066	2.043	0.041**
$\Delta NYSE_{t-5}$	0.071	0.053	1.350	0.177
$\Delta NYSE_{t-6}$	0.027	0.038	0.712	0.476
$\Delta NYSE_{t-7}$	0.005	0.022	0.236	0.813
Constant	0.002	0.018	0.115	0.909
R-squared	0.533			
Adj. R-squared	0.522			
Sum sq. resids	1263.231			
S.E. equation	0.798			
F-statistic	48.090			
Log likelihood	-2398.966			
Akaike AIC	2.411			
Schwarz SC	2.544			
Mean dependent	0.001			
S.D. dependent	1.154			

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 2.8: General short run model (FTSE)

Dependent Variable: $\Delta FTSE_t$				
Variable	Coefficient	Std Error	t-statistic	p-value
$ect1_{t-1}$	0.004	0.075	0.048	0.961
$ect2_{t-1}$	-1.575	0.143	-11.032	0.000***
$ect3_{t-1}$	0.073	0.109	0.668	0.504
$ect4_{t-1}$	0.132	0.040	3.268	0.001***
$ect5_{t-1}$	0.176	0.055	3.221	0.001***
$\Delta BRVM_{t-1}$	0.019	0.071	0.273	0.785
$\Delta BRVM_{t-2}$	0.028	0.067	0.415	0.678
$\Delta BRVM_{t-3}$	0.032	0.063	0.507	0.612
$\Delta BRVM_{t-4}$	0.019	0.057	0.338	0.735
$\Delta BRVM_{t-5}$	0.023	0.050	0.465	0.642
$\Delta BRVM_{t-6}$	0.014	0.041	0.331	0.740
$\Delta BRVM_{t-7}$	0.013	0.029	0.443	0.658
$\Delta FTSE_{t-1}$	-0.416	0.133	3.119	0.002***
$\Delta FTSE_{t-2}$	0.253	0.122	2.071	0.038**
$\Delta FTSE_{t-3}$	0.194	0.109	1.787	0.074*
$\Delta FTSE_{t-4}$	0.093	0.094	0.988	0.323
$\Delta FTSE_{t-5}$	0.103	0.077	1.342	0.180
$\Delta FTSE_{t-6}$	0.104	0.058	1.790	0.073*
$\Delta FTSE_{t-7}$	0.067	0.036	1.855	0.064*
ΔJSE_{t-1}	-0.059	0.102	-0.575	0.565
ΔJSE_{t-2}	-0.029	0.093	-0.309	0.758
ΔJSE_{t-3}	-0.035	0.083	-0.415	0.678
ΔJSE_{t-4}	-0.008	0.072	-0.105	0.917
ΔJSE_{t-5}	-0.080	0.060	-1.336	0.182
ΔJSE_{t-6}	-0.074	0.046	-1.595	0.111
ΔJSE_{t-7}	-0.064	0.030	-2.121	0.034**
$\Delta NGSE_{t-1}$	-0.114	0.040	-2.857	0.004***
$\Delta NGSE_{t-2}$	-0.103	0.038	-2.727	0.006***
$\Delta NGSE_{t-3}$	-0.117	0.036	-3.275	0.001***
$\Delta NGSE_{t-4}$	-0.067	0.033	-2.013	0.044
$\Delta NGSE_{t-5}$	-0.023	0.030	-0.753	0.451
$\Delta NGSE_{t-6}$	-0.075	0.027	-2.749	0.006***
$\Delta NGSE_{t-7}$	-0.046	0.024	-1.903	0.057*
ΔNSE_{t-1}	-0.130	0.051	-2.547	0.011**
ΔNSE_{t-2}	-0.095	0.047	-2.021	0.043**
ΔNSE_{t-3}	-0.084	0.042	-1.990	0.047**
ΔNSE_{t-4}	-0.060	0.037	-1.625	0.104
ΔNSE_{t-5}	-0.050	0.031	-1.619	0.105
ΔNSE_{t-6}	-0.034	0.024	-1.424	0.155
ΔNSE_{t-7}	-0.014	0.017	-0.811	0.417
$\Delta NYSE_{t-1}$	-0.339	0.125	-2.704	0.007***
$\Delta NYSE_{t-2}$	-0.189	0.114	-1.670	0.095*
$\Delta NYSE_{t-3}$	-0.161	0.099	-1.617	0.106
$\Delta NYSE_{t-4}$	-0.091	0.085	-1.077	0.282
$\Delta NYSE_{t-5}$	-0.093	0.067	-1.390	0.164
$\Delta NYSE_{t-6}$	-0.044	0.049	-0.897	0.369
$\Delta NYSE_{t-7}$	-0.032	0.028	-1.148	0.251
Constant	0.003	0.023	0.123	0.902
R-squared	0.512			
Adj. R-squared	0.500			
Sum sq. resids	2059.495			
S.E. equation	1.019			
F-statistic	44.196			
Log likelihood	-2895.087			
Akaike AIC	2.899			
Schwarz SC	3.032			
Mean dependent	0.003			
S.D. dependent	1.442			

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 2.9: General short run model (JSE)

Dependent Variable: ΔJSE_t				
Variable	Coefficient	Std Error	t-statistic	p-value
$ect1_{t-1}$	0.072	0.076	0.942	0.346
$ect2_{t-1}$	-0.432	0.145	-2.986	0.003***
$ect3_{t-1}$	-1.229	0.111	-11.100	0.000***
$ect4_{t-1}$	0.205	0.041	5.019	0.000***
$ect5_{t-1}$	0.215	0.055	3.884	0.000***
$\Delta BRVM_{t-1}$	-0.033	0.072	-0.460	0.645
$\Delta BRVM_{t-2}$	0.013	0.068	0.198	0.843
$\Delta BRVM_{t-3}$	0.004	0.064	0.061	0.952
$\Delta BRVM_{t-4}$	0.015	0.058	0.254	0.799
$\Delta BRVM_{t-5}$	-0.032	0.051	-0.623	0.533
$\Delta BRVM_{t-6}$	-0.011	0.042	-0.257	0.797
$\Delta BRVM_{t-7}$	0.019	0.029	0.653	0.514
$\Delta FTSE_{t-1}$	0.418	0.135	3.089	0.002***
$\Delta FTSE_{t-2}$	0.294	0.124	2.375	0.018**
$\Delta FTSE_{t-3}$	0.271	0.110	2.451	0.014**
$\Delta FTSE_{t-4}$	0.181	0.095	1.903	0.057*
$\Delta FTSE_{t-5}$	0.186	0.078	2.388	0.017**
$\Delta FTSE_{t-6}$	0.119	0.059	2.036	0.042**
$\Delta FTSE_{t-7}$	0.079	0.036	2.166	0.030**
ΔJSE_{t-1}	0.104	0.103	1.009	0.313
ΔJSE_{t-2}	0.037	0.094	0.392	0.695
ΔJSE_{t-3}	-0.011	0.084	-0.131	0.896
ΔJSE_{t-4}	-0.032	0.073	-0.433	0.665
ΔJSE_{t-5}	-0.082	0.061	-1.344	0.179
ΔJSE_{t-6}	-0.083	0.047	-1.779	0.075*
ΔJSE_{t-7}	-0.052	0.031	-1.708	0.088*
$\Delta NGSE_{t-1}$	-0.192	0.040	-4.764	0.000***
$\Delta NGSE_{t-2}$	-0.163	0.038	-4.279	0.000***
$\Delta NGSE_{t-3}$	-0.161	0.036	-4.441	0.000***
$\Delta NGSE_{t-4}$	-0.125	0.033	-3.709	0.000***
$\Delta NGSE_{t-5}$	-0.069	0.031	-2.243	0.025**
$\Delta NGSE_{t-6}$	-0.092	0.027	-3.329	0.001***
$\Delta NGSE_{t-7}$	-0.058	0.024	-2.364	0.018**
ΔNSE_{t-1}	-0.212	0.052	-4.086	0.000***
ΔNSE_{t-2}	-0.177	0.048	-3.703	0.000***
ΔNSE_{t-3}	-0.133	0.043	-3.083	0.002***
ΔNSE_{t-4}	-0.083	0.038	-2.206	0.027**
ΔNSE_{t-5}	-0.085	0.031	-2.689	0.007***
ΔNSE_{t-6}	-0.057	0.024	-2.360	0.018**
ΔNSE_{t-7}	-0.025	0.017	-1.431	0.152
$\Delta NYSE_{t-1}$	-0.539	0.127	-4.250	0.000***
$\Delta NYSE_{t-2}$	-0.337	0.115	-2.924	0.004***
$\Delta NYSE_{t-3}$	-0.301	0.101	-2.982	0.003
$\Delta NYSE_{t-4}$	-0.211	0.086	-2.467	0.014**
$\Delta NYSE_{t-5}$	-0.168	0.068	-2.459	0.014**
$\Delta NYSE_{t-6}$	-0.072	0.049	-1.459	0.145
$\Delta NYSE_{t-7}$	-0.047	0.028	-1.685	0.092*
Constant	0.002	0.023	0.096	0.924
R-squared	0.530			
Adj. R-squared	0.519			
Sum sq. resids	2112.847			
S.E. equation	1.032			
F-statistic	47.619			
Log likelihood	-2921.046			
Akaike AIC	2.925			
Schwarz SC	3.058			
Mean dependent	0.002			
S.D. dependent	1.489			

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 2.10: General short run model (NGSE)

Dependent Variable: $\Delta NGSE_t$				
Variable	Coefficient	Std Error	t-statistic	p-value
$ect1_{t-1}$	0.194	0.069	2.806	0.005***
$ect2_{t-1}$	-0.068	0.131	-0.519	0.604
$ect3_{t-1}$	0.288	0.100	2.868	0.004***
$ect4_{t-1}$	-0.509	0.037	-13.716	0.000***
$ect5_{t-1}$	0.156	0.050	3.114	0.002***
$\Delta BRVM_{t-1}$	-0.224	0.065	-3.419	0.001***
$\Delta BRVM_{t-2}$	-0.266	0.062	-4.296	0.000***
$\Delta BRVM_{t-3}$	-0.234	0.058	-4.054	0.000***
$\Delta BRVM_{t-4}$	-0.184	0.052	-3.517	0.000***
$\Delta BRVM_{t-5}$	-0.120	0.046	-2.597	0.009***
$\Delta BRVM_{t-6}$	-0.118	0.038	-3.099	0.002***
$\Delta BRVM_{t-7}$	-0.040	0.026	-1.506	0.132
$\Delta FTSE_{t-1}$	0.104	0.123	0.852	0.394
$\Delta FTSE_{t-2}$	0.094	0.112	0.842	0.399
$\Delta FTSE_{t-3}$	0.108	0.100	1.075	0.282
$\Delta FTSE_{t-4}$	0.086	0.086	0.999	0.318
$\Delta FTSE_{t-5}$	0.056	0.071	0.791	0.429
$\Delta FTSE_{t-6}$	0.044	0.053	0.835	0.404
$\Delta FTSE_{t-7}$	-0.004	0.033	-0.137	0.891
ΔJSE_{t-1}	-0.258	0.093	-2.754	0.006***
ΔJSE_{t-2}	-0.213	0.085	-2.498	0.013**
ΔJSE_{t-3}	-0.189	0.076	-2.479	0.013**
ΔJSE_{t-4}	-0.151	0.066	-2.269	0.023**
ΔJSE_{t-5}	-0.116	0.055	-2.099	0.036**
ΔJSE_{t-6}	-0.094	0.042	-2.218	0.027**
ΔJSE_{t-7}	-0.047	0.028	-1.694	0.090*
$\Delta NGSE_{t-1}$	-0.023	0.037	-0.623	0.533
$\Delta NGSE_{t-2}$	-0.047	0.035	-1.345	0.178
$\Delta NGSE_{t-3}$	-0.089	0.033	-2.726	0.006***
$\Delta NGSE_{t-4}$	-0.016	0.031	-0.536	0.592
$\Delta NGSE_{t-5}$	0.021	0.028	0.769	0.442
$\Delta NGSE_{t-6}$	-0.013	0.025	-0.519	0.604
$\Delta NGSE_{t-7}$	-0.033	0.022	-1.496	0.135
ΔNSE_{t-1}	-0.141	0.047	-2.997	0.003***
ΔNSE_{t-2}	-0.139	0.043	-3.208	0.001***
ΔNSE_{t-3}	-0.111	0.039	-2.846	0.004***
ΔNSE_{t-4}	-0.071	0.034	-2.091	0.037**
ΔNSE_{t-5}	-0.042	0.029	-1.458	0.145
ΔNSE_{t-6}	-0.014	0.022	-0.662	0.508
ΔNSE_{t-7}	0.026	0.016	1.657	0.098*
$\Delta NYSE_{t-1}$	-0.252	0.115	-2.192	0.028**
$\Delta NYSE_{t-2}$	-0.177	0.104	-1.699	0.089*
$\Delta NYSE_{t-3}$	-0.165	0.092	-1.806	0.071*
$\Delta NYSE_{t-4}$	-0.104	0.078	-1.341	0.179
$\Delta NYSE_{t-5}$	-0.103	0.062	-1.660	0.097*
$\Delta NYSE_{t-6}$	-0.074	0.045	-1.662	0.096*
$\Delta NYSE_{t-7}$	-0.018	0.025	-0.696	0.486
Constant	0.003	0.021	0.148	0.882
R-squared	0.309			
Adj. R-squared	0.293			
Sum sq. resids	1736.353			
S.E. equation	0.936			
F-statistic	18.854			
Log likelihood	-2721.853			
Akaike AIC	2.729			
Schwarz SC	2.862			
Mean dependent	0.001			
S.D. dependent	1.112			

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 2.11: General short run model (NSE)

Dependent Variable: ΔNSE_t				
Variable	Coefficient	Std Error	t-statistic	p-value
$ect1_{t-1}$	0.330	0.099	3.330	0.001***
$ect2_{t-1}$	-0.253	0.188	-1.343	0.179
$ect3_{t-1}$	0.398	0.144	2.762	0.006***
$ect4_{t-1}$	0.297	0.053	5.583	0.000***
$ect5_{t-1}$	-1.169	0.072	-16.211	0.000***
$\Delta BRVM_{t-1}$	-0.283	0.094	-3.006	0.003***
$\Delta BRVM_{t-2}$	-0.192	0.089	-2.159	0.031**
$\Delta BRVM_{t-3}$	-0.133	0.083	-1.608	0.108
$\Delta BRVM_{t-4}$	-0.101	0.075	-1.345	0.179
$\Delta BRVM_{t-5}$	-0.064	0.066	-0.963	0.336
$\Delta BRVM_{t-6}$	-0.024	0.054	-0.449	0.654
$\Delta BRVM_{t-7}$	-0.024	0.038	-0.638	0.523
$\Delta FTSE_{t-1}$	0.228	0.176	1.296	0.195
$\Delta FTSE_{t-2}$	0.249	0.161	1.543	0.123
$\Delta FTSE_{t-3}$	0.223	0.144	1.554	0.120
$\Delta FTSE_{t-4}$	0.177	0.124	1.432	0.152
$\Delta FTSE_{t-5}$	0.132	0.102	1.304	0.192
$\Delta FTSE_{t-6}$	0.120	0.076	1.569	0.117
$\Delta FTSE_{t-7}$	0.083	0.047	1.745	0.081*
ΔJSE_{t-1}	-0.396	0.134	-2.952	0.003***
ΔJSE_{t-2}	-0.365	0.123	-2.979	0.003***
ΔJSE_{t-3}	-0.321	0.109	-2.923	0.004***
ΔJSE_{t-4}	-0.282	0.096	-2.954	0.003***
ΔJSE_{t-5}	-0.198	0.079	-2.493	0.013**
ΔJSE_{t-6}	-0.165	0.061	-2.712	0.007***
ΔJSE_{t-7}	-0.125	0.039	-3.138	0.002***
$\Delta NGSE_{t-1}$	-0.154	0.052	-2.933	0.003***
$\Delta NGSE_{t-2}$	-0.202	0.049	-4.069	0.000***
$\Delta NGSE_{t-3}$	-0.149	0.047	-3.162	0.002***
$\Delta NGSE_{t-4}$	-0.132	0.044	-2.998	0.003***
$\Delta NGSE_{t-5}$	-0.091	0.039	-2.286	0.022**
$\Delta NGSE_{t-6}$	-0.084	0.036	-2.364	0.018**
$\Delta NGSE_{t-7}$	-0.057	0.032	-1.789	0.073*
ΔNSE_{t-1}	0.207	0.067	3.068	0.002***
ΔNSE_{t-2}	-0.033	0.062	-0.528	0.597
ΔNSE_{t-3}	-0.018	0.056	-0.317	0.751
ΔNSE_{t-4}	-0.061	0.049	-1.255	0.209
ΔNSE_{t-5}	-0.035	0.041	-0.858	0.391
ΔNSE_{t-6}	-0.033	0.031	-1.059	0.289
ΔNSE_{t-7}	0.014	0.022	0.614	0.539
$\Delta NYSE_{t-1}$	-0.449	0.165	-2.718	0.007***
$\Delta NYSE_{t-2}$	-0.369	0.149	-2.466	0.014**
$\Delta NYSE_{t-3}$	-0.295	0.131	-2.248	0.025**
$\Delta NYSE_{t-4}$	-0.205	0.111	-1.837	0.066*
$\Delta NYSE_{t-5}$	-0.178	0.088	-2.009	0.045**
$\Delta NYSE_{t-6}$	-0.105	0.064	-1.634	0.102
$\Delta NYSE_{t-7}$	-0.053	0.036	-1.450	0.147
Constant	0.003	0.029	0.098	0.922
R-squared	0.523			
Adj. R-squared	0.511			
Sum sq. resids	3574.391			
S.E. equation	1.343			
F-statistic	46.165			
Log likelihood	-3454.691			
Akaike AIC	3.451			
Schwarz SC	3.584			
Mean dependent	0.001			
S.D. dependent	1.921			

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 2.12: General short run model (NYSE)

Dependent Variable: $\Delta NYSE_t$				
Variable	Coefficient	Std Error	t-statistic	p-value
$ect1_{t-1}$	0.114	0.085	1.353	0.176
$ect2_{t-1}$	0.166	0.160	1.034	0.301
$ect3_{t-1}$	0.477	0.123	3.883	0.000***
$ect4_{t-1}$	0.182	0.045	4.017	0.000***
$ect5_{t-1}$	0.335	0.061	5.446	0.000***
$\Delta BRVM_{t-1}$	-0.057	0.080	-0.711	0.477
$\Delta BRVM_{t-2}$	-0.025	0.076	-0.331	0.741
$\Delta BRVM_{t-3}$	-0.019	0.071	-0.279	0.779
$\Delta BRVM_{t-4}$	-0.039	0.064	-0.619	0.536
$\Delta BRVM_{t-5}$	-0.041	0.057	-0.723	0.469
$\Delta BRVM_{t-6}$	0.005	0.046	0.109	0.913
$\Delta BRVM_{t-7}$	0.029	0.032	0.879	0.379
$\Delta FTSE_{t-1}$	0.113	0.150	0.757	0.449
$\Delta FTSE_{t-2}$	0.206	0.137	1.501	0.133
$\Delta FTSE_{t-3}$	0.282	0.122	2.300	0.021**
$\Delta FTSE_{t-4}$	0.219	0.106	2.081	0.037**
$\Delta FTSE_{t-5}$	0.213	0.087	2.463	0.014**
$\Delta FTSE_{t-6}$	0.185	0.065	2.838	0.005***
$\Delta FTSE_{t-7}$	0.109	0.040	2.716	0.007***
ΔJSE_{t-1}	-0.408	0.114	-3.563	0.000***
ΔJSE_{t-2}	-0.320	0.104	-3.062	0.002***
ΔJSE_{t-3}	-0.280	0.094	-2.992	0.003***
ΔJSE_{t-4}	-0.182	0.081	-2.229	0.026**
ΔJSE_{t-5}	-0.172	0.068	-2.539	0.011**
ΔJSE_{t-6}	-0.110	0.052	-2.112	0.035**
ΔJSE_{t-7}	-0.115	0.034	-3.369	0.001***
$\Delta NGSE_{t-1}$	-0.143	0.045	-3.204	0.001***
$\Delta NGSE_{t-2}$	-0.170	0.042	-4.010	0.000***
$\Delta NGSE_{t-3}$	-0.158	0.040	-3.918	0.000***
$\Delta NGSE_{t-4}$	-0.089	0.037	-2.367	0.018**
$\Delta NGSE_{t-5}$	-0.076	0.034	-2.225	0.026**
$\Delta NGSE_{t-6}$	-0.131	0.031	-4.299	0.000***
$\Delta NGSE_{t-7}$	-0.051	0.027	-1.891	0.059*
ΔNSE_{t-1}	-0.276	0.058	-4.804	0.000***
ΔNSE_{t-2}	-0.240	0.053	-4.529	0.000***
ΔNSE_{t-3}	-0.181	0.048	-3.794	0.000***
ΔNSE_{t-4}	-0.140	0.042	-3.349	0.001***
ΔNSE_{t-5}	-0.107	0.035	-3.041	0.002***
ΔNSE_{t-6}	-0.058	0.027	-2.183	0.029**
ΔNSE_{t-7}	-0.025	0.019	-1.289	0.198
$\Delta NYSE_{t-1}$	0.127	0.141	0.905	0.365
$\Delta NYSE_{t-2}$	0.023	0.128	0.184	0.854
$\Delta NYSE_{t-3}$	-0.112	0.112	-0.998	0.318
$\Delta NYSE_{t-4}$	-0.108	0.095	-1.130	0.258
$\Delta NYSE_{t-5}$	-0.154	0.076	-2.033	0.042**
$\Delta NYSE_{t-6}$	-0.089	0.055	-1.624	0.104
$\Delta NYSE_{t-7}$	-0.048	0.031	-1.542	0.123
Constant	0.003	0.025	0.124	0.902
R-squared	0.559			
Adj. R-squared	0.548			
Sum sq. resids	2601.017			
S.E. equation	1.146			
F-statistic	53.403			
Log likelihood	-3132.030			
Akaike AIC	3.133			
Schwarz SC	3.266			
Mean dependent	0.002			
S.D. dependent	1.704			

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 2.13: VECM residual diagnostics

Test	White heteroskedasticity	Normality	Serial correlation LM
Test-statisctics	32267.83	5873181.	41.571
p-value	0.102	0.000***	0.241

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 2.14: Granger causality test on the indices returns, 2009 - 2016

Null Hypothesis:	**F-Statistic**	**p-value**
DLNSE does not Granger Cause DLNGSE	0.453	0.636
DLNGSE does not Granger Cause DLNSE	8.478	0.000
DLBRVM does not Granger Cause DLNGSE	2.287	0.025
DLNGSE does not Granger Cause DLBRVM	2.825	0.006
DLJSE does not Granger Cause DLNGSE	7.408	0.000
DLNGSE does not Granger Cause DLJSE	0.887	0.471
DLNYSE does not Granger Cause DLNGSE	8.307	0.000
DLNGSE does not Granger Cause DLNYSE	1.370	0.214
DLFTSE does not Granger Cause DLNGSE	6.831	0.000
DLNGSE does not Granger Cause DLFTSE	1.771	0.101
DLBRVM does not Granger Cause DLNSE	1.030	0.398
DLNSE does not Granger Cause DLBRVM	0.930	0.460
DLJSE does not Granger Cause DLNSE	3.917	0.020
DLNSE does not Granger Cause DLJSE	1.390	0.249
DLNYSE does not Granger Cause DLNSE	5.934	0.000
DLNSE does not Granger Cause DLNYSE	0.833	0.544
DLFTSE does not Granger Cause DLNSE	6.594	0.001
DLNSE does not Granger Cause DLFTSE	1.821	0.162
DLJSE does not Granger Cause DLBRVM	0.420	0.835
DLBRVM does not Granger Cause DLJSE	1.525	0.179
DLNYSE does not Granger Cause DLBRVM	0.363	0.874
DLBRVM does not Granger Cause DLNYSE	0.583	0.713
DLFTSE does not Granger Cause DLBRVM	0.572	0.722
DLBRVM does not Granger Cause DLFTSE	0.239	0.946
DLNYSE does not Granger Cause DLJSE	22.013	0.000
DLJSE does not Granger Cause DLNYSE	6.601	0.000
DLFTSE does not Granger Cause DLJSE	7.566	0.000
DLJSE does not Granger Cause DLFTSE	1.636	0.147
DLFTSE does not Granger Cause DLNYSE	17.597	0.000
DLNYSE does not Granger Cause DLFTSE	18.617	0.000

Source: Author's estimations

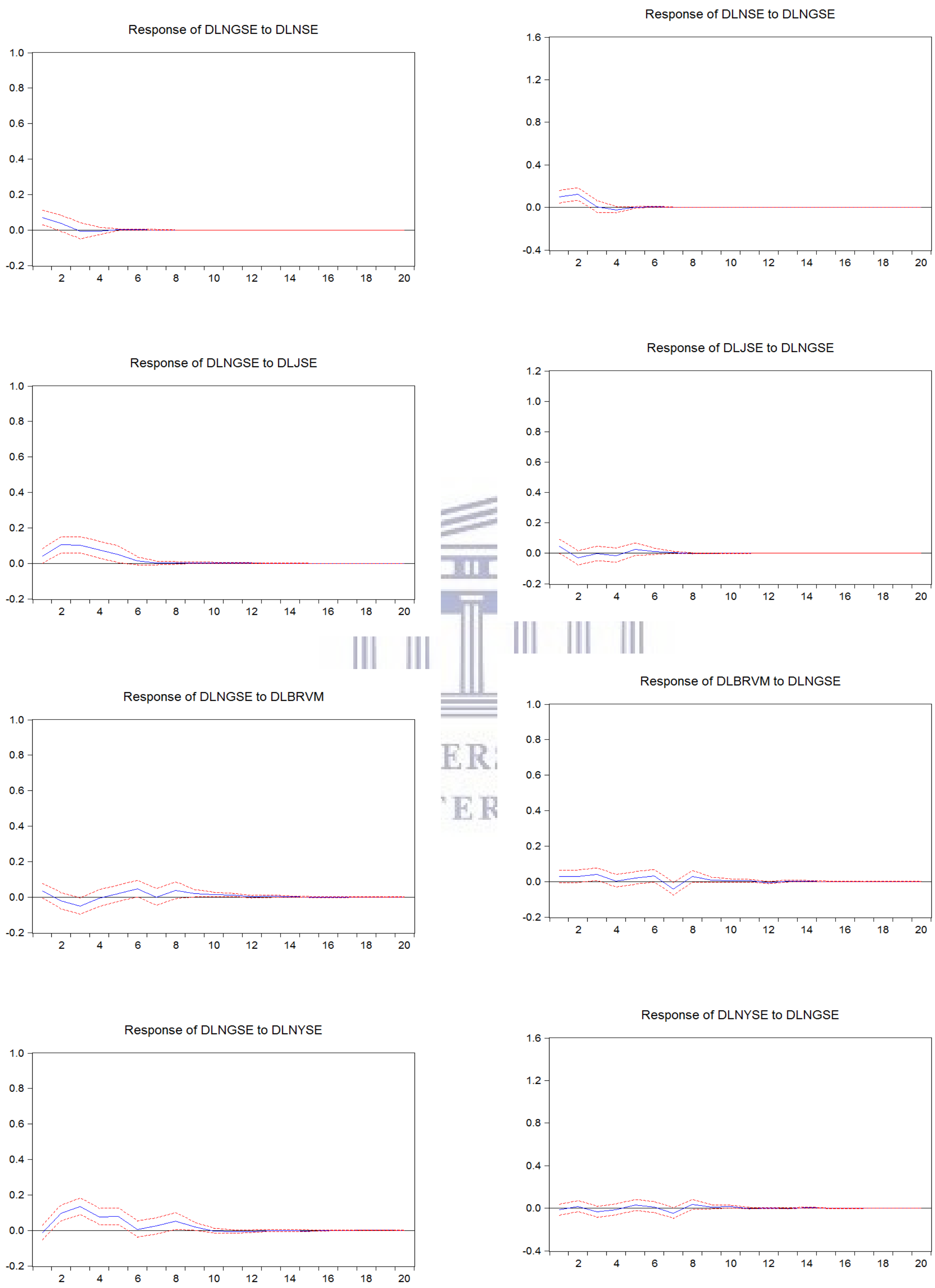
directional causality between BRVM and NGSE, NYSE and JSE, and NYSE and FTSE at the five percent level of significance. In other words, changes in the returns on the BRVM composite Granger cause changes in the NGSE all share index and vice versa. Similarly, changes in the NYSE composite index Granger cause changes in the return on the JSE All share index, and vice versa; and the same occurs between the FTSE all share index and the NYSE composite index.

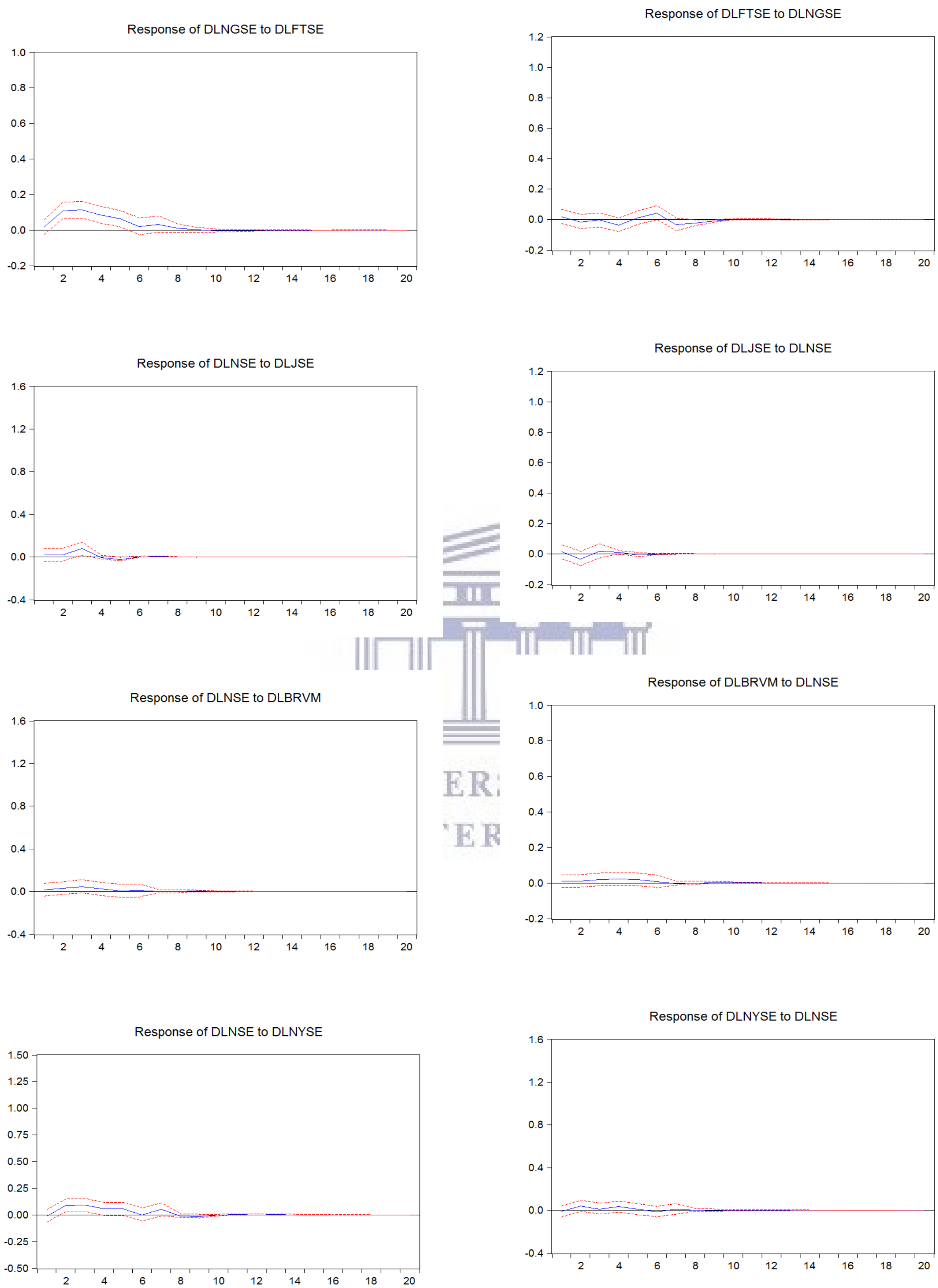
Moreover, there are uni-directional causalities from the FTSE to the NGSE, NSE and JSE. That is, changes in the returns on the FTSE All share index Granger cause changes in the returns on the NGSE All share, the NSE All share and the JSE All share. Changes in the returns on the NYSE composite Granger cause changes in the returns on both the NSE All share and the NGSE All share; while changes in the returns on the JSE All share Granger cause changes in the returns on the NGSE All share and the NSE All share. Finally, changes in the returns on the NGSE All share Granger cause changes in the returns on the NSE All share. These results show that the selected markets in Sub-Saharan Africa are not completely isolated from shocks coming from developed countries as well as shocks occurring among themselves.

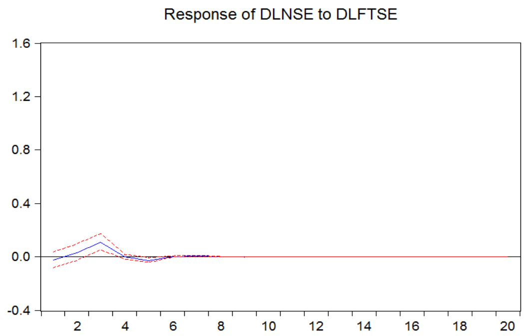
Impulse Response Functions

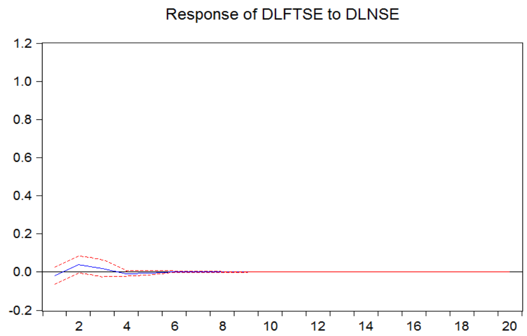
The impulse response function detects the responsiveness of dependent variables to shocks to each variable observed in the model. Thus, when observing each variable in individual equations separately, a shock is applied to the error term, and the overall effects of the shock will be observed over a period of time. According to Brooks (2008: 299), if the system is stable, the shock should gradually be eliminated. Simo-Kengne, Gupta and Bittencourt (2012: 12) describe the impulse response functions as a convenient tool for the analysis of spillover effects because an impulse response function traces out, for several periods in the future, the effect of an exogenous shock applied to a variable in the system at a given point in time on the expected future values of variables in a dynamic system. A positive shock to a given variable is an unanticipated and sudden increase in the value of that variable (Gujarati and Porter, 2009: 785).

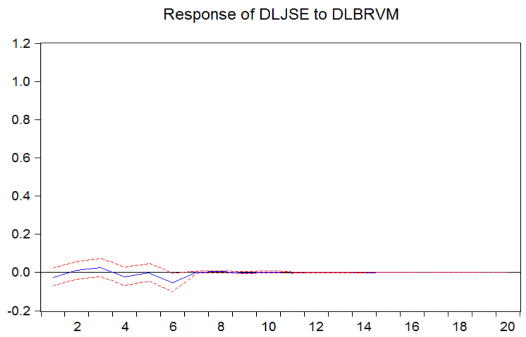
Figure 2.4: Impulse response functions of stock indices

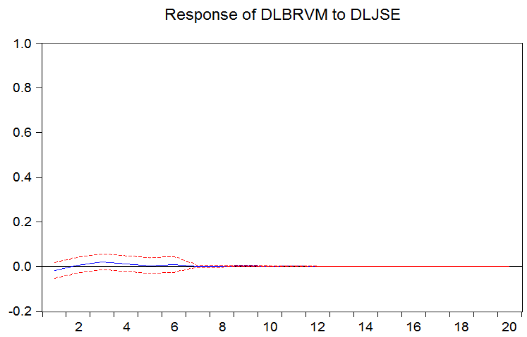


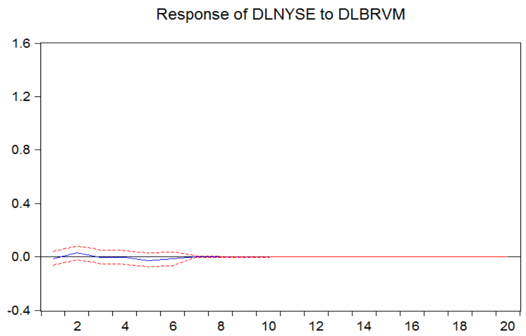

Response of DLNGSE to DLFTSE
Response of DLFTSE to DLNGSE
Response of DLNSE to DLJSE
Response of DLJSE to DLNSE
Response of DLNSE to DLBRVM
Response of DLBRVM to DLNSE
Response of DLNSE to DLNYSE
Response of DLNYSE to DLNSE

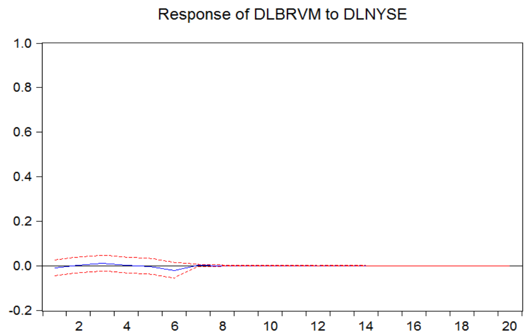

Response of DLNSE to DLFTSE

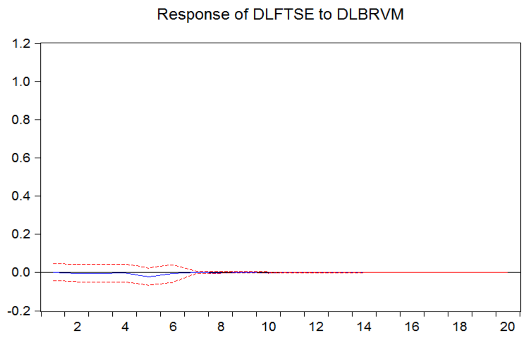

Response of DLFTSE to DLNSE

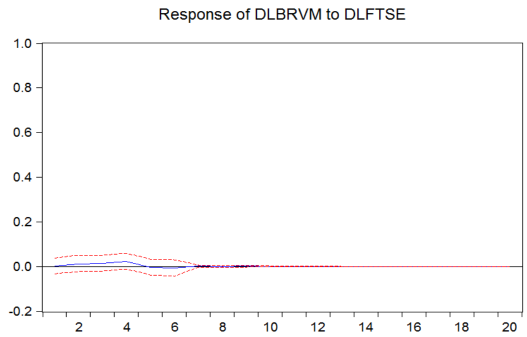

Response of DLJSE to DLBRVM

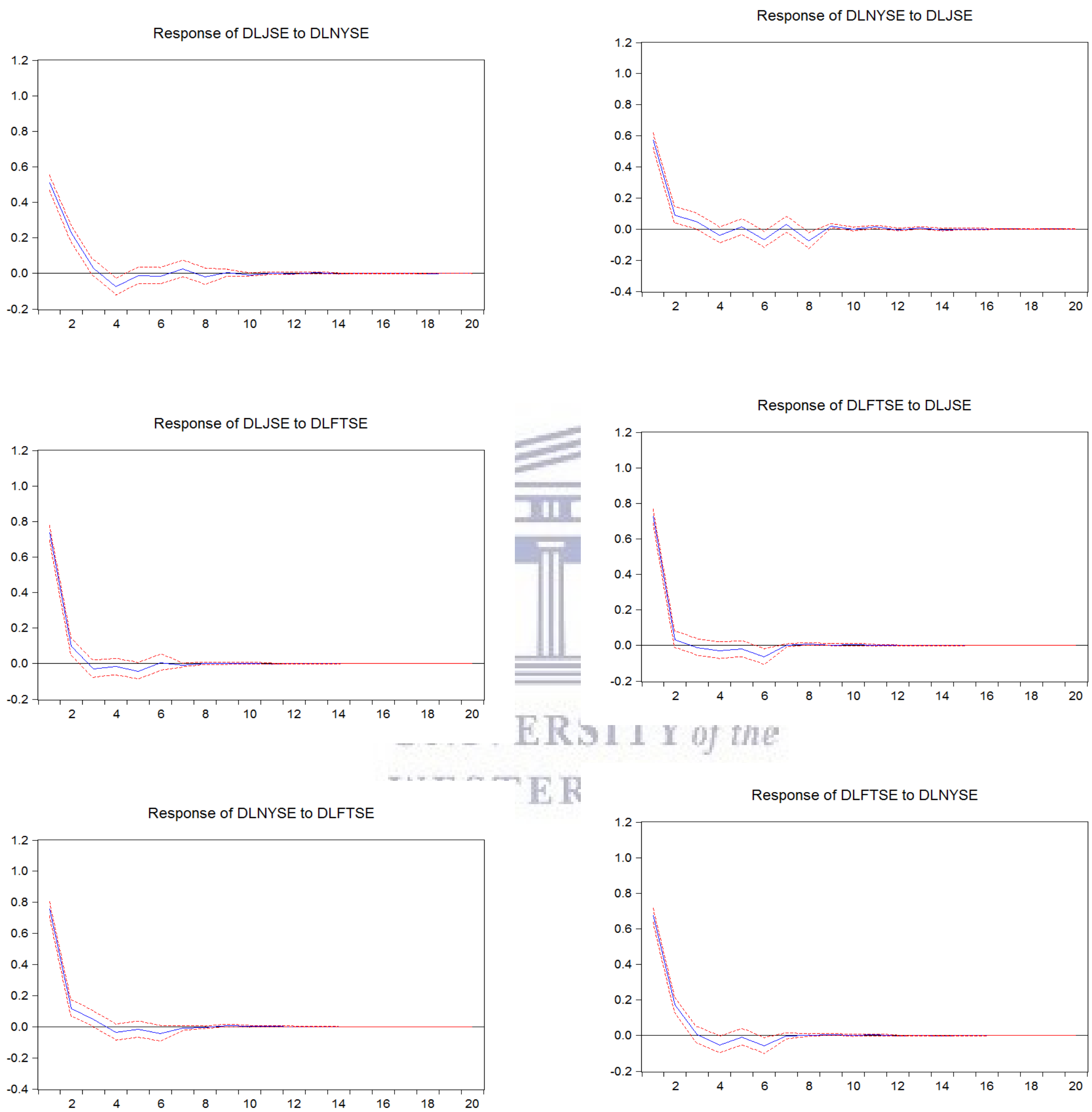

Response of DLBRVM to DLJSE


Response of DLNYSE to DLBRVM


Response of DLBRVM to DLNYSE


Response of DLFTSE to DLBRVM


Response of DLBRVM to DLFTSE



Source: Author's estimations

When the impulse response test is run on the 15 pairs of stock markets, Figure 2.4 depicts the response of the stock indices to a one percent shock to the other index in the pair. On each graph, the blue continued line represents the response, while the two discontinued lines represent the confidence interval for the response. From the figure, it can be seen that the response of BRVM to a shock to any of the other five markets, whether African or others, is not statistically significant as the confidence interval in each case includes zero. In reverse, a shock to the BRVM does not lead to a statistically significant response from any of the other markets.

Similarly, the JSE's response to a shock to any of the African markets is not statistically significant. However, the response of the South African market to a shock to the NYSE is statistically significant only during the first four days. The market's response is strongly positive (with an increase of almost six percent the first day) and decreases until day four when it becomes negative. Moreover, a shock to the FTSE also produces a strong positive response of almost eight percent from the JSE in day one, which then decreases until day three when it becomes statistically insignificant.

In turn, a shock to the JSE produces significant responses from the NGSE, the NYSE and the FTSE. The response of the NGSE is the longest one, being statistically significant up to the sixth day, while being statistically different from zero for two and three days in the case of the FTSE and the NYSE, respectively. The response of the NGSE increases from day one to day two, remains constant in day two and three after which it decreases until day six. However, that response of the NGSE remains weaker than the other two markets, being lower than two percent; while the NYSE and FTSE respond with an increase of almost six percent and eight percent, respectively, in day one.

A shock to the NGSE leads to a response from the NSE that is statistically significant up to day three. The responses from the other markets are not statistically different from zero. Conversely, a shock to NYSE creates a statistically significant response of the NGSE between day two and five. The response is positive but decreasing up to the fifth day. A similar response is observed when a shock occurs in the FTSE.

Likewise, a shock to NSE does not create a statistically significant response of any of the markets, except the NGSE, where the weak positive response is statistically significant until day two. However, a shock to the NYSE leads to positive and statistically significant response of the NSE between day two and three; while a shock to the FTSE produces a positive and statistically significant response of the NSE on the third day only.

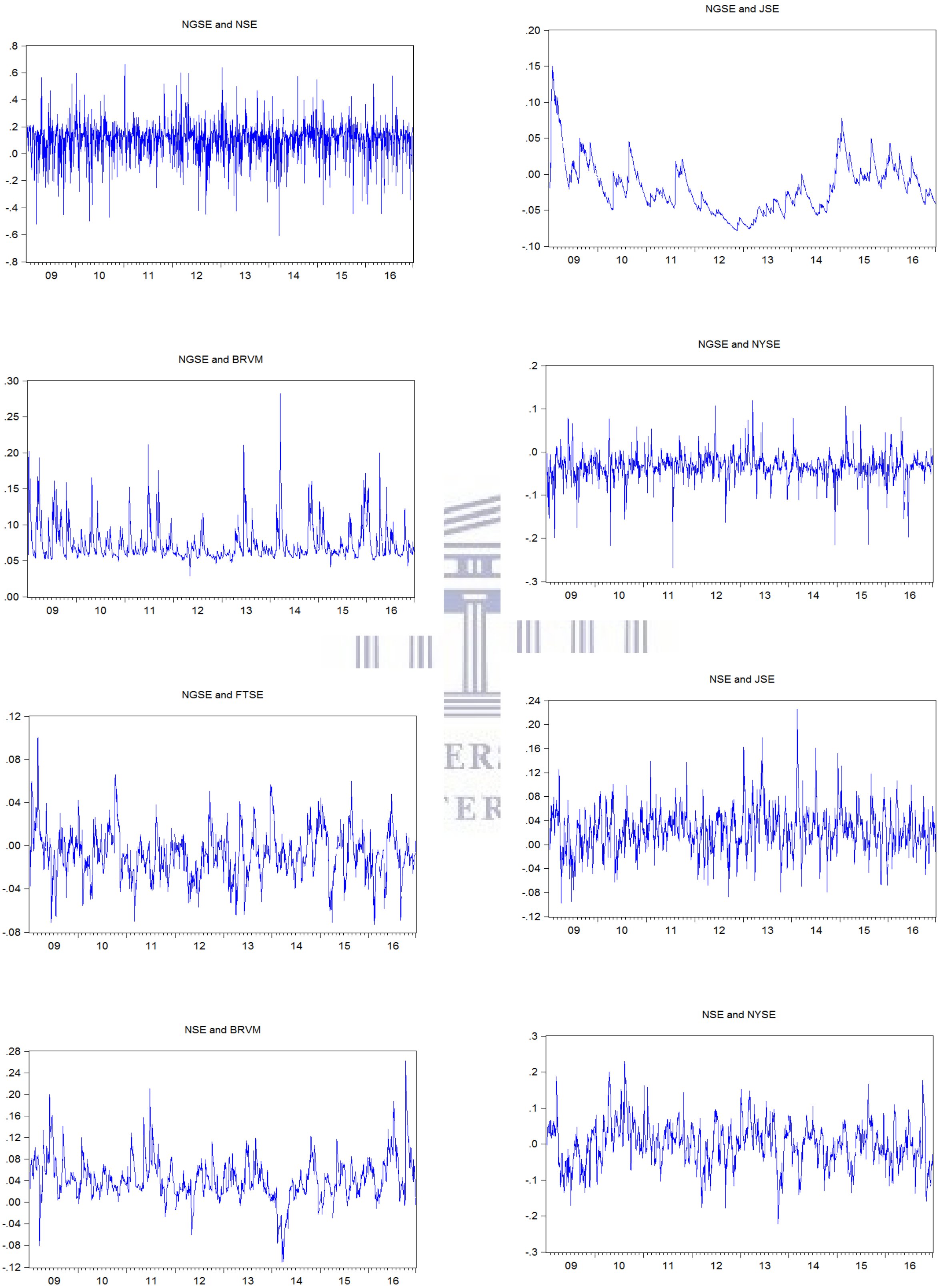
Time varying correlation with the DCC-GARCH

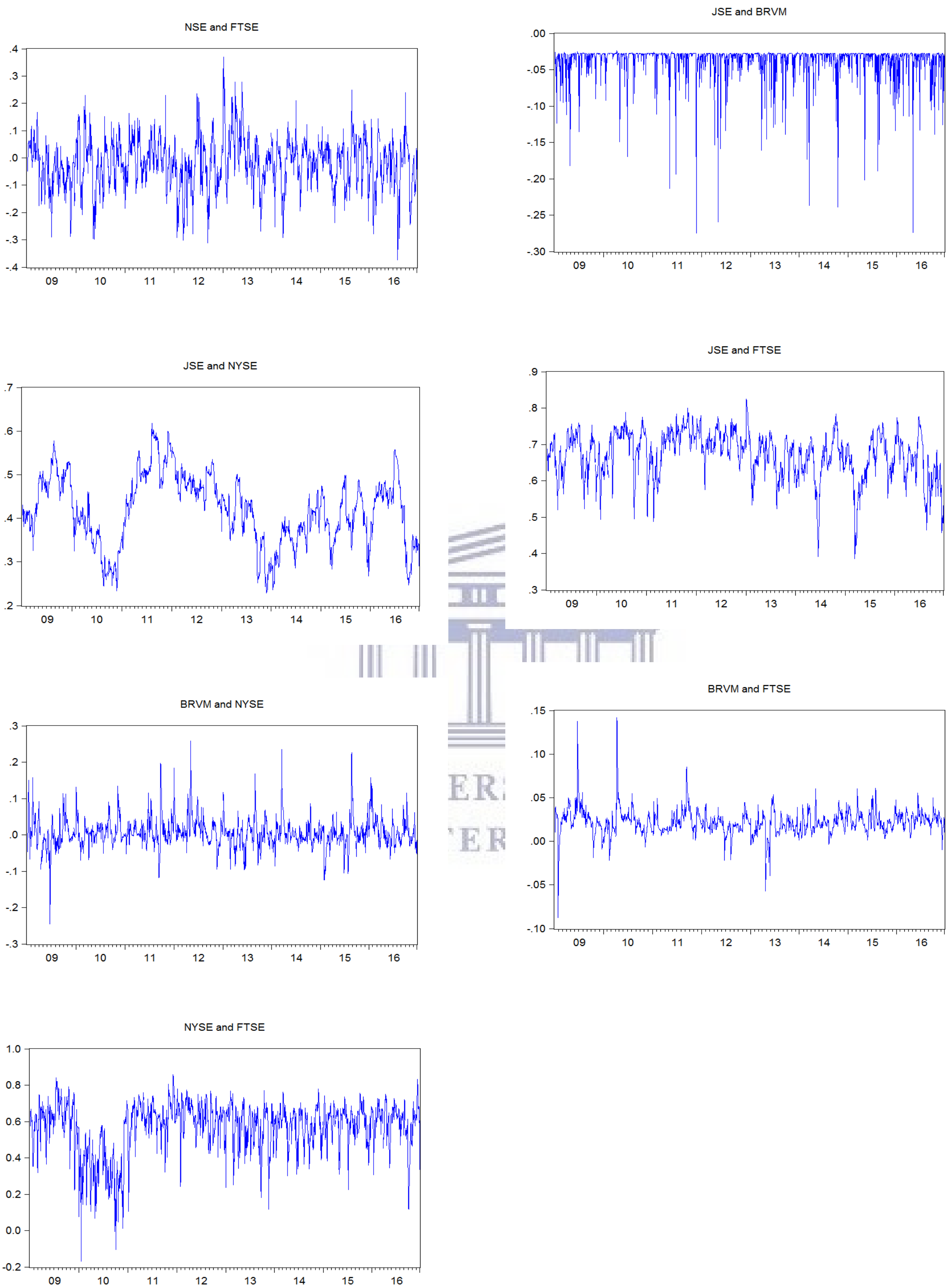
In order to estimate time varying correlation between the markets, a Dynamic Conditional Correlation (DCC) GARCH model is used, for it is better suited to depict dynamic market conditions resulting from shocks (Gupta and Guidi, 2012). The first step when running the DCC model is the selection of the most appropriate univariate volatility model for each of the markets under consideration. The estimates of the models' parameters are presented in Table A.1 in Appendix A. The selection process was based on the following criteria. Firstly, the stationarity of the model was considered. That is, $\alpha_i + \beta_i$ must be less than one (or equal to one in the case of the IGARCH). Secondly, using the ARCH-LM statistic, the ability of the model to appropriately model volatility is examined. Finally, if the models are indistinguishable, the one with the lower AIC and SIC is selected. According to results in Table A.1, the most appropriate model selected for the NGSE is the GARCH (1,1). The GJR-GARCH (1,1,1) is selected for the NSE and BRVM, the APARCH (1,1) for the JSE; the GARCH-M (1,1) for the NYSE and the CGARCH(1,1) for the FTSE. However, when running the DCC models with Eviews 8, the only choices for univariate volatility models are the GARCH, GJR-GARCH and EGARCH. Thus, four pairs (i.e. NSE-JSE, NSE-BRVM, NSE-NYSE and NSE-FTSE) used the GJR-GARCH, as it was most appropriate based on the AIC and SIC. The remaining 11 pairs where fitted with a GARCH (1,1). The estimated parameters of the DCC GARCH models are reported in Table A.2 in Appendix A.

From the table, it can be seen that for most of the pairs, the estimates of the variance equation are statistically significant and the sum of the estimated coefficients is close to one. This shows that volatility in most pairwise correlation among the stock markets is highly persistent, except for NGSE and NSE, NSE and BRVM, NSE and NYSE, NSE and FTSE. Moreover, the estimated coefficients, θ_1 and θ_2, of the correlation equation are both statistically significant only for the following pairs: NSE-FTSE, JSE-NYSE, JSE-FTSE, BRVM-FTSE, NYSE-FTSE. This shows that the conditional correlations are not constant. In these cases, θ_1, which represents the impact of the most recent co-movement, is low and close to zero; while θ_2, which indicates the persistence of the time varying correlations is high and close to one. For seven of the remaining pairs, namely NGSE-JSE, NGSE-BRVM, NGSE-NYSE, NGSE-FTSE, NSE-JSE, NSE-BRVM and NSE-NYSE, only θ_2 is statistically significant, high and close to unity.

The estimated dynamic time varying correlations obtained from the DCC models above are plotted in Figure 2.5. From the graphs, it can be seen that only the pairwise correlations for the NGSE and JSE, JSE and NYSE show strong evidence of varying patterns in the correlation dynamic paths for the entire sample period. For most of the other pairs, the patterns in the correlation dynamic paths show small variations, and even seem to be constant in the case of the NGSE-NSE, NGSE-BRVM, NGSE-NYSE, JSE-BRVM, BRVM-NYSE and BRVM-FTSE. In the case of the pair NGSE and JSE, the correlation is higher in periods of high volatility in the JSE and lower in periods of low volatility. Similarly, in the case of the JSE and NYSE, correlation is higher in periods of high volatility in the NYSE. The highest correlations can be observed between the JSE and NYSE, JSE and FTSE, and the NYSE and FTSE. The remaining 12 pairs show low correlation with the lowest correlation between the BRVM and FTSE. Interestingly, the correlation between the JSE and BRVM is always negative during the sample period, while the correlation between the NGSE and BRVM is always positive during the sample period.

Figure 2.5: Time varying correlations for pairwise stock markets returns





Source: Author's estimations

2.5.2 Volatility linkages

As mentioned in the previous section, the analysis of volatility in each of the markets gave the results reported in Table A.1 in Appendix A. From these results and using the criteria of stationarity, ARCH-LM statistic and the AIC and SIC, the most appropriate model for volatility in each individual market was selected. The GARCH model was selected for the NGSE, the GJR-GARCH for the NSE and BRVM, the APARCH for the JSE, the GARCH-M for the NYSE and the CGARCH for the FTSE.

Based on these models selected, the conditional volatility series for each market is estimated. In order to formally examine the behaviour of volatility in the long term, a simple regression is run with the conditional variances for each market being regressed on a time variable. Table 2.15 presents the results from the estimations.

Table 2.15: Volatility over time

Stock markets	β_0	β_1
NGSE	1.191***	-8.57E-05*
NSE	0.451	0.004*
JSE	1.591***	-0.000***
BRVM	0.724***	-7.07E-05***
NYSE	2.517***	-0.001***
FTSE	1.632***	-0.000***

Source: Author's estimations

Notes: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

The results indicate that volatility in almost all the markets is decreasing over time, except in the NSE where volatility is increasing. However, the coefficient for the time variable in the case of the NGSE and NSE are only significant at the 10 percent level which can be considered as a weak statistical significance. The decreasing volatility over time can be seen as a sign of increasing investors' confidence in the stock markets.

The conditional variance series for the six markets are then examined within a VAR framework to determine possible linkages between them. The optimal lag order is selected using the same procedure as the one used in Section 2.5.1.1. The results are summarized in Table 2.16.

Based on the lags selected in Table 2.16, a VAR model is estimated for each pair of mar-

Table 2.16: Optimal lag order selected for bivariate VAR in volatility linkages analysis

Pair of Stock indices	**Chosen lag length**
NGSE and NSE	26
NGSE and JSE	5
NGSE and BRVM	5
NGSE and NYSE	5
NGSE and FTSE	5
NSE and JSE	3
NSE and BRVM	3
NSE and NYSE	3
NSE and FTSE	5
BRVM and JSE	3
BRVM and NYSE	3
BRVM and FTSE	5
JSE and NYSE	6
JSE and FTSE	6
NYSE and FTSE	6

Source: Author's estimations

kets and Granger causality test, impulse response functions and variance decompositions are subsequently done. The results of the Granger causality tests are presented in Table 2.17.

Granger causality for volatility linkages

Table 2.17 shows that, at the five percent level of significance, there is bi-directional causality in volatility between the NGSE and NSE, NGSE and JSE, JSE and NYSE, JSE and FTSE, and the NYSE and FTSE. In other words, changes in volatility in the NGSE Granger cause changes in volatility in the NSE and the JSE, and vice versa. Similarly, changes in volatility in the JSE Granger cause changes in volatility in the NYSE and the FTSE, and vice versa. Finally, changes in volatility in the NYSE Granger cause changes in volatility in the FTSE, and vice versa. For the 10 remaining pairs, the Granger causality is not statistically significant. This implies that, in each of these cases, changes in volatility are independent for each market.

Impulse response functions for volatility linkages

Figure 2.6 reports the impulse response functions for the volatility linkages. As it can be

Table 2.17: Granger causality test on the stock markets' conditional volatilities, 2009 - 2016

Null Hypothesis:	F-Statistic	p-value
NSE does not Granger Cause NGSE	8.870	2.E-32
NGSE does not Granger Cause NSE	2.439	7.E-05
JSE does not Granger Cause NGSE	2.512	0.0282
NGSE does not Granger Cause JSE	2.712	0.0189
BRVM does not Granger Cause NGSE	0.115	0.9892
NGSE does not Granger Cause BRVM	1.143	0.3353
NYSE does not Granger Cause NGSE	2.069	0.0664
NGSE does not Granger Cause NYSE	0.276	0.9262
FTSE does not Granger Cause NGSE	0.811	0.5416
NGSE does not Granger Cause FTSE	1.881	0.0944
JSE does not Granger Cause NSE	1.764	0.1519
NSE does not Granger Cause JSE	1.326	0.2641
BRVM does not Granger Cause NSE	0.094	0.9631
NSE does not Granger Cause BRVM	0.049	0.9855
NYSE does not Granger Cause NSE	0.356	0.7858
NSE does not Granger Cause NYSE	0.208	0.8911
FTSE does not Granger Cause NSE	1.103	0.3566
NSE does not Granger Cause FTSE	1.641	0.1457
JSE does not Granger Cause BRVM	0.514	0.6722
BRVM does not Granger Cause JSE	1.679	0.1693
NYSE does not Granger Cause BRVM	0.469	0.7040
BRVM does not Granger Cause NYSE	0.071	0.9756
FTSE does not Granger Cause BRVM	0.304	0.9106
BRVM does not Granger Cause FTSE	0.840	0.5211
NYSE does not Granger Cause JSE	5.000	4.E-05
JSE does not Granger Cause NYSE	14.447	3.E-16
FTSE does not Granger Cause JSE	10.813	7.E-12
JSE does not Granger Cause FTSE	10.054	6.E-11
FTSE does not Granger Cause NYSE	8.016	1.E-08
NYSE does not Granger Cause FTSE	4.841	6.E-05

Source: Author's estimations

expected following the results of the Granger causality test, the response of volatility in the BRVM to a shock to volatility in any of the other five markets, whether African or others, is not statistically significant as the confidence interval in each case includes zero. Conversely, a shock to volatility in the BRVM does not lead to a statistically significant response from any of the other markets. Similarly, a shock to volatility in the NSE does not create a statistically significant response of any of the markets, except the NGSE, where the weak positive response fluctuates between 0.05 and 0.2 until day 26 when it becomes statistically insignificant. However, volatility in the NSE only responds to a shock in volatility in the NGSE with a weak positive response that is only statistically significant until day four.

The response of volatility in the JSE to a shock to any of the African markets is not statistically significant. However, the response of volatility in the market to a shock to volatility in the NYSE is positive but decreasing, and statistically significant during the first 25 days. Moreover, a shock to volatility in the FTSE also produces a weak positive response from the JSE, which then decreases until day 35 when it becomes statistically insignificant.

In turn, a shock to volatility in the JSE produces significant responses from the NGSE, the NYSE and the FTSE. The response of volatility in the NGSE is the weakest, and is statistically significant for 120 days. In the case of the FTSE and the NYSE, the response is statistically significant for 105 days and 120 days respectively. The response of the NGSE is weak but remains positive, while the NYSE and FTSE respond with an immediate increase, then a decrease until becoming statistically insignificant.

Finally, although a shock to volatility in the NGSE does not significantly affect any of the markets, except the NSE, volatility in the NGSE responds to a shock to volatility in the NYSE and the FTSE, with a weak but positive response which decreases until it becomes statistically insignificant in the 14th and 15th day for the FTSE and NYSE, respectively.

Variance decomposition for volatility linkages

Lastly, the pairwise variance decompositions for each of the markets is estimated, to obtain

Table 2.18: Pairwise variance decomposition for stock markets volatility linkages

Variance decomposition of NGSE						
Period	NGSE	NSE	JSE	BRVM	NYSE	FTSE
1	N/A	0.000	0.081	0.000	0.118	0.244
10	N/A	6.529	1.168	0.025	1.918	1.190
20	N/A	12.147	2.371	0.032	2.436	1.788
Variance decomposition of NSE						
Period	NGSE	NSE	JSE	BRVM	NYSE	FTSE
1	0.906	N/A	0.091	0.000	1.56E-05	0.001
10	1.378	N/A	0.339	0.0339	0.043	0.241
20	1.674	N/A	0.341	0.034	0.052	0.266
Variance decomposition of JSE						
Period	NGSE	NSE	JSE	BRVM	NYSE	FTSE
1	0.000	0.000	N/A	0.000	6.953	23.255
10	0.249	0.039	N/A	0.275	9.136	31.201
20	0.364	0.054	N/A	0.457	8.515	28.227
Variance decomposition of BRVM						
Period	NGSE	NSE	JSE	BRVM	NYSE	FTSE
1	0.010	0.001	4.68E-05	N/A	0.014	0.028
10	0.384	0.026	0.088	N/A	0.089	0.212
20	0.482	0.026	0.094	N/A	0.089	0.226
Variance decomposition of NYSE						
Period	NGSE	NSE	JSE	BRVM	NYSE	FTSE
1	0.000	0.000	0.000	0.000	N/A	0.000
10	0.024	0.049	7.868	0.005	N/A	6.166
20	0.042	0.055	15.726	0.004	N/A	7.609
Variance decomposition of FTSE						
Period	NGSE	NSE	JSE	BRVM	NYSE	FTSE
1	0.000	0.000	0.000	0.000	18.140	N/A
10	0.232	0.525	1.407	0.009	27.656	N/A
20	0.887	0.558	3.655	0.010	34.699	N/A

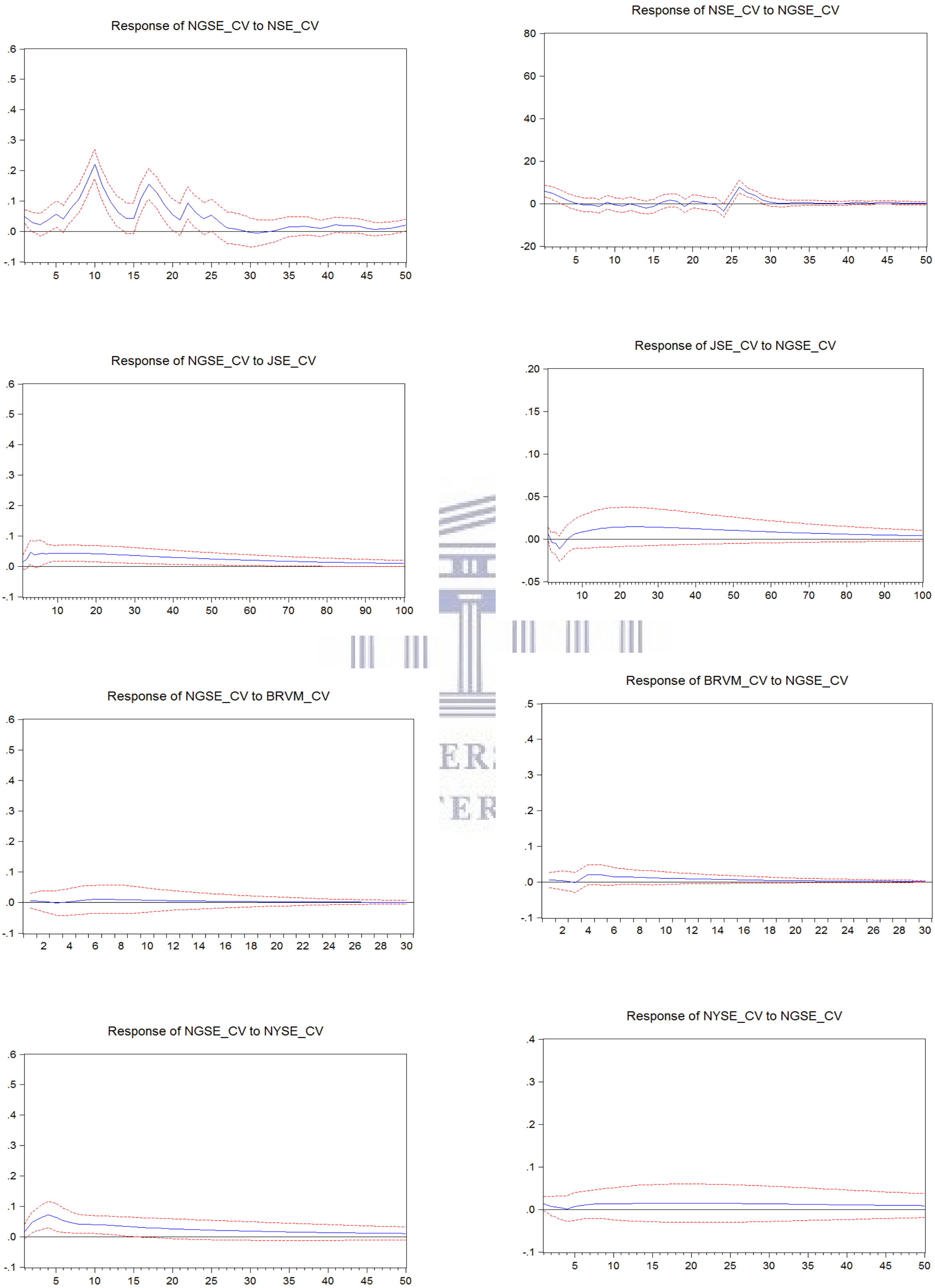
Source: Author's estimations

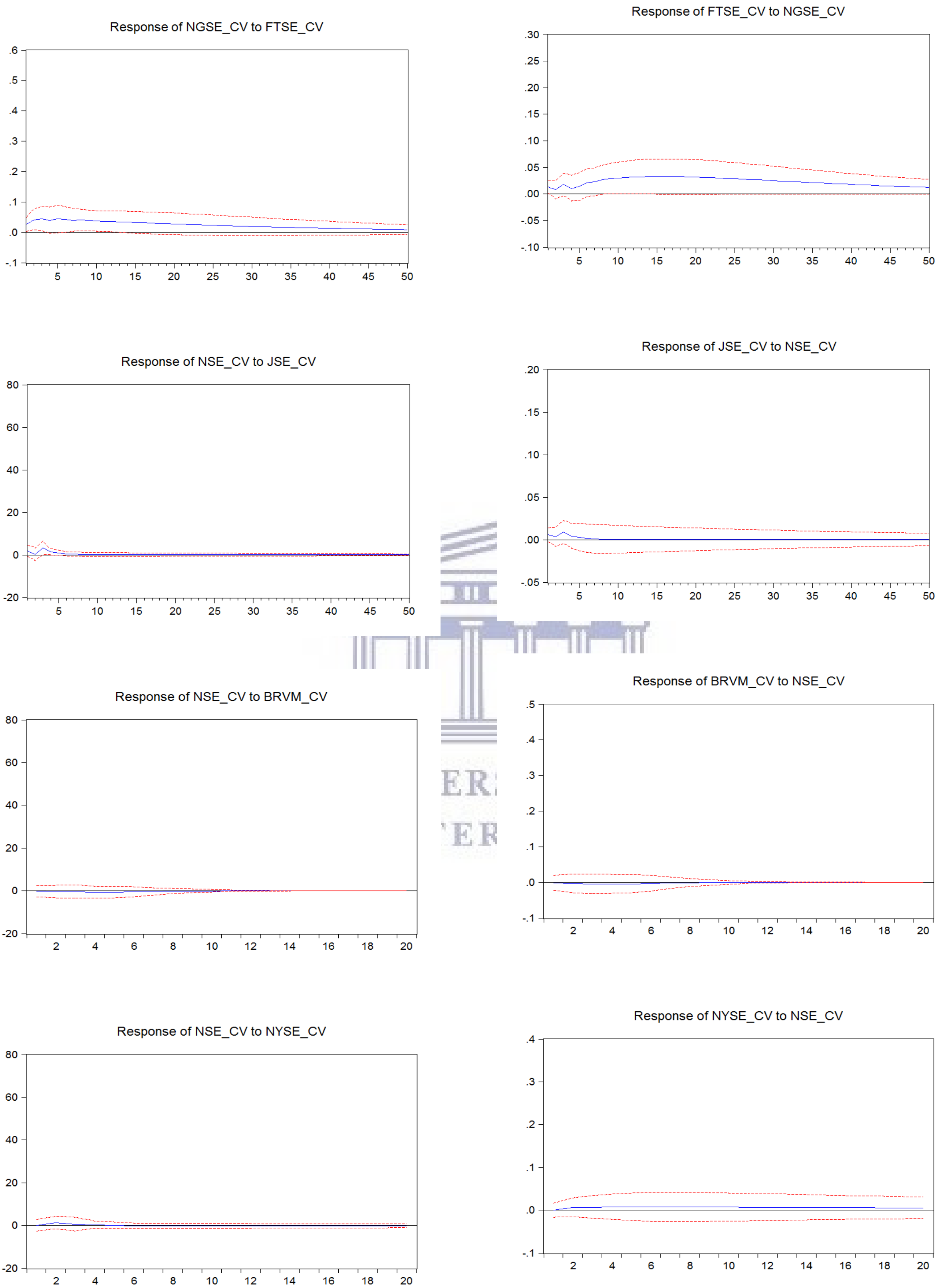
more insight into the actual value of each market in explaining volatility in the other markets. Table 2.18 summarizes the results. There is some evidence that innovations from the NSE are important in explaining the variations in volatility in the NGSE, while innovations in the NYSE and the FTSE are important in explaining volatility in the JSE. Outside of these cases, it can be seen that own innovations are most important in explaining variations in the current stock market volatility for each pair of markets.

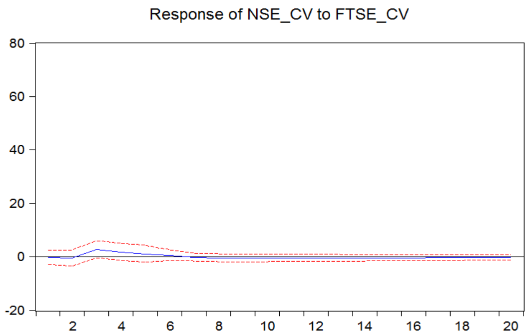
2.5.3 Discussion of the results

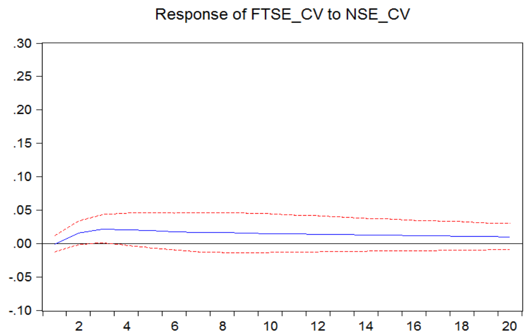
The results of the empirical analysis uncovered some interesting patterns. In the short run

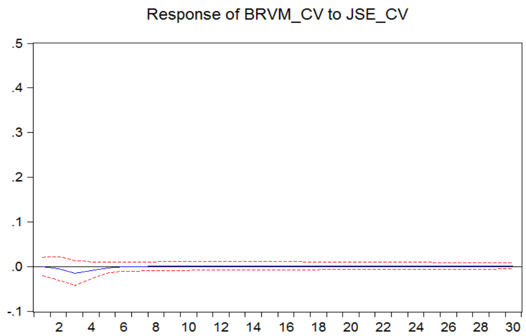
Figure 2.6: Impulse response functions for stock markets volatility linkages

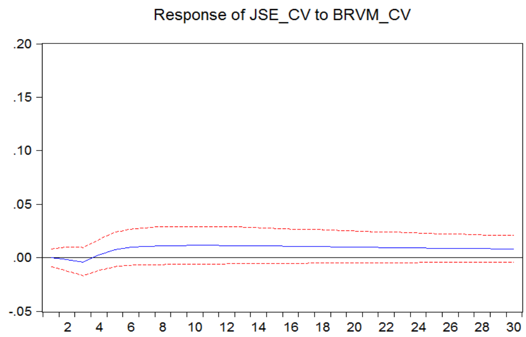


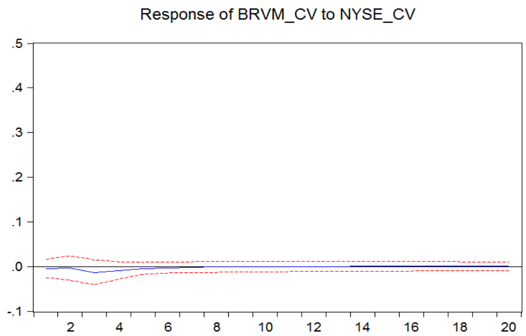

Response of NGSE_CV to FTSE_CV
Response of FTSE_CV to NGSE_CV
Response of NSE_CV to JSE_CV
Response of JSE_CV to NSE_CV
Response of NSE_CV to BRVM_CV
Response of BRVM_CV to NSE_CV
Response of NSE_CV to NYSE_CV
Response of NYSE_CV to NSE_CV

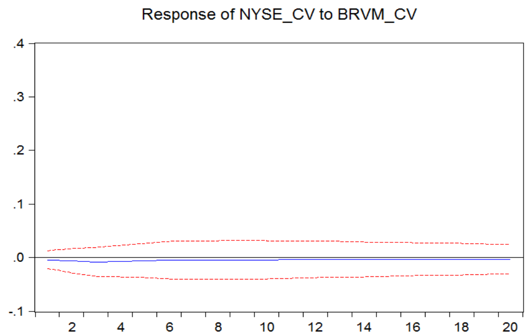

Response of NSE_CV to FTSE_CV
80
60
40
20
0
-20
2 4 6 8 10 12 14 16 18 20


Response of FTSE_CV to NSE_CV
.30
.25
.20
.15
.10
.05
.00
-.05
-.10
2 4 6 8 10 12 14 16 18 20


Response of BRVM_CV to JSE_CV
.5
.4
.3
.2
.1
.0
-.1
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30


Response of JSE_CV to BRVM_CV
.20
.15
.10
.05
.00
-.05
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30


Response of BRVM_CV to NYSE_CV
.5
.4
.3
.2
.1
.0
-.1
2 4 6 8 10 12 14 16 18 20


Response of NYSE_CV to BRVM_CV
.4
.3
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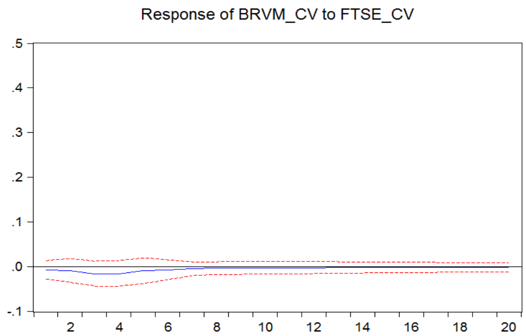
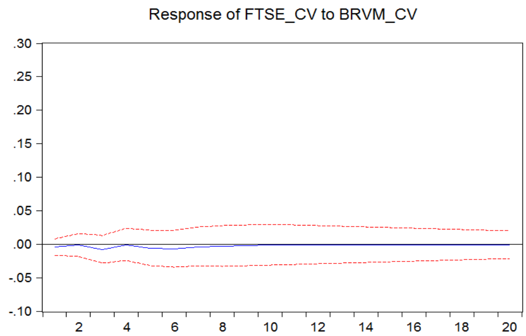
.1
.0
-.1
2 4 6 8 10 12 14 16 18 20


Response of BRVM_CV to FTSE_CV
.5
.4
.3
.2
.1
.0
-.1
2 4 6 8 10 12 14 16 18 20


Response of FTSE_CV to BRVM_CV
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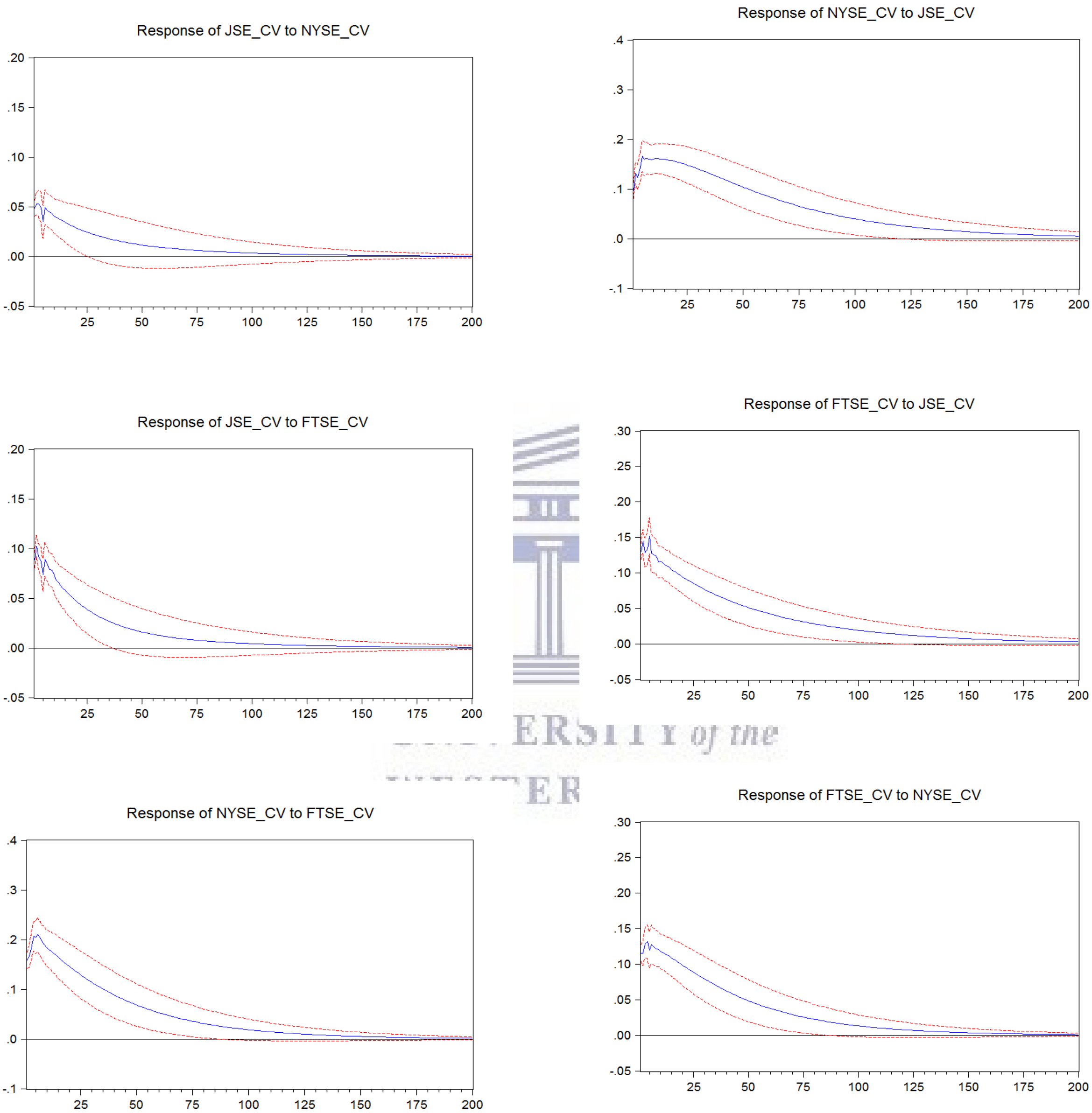
.25
.20
.15
.10
.05
.00
-.05
-.10
2 4 6 8 10 12 14 16 18 20



Source: Author's estimations

model, the depression of stock returns on most of the African markets resulting from changes in lagged stock returns of the NYSE illustrate the significant short- and long-run stock price co-movements existing between the African markets and the American stock market. This may be due to the important trade and financial linkages between these economies. However, as it can be seen from the impulse response showing that a shock to the BRVM does not significantly affect any of the other stock markets speaks to the still-relatively small size of this market compared to the other African markets which are more dominant, especially in their respective subregions. The BRVM, being the youngest, the smallest in terms of market capitalization and the least developed of the four does not have the necessary dominance in the region to be able to affect the other markets. Moreover, the geographical proximity between the BRVM and NGSE, and the fact that they are both members of the ECOWAS does not improve the level of integration between their stock markets, despite their strong trade links. With South Africa being ranked high on the list of the African trading partners of Nigeria, Kenya and the WAEMU, and with the JSE being the dominant market in the region, it is intuitive that a shock to the market has a significant impact on the other three smaller markets, but only get affected by shocks from the more developed markets such as the NYSE and the FTSE with whom it shares strong trade ties. The JSE surely represents a more attractive option to the international investors looking to expand their portfolios to African stocks. That could be the source of a spillover of shocks from the JSE to the NYSE and FTSE. Additionally, the influence of the Nigerian and Kenyan markets on each other, could stem from their strong economic and financial ties with South Africa, which also links them indirectly.

From the time-varying correlation analysis, it can be seen that the effect of most recent co-movement and persistence is only significant for mostly developed markets. This confirms the hypothesis that the impact of economic shocks in one country could affect other countries with which it has strong economic ties. However, the puzzling case of the correlation between the BRVM and FTSE leads to the argument that co-movements may not only happen among economies with direct ties. As posited by Kambadza and Chinzara (2012), in cases where there are strong economic ties between the concerned countries and a third party country, an economic shock to the third party country may lead to a co-movement of the concerned countries' stock markets. Furthermore, in lieu of economic factors, the positions taken by investors to diversify their portfolio in anticipation of an expected future crisis in one economy, may be the source of contagion and the co-movement in stock prices in the other related countries.

2.6 CONCLUSION AND RECOMMENDATIONS

2.6.1 Summary of findings

The rising level of foreign direct investment and portfolio investment towards the African continent constitutes an important contribution to the development of the region's financial sector and economy as a whole. Moreover, following the worldwide movement toward economic and financial integration, developing markets are more targeted now than they were decades ago, hence the increased interest in studying financial markets in the region. The main objective of this study was to investigate the existence of stock price co-movements and volatility spillovers among stock markets in Sub-Saharan Africa as well as their linkages with the more developed markets. The study considered four Sub-Saharan African markets, namely, the Nigeria Stock exchange, the Nairobi Securities Exchange, the Johannesburg stock Exchange and the West African Exchange. To be compared to these emerging markets, two developed markets were chosen, namely the New York Stock Exchange and the London Stock Exchange. The analysis was conducted using daily closing prices of all six markets' All Share indices covering the period 2 January 2009 - 31 December 2016.

The results from the bivariate and multivariate Johansen cointegration tests showed the existence of cointegration between all six markets. This indicates the existence of long-run relationships between the markets. Thus, to further investigate the short-run relationship existing between the markets, the VECM was estimated. It was seen that the stock returns of almost all the African markets under consideration were significantly depressed by changes in lagged stock returns in the NYSE, except in the case of the NGSE which was only affected by changes in the lagged stock returns of the other African stock markets. Apart from the JSE, none of the other African markets are affected by changes in lagged stock returns in the FTSE. On the African sphere, while the BRVM is the only market that does not significantly affect the JSE, it is in turn affected by changes in lagged returns in the JSE. The Granger causality test and impulse response functions were also run. The Granger causality test confirmed the presence of bi-directional causality between the NYSE and BRVM and NGSE, NYSE and JSE, and NYSE and FTSE at the five percent level of significance. Also, there were uni-directional causalities from the FTSE to the NGSE, NSE and JSE. This showed that the returns from the selected markets in Sub-Saharan Africa are not completely isolated from shocks coming from developed countries as well as shocks occurring among themselves. The impulse response functions showed that the BRVM does not significantly respond to a shock to any of the other five markets, whether African or others, and a shock to the BRVM does not lead to a statistically significant response from any of the other markets. Moreover, the JSE's response to a shock to any of the African markets is not statistically significant, although the JSE's response to a shock to the NYSE, as well as to the FTSE, is strongly positive but statistically significant for a few days only. In turn, a shock to the JSE produces significant responses from the NGSE, the NYSE and the FTSE. Both the NGSE and NSE are significantly responsive to each other's innovations, while they both also significantly respond to innovations in the NYSE and FTSE.

The results of estimation of time varying correlation between the markets showed that volatility in most pairwise correlation among the stock markets is highly persistent, except for NGSE and NSE, NSE and BRVM, NSE and NYSE, NSE and FTSE. This shows that the conditional correlations are not constant for the pairs NSE-FTSE, JSE-NYSE, JSE-FTSE, BRVM-FTSE, NYSE-FTSE. Only the pairwise correlations for the NGSE and JSE, JSE and NYSE, show strong evidence of varying patterns in the correlation dynamic paths for the entire sample period. For most of the other pairs, the patterns in the correlation dynamic paths show small variations, and even seem to be constant in the case of the NGSE-NSE, NGSE-BRVM, NGSE-NYSE, JSE-BRVM, BRVM-NYSE and BRVM-FTSE. In the case of the pair NGSE and JSE, the correlation is higher in periods of high volatility in the JSE and lower in periods of low volatility. Similarly, in the case of the JSE and NYSE, correlation is higher in periods of high volatility in the NYSE. The JSE has the highest correlation with the NYSE and the FTSE. While the NYSE and FTSE also have the highest correlations. The remaining 12 pairs show low correlation with the lowest correlation between the BRVM and FTSE. Interestingly, the correlation between the JSE and BRVM is always negative during the sample period, while the correlation between the NGSE and BRVM is always positive during the sample period.

The results from the volatility analysis selected different models as most appropriate in modeling volatility in the six markets. The GARCH model was selected for the NGSE, the GJR-GARCH for the NSE and BRVM, the APARCH for the JSE, the GARCH-M for the NYSE and the CGARCH for the FTSE. Volatility in almost all of the markets is decreasing over time, except in the NSE where volatility is increasing, which can be considered as a sign of increasing investors' confidence in the stock markets. Furthermore, the Granger causality found that there is bi-directional causality in volatility between the NGSE and NSE, NGSE and JSE, JSE and NYSE, JSE and FTSE, and the NYSE and FTSE. In the remaining cases, changes in volatility are found to be independent.

This was confirmed by the impulse response functions that indicated that volatility in the BRVM does not significantly respond to shocks to volatility in any of the other five markets; nor does a shock to the BRVM create significant response from any of the other markets. Similarly, a shock to volatility in the NSE significantly affects only the NGSE, and vice versa. Additionally, volatility in the JSE only responds to shocks to volatility in the NYSE and the FTSE. In turn, a shock to volatility in the JSE significantly affects the NGSE, the NYSE and the FTSE. Although a shock to volatility in the NGSE does not significantly affect any of the markets, except the NSE, volatility in the NGSE responds to a shock to volatility in the NYSE and the FTSE. Finally, the pairwise variance decompositions showed evidence that innovations from the NSE are important in explaining the variations in volatility in the NGSE, while innovations in the NYSE and the FTSE are important in explaining volatility in the JSE. Outside of these cases, it can be seen that own innovations are most important in explaining variations in the current stock market volatility for each pair of markets.

Generally, this evidence suggests that there are limited returns and volatility linkages among the African markets and only the NGSE, NSE and JSE are significantly affected by innovations in the developed markets. This confirms the theory that stipulates that countries that share strong economic ties are more likely to have their stock markets co-move. In effect, as the UK and the USA are both major trading partners of the African countries considered in the study, it was anticipated that movements on these developed markets would affect the emerging one. In effect, as the UK and the USA are both major trading partners of the English-speaking African countries considered in the study, it was anticipated that movements on these developed markets would affect the developing ones.

2.6.2 Implications and Policy Recommendations

The results found in this study have important implications for investors, as the limited co-movements and volatility spillovers reveal an existing opportunity to diversify investment portfolios. In effect knowing the volatility linkages between markets could help investors in minimizing the volatility of their portfolios. In addition, these results could also assist in arbitrage and stock market predictability exercises. Furthermore, the stronger responsiveness of returns and volatility to domestic shocks compared to foreign shocks imply that policymakers should put an emphasis on domestic macroeconomic stability in order to maintain financial stability. Policymakers in South Africa and Nigeria more specifically should, however, remain vigilant to volatility crises in the developed economies as they tend to have a more significant effect on their domestic markets volatility. Lastly, the importance of the existing regional trade and financial linkages might encourage the diversification of the exports base as a natural macroeconomic strategy in an attempt to limit the harmful effects of volatility into the domestic stock markets, created by a slow-down in the demand for certain exports.

2.6.3 Limitations of the study and areas of further research

This study was limited by the unavailability of values for business days that were holidays in the different markets considered. This imposed the use of interpolation to replace the missing values and increases the risk of data mining. While the study was only confined to a few Sub-Saharan African countries, and only two developed markets, it could be interesting to deepen the analysis by including more African countries and more developed markets (preferably Asian markets).

Additionally, the sample period could be extended to include periods of economic/financial as well as political turmoil in the developed markets, in order to investigate the effect of the crisis on the selected linkages.

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Appendix A

Table A.1: GARCH models selection

Panel A: GARCH (1,1)

Parameters	NGSE	NSE	JSE	BRVM	NYSE	FTSE
ω	0.087***	0.240***	0.018***	0.199***	0.028***	0.029***
α_1	0.221***	2.480***	0.072***	0.193***	0.114 ***	0.114***
β_1	0.699***	0.050***	0.910***	0.503***	0.864***	0.859***
α_2	N/A	N/A	N/A	N/A	N/A	N/A
β_2	N/A	N/A	N/A	N/A	N/A	N/A
$\alpha_i + \beta_i$	0.921	2.485	0.983	0.696	0.978	0.973
γ	N/A	N/A	N/A	N/A	N/A	N/A
F-LM	2.280	0.036	1.104	0.258	2.111	0.237
AIC	2.631	2.747	2.783	2.296	2.797	2.704
SIC	2.642	2.758	2.794	2.307	2.808	2.715

Panel B: GARCH-M (1,1)

Parameters	NGSE	NSE	JSE	BRVM	NYSE	FTSE
λ	0.006	-0.004*	0.076**	0.070	0.067**	0.105***
ω	0.087***	0.257***	0.019***	0.200***	0.027***	0.030***
α_1	0.221***	2.475***	0.073***	0.193***	0.114***	0.114***
β_1	0.699***	0.033***	0.909***	0.502***	0.864***	0.858***
α_2	N/A	N/A	N/A	N/A	N/A	N/A
β_2	N/A	N/A	N/A	N/A	N/A	N/A
$\alpha_i + \beta_i$	0.920	2.509	0.982	0.694	0.978	0.972
γ	N/A	N/A	N/A	N/A	N/A	N/A
F-LM	2.231	0.038	1.315	0.438	1.905	0.136
AIC	2.632	2.745	2.782	2.296	2.795	2.700
SIC	2.646	2.759	2.796	2.310	2.809	2.714

Panel C: IGARCH (1,1)

Parameters	NGSE	NSE	JSE	BRVM	NYSE	FTSE
ω	N/A	N/A	N/A	N/A	N/A	N/A
α_1	0.078***		0.059***	0.003***	0.066***	0.070***
β_1	0.922***		0.941***	0.997***	0.934***	0.930***
α_2	N/A	N/A	N/A	N/A	N/A	N/A
β_2	N/A	N/A	N/A	N/A	N/A	N/A
$\alpha_i + \beta_i$	1		1	1	1	1
γ	N/A	N/A	N/A	N/A	N/A	N/A
F-LM	24.610***		0.016	179.003***	0.953	5.209**
AIC	2.695		2.797	2.396	2.825	2.725
SIC	2.701		2.802	2.401	2.830	2.730

Panel D: EGARCH (1,1,1)

Parameters	NGSE	NSE	JSE	BRVM	NYSE	FTSE
ω	-0.305***	-0.752***	-0.061***	-0.473***	-0.087***	-0.137***
α_1	0.385***	1.156***	0.077***	0.397***	0.114***	0.169***
β_1	0.893***	0.440***	0.986***	0.620***	0.983***	0.963***
α_2	N/A	N/A	N/A	N/A	N/A	N/A
β_2	N/A	N/A	N/A	N/A	N/A	N/A
$\alpha_i + \beta_i$	1.278	1.596	1.063	1.017	1.097	1.132
γ	0.021*	-0.626***	-0.111***	0.044***	-0.119***	-0.150***
F-LM	6.039**	0.009	2.130	0.005	0.429	3.162*
AIC	2.637	2.759	2.747	2.296	2.767	2.652
SIC	2.651	2.772	2.761	2.310	2.781	2.666

Panel E: GJR-GARCH (1,1,1)

Parameters	NGSE	NSE	JSE	BRVM	NYSE	FTSE
ω	0.082***	0.096***	0.014***	0.197***	0.025***	0.029***
α_1	0.232***	0.429***	-0.012	0.234***	0.005	-0.012
β_1	0.711***	0.447***	0.932***	0.505***	0.894***	0.876***
α_2	N/A	N/A	N/A	N/A	N/A	N/A
β_2	N/A	N/A	N/A	N/A	N/A	N/A
$\alpha_i + \beta_i$	0.943	0.876	0.921	0.739	0.899	0.864
γ	-0.036	1.906***	0.131***	-0.080***	0.154***	0.217***
F-LM	2.459	0.001	4.005**	0.192	1.911	5.352**
AIC	2.631	2.728	2.754	2.295	2.770	2.653
SIC	2.645	2.741	2.768	2.309	2.784	2.667

Panel F: APARCH (1,1)

Parameters	NGSE	NSE	JSE	BRVM	NYSE	FTSE
ω	0.092***	0.221***	0.015***	0.074***	0.021***	0.034***
α_1	0.225***	2.692***	0.056***	0.076***	0.071***	0.088***
β_1	0.712***	0.003	0.944***	0.358***	0.930***	0.891
α_2	N/A	N/A	N/A	N/A	N/A	N/A
β_2	N/A	N/A	N/A	N/A	N/A	N/A
$\alpha_i + \beta_i$	0.937	2.695	0.999	0.434	1.001	0.980
δ	1.649***	2.782***	0.940***	5.260***	0.924***	1.138
γ	-0.046	0.540***	1.000***	-0.061321**	0.999***	0.961764***
F-LM	2.974*	0.002	2.575	0.014	0.446	3.855**
AIC	2.631	2.646	2.748	2.290	2.762	2.648
SIC	2.648	2.662	2.765	2.307	2.779	2.664

Panel G: CGARCH (1,1)

Parameters	NGSE	NSE	JSE	BRVM	NYSE	FTSE
ω	1.015***	1.816***	0.989***	0.663***	1.318***	1.483***
α_1	0.227***	0.398***	-0.191***	-0.073*	0.013	-0.159***
β_1	0.114	0.204	0.990***	0.107	-0.362*	1.070265***
α_2	N/A	N/A	N/A	N/A	N/A	N/A
β_2	N/A	N/A	N/A	N/A	N/A	N/A
$\alpha_i + \beta_i$	0.341	0.602	0.799	0.034	-0.349	0.911
ρ	0.957***	0.204***	0.965***	0.685***	0.976***	0.984268***
ϕ	0.119***	0.120	0.137***	0.211***	0.129***	0.173***
γ	-0.031	-0.403***	0.144***	0.168***	-0.111***	0.141***
F-LM	0.472	2.957***	1.237	0.312	0.696	0.347
AIC	2.617	2.992	2.772	2.291	2.791	2.670
SIC	2.636	3.012	2.791	2.311	2.811	2.689

Source: Author's estimations

Note: *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table A.2: Results of bivariate DCC-GARCH models on indices' daily returns.

A - NGSE and NSE markets		
	NGSE	NSE
I. Mean equation		
μ	-0.014(0.016)	0.257***(0.039)
II. Variance equation		
ω	0.089***(0.019)	0.240***(0.051)
α	0.227***(0.040)	2.482*(1.461)
β	0.692*** (0.043)	0.049(0.049)
III. Correlation equation		
θ_1	0.425***(0.054)	
θ_2	0.137(0.128)	
B - NGSE and JSE markets		
	NGSE	JSE
I. Mean equation		
μ	-0.014(0.016)	0.055***(0.019)
II. Variance equation		
ω	0.089***(0.019)	0.019***(0.007)
α	0.227***(0.040)	0.078***(0.012)
β	0.693***(0.043)	0.905***(0.015)
III. Correlation equation		
θ_1	-0.018(0.052)	
θ_2	0.984***(0.019)	
C - NGSE and BRVM markets		
	NGSE	BRVM
I. Mean equation		
μ	-0.014(0.016)	0.007(0.016)
II. Variance equation		
ω	0.089***(0.019)	0.200***(0.069)
α	0.227***(0.040)	0.194***(0.042)
β	0.693***(0.043)	0.502***(0.121)
III. Correlation equation		
θ_1	0.002(0.015)	
θ_2	0.831***(0.107)	
D - NGSE and NYSE markets		
	NGSE	NYSE
I. Mean equation		
μ	-0.014(0.016)	0.045**(0.020)
II. Variance equation		
ω	0.089***(0.019)	0.028***(0.011)
α	0.227***(0.040)	0.118***(0.021)
β	0.692***(0.043)	0.860***(0.025)
III. Correlation equation		
θ_1	-0.017(0.013)	
θ_2	0.742***(0.250)	

E - NGSE and FTSE markets		
	NGSE	FTSE
I. Mean equation		
μ	-0.014(0.016)	0.049**(0.019)
II. Variance equation		
ω	0.089***(0.019)	0.030***(0.009)
α	0.227***(0.040)	0.119***(0.018)
β	0.693***(0.043)	0.854***(0.021)
III. Correlation equation		
θ_1	0.009(0.013)	
θ_2	0.904***(0.126)	
F - NSE and JSE markets		
	NSE	JSE
I. Mean equation		
μ	0.112***(0.027)	0.016(0.019)
II. Variance equation		
ω	0.097(0.080)	0.015***(0.004)
α	0.428**(0.172)	-0.004(0.013)
β	0.445*(0.262)	0.924***(0.010)
III. Correlation equation		
θ_1	0.026(0.025)	
θ_2	0.801***(0.134)	
G - NSE and BRVM markets		
	NSE	BRVM
I. Mean equation		
μ	0.112***(0.027)	0.013(0.016)
II. Variance equation		
ω	0.097(0.080)	0.198***(0.068)
α	0.428**(0.172)	0.235***(0.083)
β	0.445*(0.262)	0.504***(0.118)
III. Correlation equation		
θ_1	0.012(0.013)	
θ_2	0.918***(0.063)	
H - NSE and NYSE markets		
	NSE	NYSE
I. Mean equation		
μ	0.112***(0.027)	0.009(0.019)
II. Variance equation		
ω	0.097(0.080)	0.025***(0.008)
α	0.428**(0.172)	0.005(0.017)
β	0.445*(0.262)	0.892***(0.017)
III. Correlation equation		
θ_1	0.035(0.026)	
θ_2	0.887***(0.104)	

I - NSE and FTSE markets		
	NSE	FTSE
I. Mean equation		
μ	0.112***(0.027)	0.008(0.018)
II. Variance equation		
ω	0.097(0.080)	0.029***(0.007)
α	0.428**(0.172)	-0.011(0.017)
β	0.445*(0.262)	0.875***(0.016)
III. Correlation equation		
θ_1	0.075***(0.027)	
θ_2	0.801***(0.070)	
J - JSE and BRVM markets		
	JSE	BRVM
I. Mean equation		
μ	0.055***(0.019)	0.007(0.016)
II. Variance equation		
ω	0.019***(0.007)	0.200***(0.069)
α	0.078***(0.012)	0.194***(0.042)
β	0.905***(0.015)	0.502***(0.121)
III. Correlation equation		
θ_1	-0.000(0.014)	
θ_2	0.358(0.357)	
K - JSE and NYSE markets		
	JSE	NYSE
I. Mean equation		
μ	0.055***(0.019)	0.045**(0.020)
II. Variance equation		
ω	0.019***(0.007)	0.028***(0.011)
α	0.078***(0.012)	0.118***(0.021)
β	0.905***(0.015)	0.860***(0.025)
III. Correlation equation		
θ_1	0.017**(0.007)	
θ_2	0.971***(0.014)	
L - JSE and FTSE markets		
	JSE	FTSE
I. Mean equation		
μ	0.055***(0.019)	0.049**(0.019)
II. Variance equation		
ω	0.019***(0.007)	0.030***(0.009)
α	0.078***(0.012)	0.119***(0.018)
β	0.905***(0.015)	0.854***(0.021)
III. Correlation equation		
θ_1	0.042***(0.016)	
θ_2	0.916***(0.037)	

M - BRVM and NYSE markets		
	BRVM	NYSE
I. Mean equation		
μ	0.007(0.016)	0.046**(0.019)
II. Variance equation		
ω	0.199***(0.069)	0.028***(0.011)
α	0.194***(0.042)	0.118***(0.022)
β	0.502***(0.121)	0.860***(0.021)
III. Correlation equation		
θ_1	0.021(0.018)	
θ_2	0.801(0.000)	
N - BRVM and FTSE markets		
	BRVM	FTSE
I. Mean equation		
μ	0.007(0.016)	0.049**(0.019)
II. Variance equation		
ω	0.199***(0.069)	0.031***(0.010)
α	0.194***(0.042)	0.119***(0.018)
β	0.502***(0.121)	0.854***(0.021)
III. Correlation equation		
θ_1	-0.008*(0.004)	
θ_2	0.885***(0.146)	
O - NYSE and FTSE markets		
	NYSE	FTSE
I. Mean equation		
μ	0.046**(0.020)	0.049**(0.019)
II. Variance equation		
ω	0.028***(0.011)	0.030***(0.009)
α	0.118***(0.022)	0.119***(0.018)
β	0.860***(0.025)	0.854***(0.021)
III. Correlation equation		
θ_1	0.124***(0.037)	
θ_2	0.788***(0.078)	

Source: Author's estimations

Notes: Standard errors are in parenthesis. *,**,*** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Chapter 3

FINANCIAL LIBERALISATION AND THE DEVELOPMENT OF STOCK MARKETS IN SUB-SAHARAN AFRICA

3.1 INTRODUCTION

3.1.1 Background and problem statement

Before the 1980s, prudential regulation and supervision of the financial systems were not high priorities for developing economies. The reasons for this were that, firstly, developing world's governments, wanting to use controls over the financial system to promote economic, social and political objectives, implemented policies emphasizing economic regulation, such as controls over interest rates and the sectoral allocation of credit (Brownbridge and Kirkpatrick, 2000). Secondly, many developing countries in general, and Sub-Saharan African countries in particular, remained tightly linked to the colonial power from which they had inherited their banking and regulatory systems. According to those banking and regulatory systems of the time, there was limited need for supervision by domestic regulators since banks, mainly under the ownership of reputable foreign banks, were conservatively managed and under strict controls from parent banks (Brownbridge and Kirkpatrick, 2000). The inadequacy of those prudential systems was soon exposed through the fragility emerging in the financial systems of those developing countries which then faced imminent changes to their financial systems framework, especially in the ownership of their banks (Brownbridge and Kirkpatrick, 2000).

Hence, after the financial crises of the 1980s, major reforms were implemented as part of broader programs of financial sector reforms funded by loans from the World Bank or other multilateral agencies. Reforms regarding the bank regulations and supervision were high on the list of conditions of the World Bank financial sector adjustment loans, bearing higher probability of inclusion than interest rate deregulation, bank privatization or directed credit reforms (Brownbridge and Kirkpatrick, 2000).

However, as seen in Kenya in the mid-1990s, Indonesia, Korea, Malaysia and Thailand all in 1997-1998, a number of developing economies faced banking crises during the mid to late 1990s. These crises occurred many years after the prudential reforms started to be implemented (Brownbridge and Kirkpatrick, 2000). According to Brownbridge and Kirkpatrick (2000), those banking crises were an indication that the prudential systems of the developing countries were still prone to major weaknesses. In fact, the crises following financial liberalization were attributed to an incorrect sequencing of financial sector reforms, with liberalization preceding prudential reforms. It is protocol that emerging economies should only liberalize their financial sectors after sound prudential systems have been put in place, or at least gradually while systems are being strengthened (Brownbridge and Kirkpatrick, 2000). Nevertheless, multilateral organizations such as the IMF and the World Bank still support the traditional free market neoclassical view arguing that financial repression is the cause of the slow growth and the alarming rate of persistent poverty in Africa. Actually, the proponents of this view maintain that restrictions such as interest rate control or considerable reserve requirements constitute the main sources of the low growth and poor driven allocation of financial resources on the continent (Yusuf, Malarvizhi and Jayashree, 2014: 166).

In spite of the banking crises plaguing the financial markets worldwide in the 1980s - 1990s, that period saw a mushrooming of stock markets in Sub-Saharan Africa. Besides a few early risers such as the Egypt Exchange, the Johannesburg Stock Exchange, the Casablanca Stock Exchange and the Zimbabwe Stock Exchange, established in 1883, 1887, 1929 and 1948, respectively, 13 of the 29 exchanges housed on the continent were established between 1988 and 1999. Before the 2008 financial crisis, the equity market sector improved and expanded rapidly. In fact, market capitalization in most African exchanges doubled between 1992 and 2002, increasing from US$113.4 billion to US$244.6 billion (Yartey and Adjasi, 2007: 6). Although these markets remain small in size and relatively illiquid, many have yielded high returns to investors over time. Since 1995, at least one African stock market has been ranked in the world's top-10 best performing markets every year. For example, the six African exchanges, namely Egypt, Ghana, Kenya, Mauritius, Nigeria and Uganda were in the top 10 best performing markets in 2004. In 2005, three African markets, Egypt, Uganda and Zambia were in the top five; while Malawi was the best performing market in the world in 2006 (Massa, 2009:1). However, the global financial crisis, creating gloomy growth prospects worldwide, tighter credit conditions as well as an increase in risk aversion, affected foreign investors' interest in African markets' investment opportunities. Thus, in 2008 there was fall in foreign direct investment and portfolio equity flows, as well as a sharp fall in equity prices. This was especially the case in Nigeria were the stock market recorded a 46 percent fall in 2008, ranking it as the worst performing market in the world (Massa, 2009:1). Moreover, the decrease in private sector credit growth in some countries and the stiffening of domestic banking lending conditions in others impacted negatively on the development of the banking sector which is considered as playing a complementary role for stock market development in Africa.

According to the PwC 2016 Africa Capital Markets Watch, African equity capital market activity was high between 2012 and 2016, with 110 IPOs and 340 FOs, of which the largest number occurred in 2015 with 30 IPOs and 93 FOs. However, with the economic uncertainty and political turmoil around the world, there was a decline of 28 percent in the number of African equity capital market transactions in 2016. The value of the proceeds that arose from equity capital activities also declined by 33 percent in US dollar terms, reaching a three-year low. There was a continuous outflow from the markets across the continent since capital was redirected to more advanced economies in a bid to uncover lower risk profiles (PwC, 2017: 5).

In light of the preceding discussion, it is relevant to pose the following research questions: Does the liberalization of the financial sector impact the performance of stock markets in Sub-Saharan Africa? Could financial liberalization induce the development of stock markets?

3.1.2 Objectives of the study

The objective of this study is to investigate the relationship between financial liberalization and the development of stock markets in selected Sub-Saharan African countries.

However, the specific objectives are to:

i. Evaluate the degree of financial liberalization in selected Sub-Saharan Africa countries and;

ii. Examine the effects of the different forms of liberalization on the stock markets' performance.

3.1.3 Relevance

With the rising importance of equity as a means of financing for Sub-Saharan African economies, it is of relevance to examine the effect of changes to the financial regulatory environment on the stock markets in the region. Hence, an analysis of the impact of liberalization in the financial sector on the stock markets could contribute to form policy makers' understanding of the right instruments to employ in order to promote the development of security exchanges. Despite, the considerable number of already available studies on the effect of financial liberalization on the development of financial markets in general, there is limited existing literature on the effect of liberalization specifically on the stock market development. Therefore, this essay aims at contributing to the existing literature by focusing on the development of securities exchanges in the Sub-Saharan African region. More precisely, this study will focus on four stock markets in the region, namely, the Nigerian stock exchange, the Nairobi stock market, the Johannesburg stock exchange and the West African stock market[1] (i.e the Bourse Regionale des Valeurs Mobilieres). These four markets, with a total market capitalization of US$1 174 trillion constitute more than 80 percent of the total market capitalization in the Sub-Saharan African region.

3.1.4 Structure of the chapter

The rest of the chapter is organized as follows. Section 3.2 will describe the evolution of financial liberalization in the region up to the present. Section 3.3 provides a theoretical and empirical literature review and the choice of the methodology is justified by reviewing the different tools used in the existing literature. Section 3.4 discusses the methodology used in this analysis and provides a detailed description of the data. Section 3.5 presents the empirical analysis and discusses the findings; while Section 3.6 provides a conclusion to the study and recommendations for future research.

[1]The BRVM is a regional stock market serving the eight West African countries comprising the West African Monetary Union and the BCEAO. These countries are: Benin, Burkina Faso, Guinea Bissau, Cote d'Ivoire, Mali, Niger, Senegal and Togo.

3.2 EVOLUTION OF FINANCIAL LIBERALIZATION IN SUB-SAHARAN AFRICA

3.2.1 Introduction

Financial liberalization in the more developed parts of the world has been advocated for a long time and has been cited as one of the main drivers of financial sector development. From the seminal work of McKinnon (1973) and Shaw (1973), the deplorably slow growth performance of developing economies can be partly attributed to the financial repression prevailing in these economies. They argued that the situation can be remedied by adopting financial liberalization policies. Thus, most Sub-Saharan African economies joined the global movement in the 1980's, as these reforms of the financial sector were also included in the list of conditions given to the countries by some of the international financial institutions and loan-providers.

The financial liberalization process was not uniform around the continent. In fact, countries such as South Africa, Mauritius and Senegal were quite early in their embrace of the reforms (as early as 1980), while others such as Sierra Leone, Uganda, Zambia and Zimbabwe were quite late in joining the movement, with liberalization starting in 1991 in Zambia and Zimbabwe, and in 1992 in Sierra Leone and Uganda (Fowowe, 2008: 8). Moreover, some countries followed a gradual approach to liberalization by executing different measures in different years. This was the case in Zambia, Malawi, Kenya and Botswana. However, other countries chose to rather implement multiple liberalization reforms in the same year. This was the case in Zimbabwe, Uganda, Mali, Gambia and Cote d'Ivoire (Fowowe, 2008: 8).

Figure B.1 in the Appendix B depicts the evolution of financial liberalization in Sub-Saharan Africa using the Chinn-Ito (2006) financial liberalization index. The index has been normalized to range between zero and one, with one representing the highest level of liberalization. In 1970, before the idea of liberalization gained momentum, most countries in the region including South Africa, Nigeria and Kenya, had very low liberalization indices, registered below 0.16. However, Liberia was the only country with the highest index equal to one (i.e. full liberalization), while countries such as Cote d'Ivoire, Senegal and Togo had an index between 0.16 and 0.23, which was still quite weak. In 1980, most WAEMU member states had high indices that were closer to one than they were in 1970.Some countries, however, recorded liberalization indices that were worse in 1980 than they were in 1970. This was the case of Niger, Chad, Madagascar and the Republic of Congo. In 2014, it seems that the reforms undertaken since 1980 were reversed, as most countries in the region still had low liberalization indices. Very few countries were observed as highly and even fully liberalized. These are Madagascar (0.4), Kenya (0.69), Rwanda (0.75), Botswana (1), Uganda (1) and Zambia (1).

The following subsections will give an overview of the evolution of financial liberalization in the four markets considered in this study, focusing on three specific forms of liberalization undertaken as part of the broader liberalization process, namely capital account liberalization, stock market liberalization and financial sector liberalization. The last subsection will provide a conclusion to the discussion.

3.2.2 Capital account liberalization

Introduction

Authorities in emerging and developing economies have taken considerable steps towards liberalization in the last 40 years. This has led to a record increase in the flows of capital to these markets. The 1993 World Development Report reported an amount of US$850 billion of gross capital flows to the main developing countries between 1990 and 1993. This amount was a substantial increase compared to the US$100 billion recorded between 1980 and 1985 (Tswamuno, Pardee and Wunnava, 2007).

According to Bicaba, Brixiová and Ncube (2015: 8), as of 2012, capital accounts were liberalized in 18 African economies, most of which are frontier markets[2] . A general trend towards capital

[2]Refers to developing countries that are more developed than the least developing countries, yet too small to be classified as emerging markets. According to the FTSE classification of markets as at September 2016, the frontier markets in Africa are: Botswana, Cote d'Ivoire, Ghana, Kenya, Mauritius, Morocco, Nigeria, Tunisia (FTSE Russell, 2016: 3).

account liberalization can thus be identified in Africa, although this was delayed compared to the other regions. The capital account liberalization process in most African economies kicked off through the removal of restrictions on long term transactions, particularly FDI inflows (Bicaba *et al.*, 2015: 8). The most common controls remaining untouched were the restrictions on all types of capital outflows (i.e. financial, direct investment and equity). As mentioned before, the process of liberalization was not uniform across countries and the speed differed considerably. For example, full capital account liberalization was already recorded in Mauritius and Zambia in the early 1990s; while Angola and Tanzania still had tight restrictions in place from 1995 to 2005 (Bicaba *et al.*, 2015: 8).

WAEMU countries

While member states of the West African Monetary Union (WAEMU) harmonized capital account guidelines and lifted capital control restrictions on inward FDI and foreign borrowing by residents in 1999; the administrative restrictions on capital outflows to non-WAEMU countries were held in place (Bicaba *et al.*, 2015: 8). In effect, the WAEMU zone keeps up restrictive measures on most capital exchanges with non-residents. In all WAEMU nations, comparable measures are in place and they are overseen jointly by the country's ministry of finance and the BCEAO. Despite the slight variations in the rules from country to country, a prior approval by the ministry of finance is generally required for nearly all outward capital flows, with the exception of the amortization of obligations and settlement of short-term loans. Specifically, this approval is needed in cases of capital outflow transactions from residents to non-residents such as a direct venture abroad by residents, including investment through foreign firms under direct or indirect control of residents; the acquisition of money market instruments; the purchase of foreign securities; financial credits and loans; the conceding of guarantees and sureties; the reinvestment of liquidation earnings; as well as gifts and any other transfer of assets. Moreover, an exchange authorization, subject to the approval of the central bank is required for outflows of funds needed for the servicing of credit facilities to non-residents (Kireyev, 2015: 8). In addition, despite the more liberal regulation on inward capital transfers, there are still considerable restrictions. These include the surrender to the BCEAO of all assets denominated in euros and other currencies held by authorized forex dealers in their establishments.

Figure B.2 in the Appendix B depicts the trends in capital account balances, FDI flows and Net portfolio investment flows in the WAEMU countries between 1970 and 2015. Before 2006, the balance of the financial account remained negative, even after the removal of restrictions on inward capital flows that occurred in 1999. However, since 2006 that account balance has seen considerable fluctuations between a high of almost US$ 7.2 billion in 2006 and a low of US$ -3.7 billion in 2013. The net inflow of FDI was mostly positive from 1970 to 2015, although it remained very low (below US$ 1 billion) until 2005, after which it increased significantly to reach a peak of US$ 3.3 billion in 2011. That same year, the value of net portfolio investment reached its lowest level since 1970 with a total of -0.62 billion. As can be seen from Figure 3.2, portfolio investment in the WAEMU zone has rarely seen inflows exceeding outflows, even after liberalization of capital inflows in 1999.

The 2016 IMF's Annual Report on Exchange Arrangements and Exchange Restrictions posits that the foreign exchange markets in its member states kept evolving in 2015 until July 2016, as a response from countries to developments international and home markets (IMF, 2016). In terms of exchange rate arrangements, the CFA Francs, which is the currency of the eight WAEMU countries, is still anchored to the Euro, along with 11 other Sub-Saharan African countries. Another development occurred in the WAEMU, where there was the strengthening of the terms and conditions for making rapid money transfers as a subagent within the union (IMF, 2016).

South Africa

In an attempt to take advantage of the capital flows attracted through liberalization, South Africa also loosened exchange controls on capital markets. The Exchange Control Regulations Act, representing the current exchange control measures, was passed in 1961 as an effort by the government to thwart the deterioration of the capital account (Tswamuno *et al.*, 2007). A dual exchange rate system was adopted by the government, followed by the introduction of the financial rand for all transactions by non-resident investors. In 1983, capital and foreign exchange controls were temporarily lifted. However, they were reintroduced in 1985 following the rising of political unrest and the severe depreciation of the rand caused by the withdrawal of credit lines to the country by foreign banks (Tswamuno *et al.*, 2007). Despite this reintroduction of these measures, the financial account balance saw an increase until it reached a peak of US$ 4.4 billion in 1987, the highest positive value that it has ever reached to this day (cf. Figure B.3 in Appendix B).

Most of the liberalization reforms in South Africa occurred after the international sanctions were lifted, that is by the end of 1992. In 1995, exchange controls for South African residents were relaxed, while those on non-residents were lifted. Further easing measures were implemented in March 1997 and 1998, which allowed the repatriation of more funds for investment by South African firms, while domestic firms were allowed to borrow from foreign institutions. These measures may have helped to boost the financial account balance out of its decreasing trend, as it increased from US$ -4.03 billion in 1998, to almost US$ 1.3 billion in 2001, as observed in Figure 3. In March 2001, the limit in foreign investment was raised (Precious, Bahle and Praise, 2014: 239). In that same year, both net inflow of FDI and net portfolio investment reached their highest level since 1970, with US$ 7.3 billion and US$ 8.3 billion respectively. However, the peak for the two balances was reached in 2008, with values of US$ 14.3 billion for net portfolio investment and almost US$ 9.9 billion for net FDI inflows (cf. Figure B.3 in Appendix B).

In 2015 – 2016, South Africa was part of a group of countries which liberalized current transactions. Eight measures were implemented, including amongst others, the increase in the single discretionary allowance to ZAR one million per person for a calendar year for any purpose. The country also raised the legal limit on credit card payments for imports, and exempted the limit for funds transfer outside the country from anti money laundering regulations (IMF, 2016: 31). In addition, South Africa liberalized the regulations governing transactions on resident accounts by increasing to ZAR 11 million the amount of foreign currency deposits that South African residents can hold with authorized dealers for the purpose of investing on foreign markets.

Nigeria

In Nigeria, the liberalization process followed a gradual approach. In fact, capital accounts were liberalized after the liberalization of the financial sector through interest rates. Between 1970 and 1986, the financial account balance was in a deficit of US$ 1.3 billion on average; there was an average inflow of US$ 0.27 billion in FDI and an average outflow of 0.45 billion in portfolio investment. The process of capital account liberalization took off in September 1986 when a second-tier foreign exchange market was established. The two foreign exchange markets were unified later that year. The year 1988 saw the granting of permission to establish private foreign exchange bureaus (Owusu, 2011: 108). The adoption of these measures was followed by the virtual disappearance of black market dealings in foreign exchange. Owusu (2011: 108) argues that, as the citizens were now permitted to hold foreign currency accounts with local banks, the formal sector ultimately absorbed almost all the foreign exchange resources from the black market. In 1992, after the deregulation of capital markets was initiated, foreign exchange markets were reorganized. However, the exchange controls were imposed again in 1994, before the Exchange Control Act of 1962 was completely abolished the following year. Foreign exchange markets were thus fully liberalized (Owusu, 2011: 130-131).

After full liberalization in 1995, Figure 4 shows that the financial account balance fluctuated between deficit and surplus until 1999. From 1999 it remained in surplus reaching a peak of US$ 29.9 billion in 2006. The balance then decreased and reached a value of US$ -12.5 billion, the highest deficit since 1982, in 2009. Net FDI inflows in the country remained mostly positive and relatively stable between 1970 and 2004. After 2004, the inflows increased considerably and recorded a total of US$ 23.4 billion from 2009 to 2011. However, net portfolio investment which was also relatively stable between 1984 and 2004, fell sharply between 2005 and 2012, recording a total outflow of US$ 18.97 billion in that period. In 2015, net portfolio investment outflows fell to US$ 0.87 billion, while the financial account balance recorded a surplus of US$ 1.05 billion and the FDI inflow fell to US$ 3.13 billion.

In 2016, Nigeria was the only IMF member state that removed foreign exchange auctions from its toolkit (IMF, 2016: 16). It was announced by the Central Bank of Nigeria, that its Dutch Auction System was closing and a request was made for all foreign exchange transactions to be conducted via the interbank market in a bid to move to a more flexible exchange rate arrangement. Moreover, it was reported that foreign exchange was allocated to the interbank foreign exchange market based on the demand and availability of foreign exchange, as well as the reported needs of the market participants' customers. The unused funds within a time limit of two working days of the value date are repurchased by the central bank at its own buying rate (IMF, 2016: 16). Although the bureau de changes in Nigeria still exist, the Central Bank suspended cash sales to them. Their procurement of foreign exchange would now be done through independent sources in lieu of the interbank market (IMF, 2016: 16). In contrast to South Africa, Nigeria was among the few countries that tightened its regulations on residents' accounts by prohibiting cash deposits into foreign exchange accounts. In a bid to restraint flight of capital, as well as the pressure on the naira, a restriction was imposed on the acquisition of foreign currency domestically for investment in foreign securities. This could only be done using the investor's own funds, without resorting to the local foreign exchange market (IMF, 2016: 16).

Kenya

Kenya adopted the IMF's Structural Adjustment Programme (SAP) in 1992. This led the shift in exchange rate regime from a fixed one to a floating one. Since then, the Kenyan Shilling to U.S. dollar exchange rate has fluctuated considerably over the years (Otieno, Njeru and Waititu, 2016: 2694). Despite the implementation of this measure, net portfolio investment and net FDI inflows in the country remained very low, with a total of US$ 33.7 million and US$ 0.88 billion respectively between 1970 and 1995 (cf. Figure B.5 in Appendix B). During the same period, net financial account balance remained in a deficit which reached its highest value of US$ 0.88 billion in 1980.

In order to boost foreign portfolio investments, the Kenyan government put a series of incentives in place in 1995, including loosening up exchange control for domestically controlled companies by doubling the aggregate limit from 20 percent to 40 percent and individual limit from 2.5 percent to 5 percent (NSE, 2015). Additionally, while listed securities are exempted from stamp duty, capital gains tax and value added tax, the withholding tax on dividends only amounts to five percent for residents and 10 percent for non-residents. In December 1995, the exchange control act was abolished.

Even with the removal of these controls, net portfolio investment and FDI inflows kept the same trend. However, while FDI inflows increased considerably from US$ 0.16 billion in 2012 to its highest value since 1970 of US$ 1.4 billion in 2015, net portfolio investment flows fell sharply from a net inflow of US$ 13.59 million in 2012 to a net outflow of US$ 3.5 billion in 2014. The financial account balance followed a similar trend between 2006 and 2014, with a growing deficit which reached its highest peak in 2014 at a value of US$ 5.4 billion (cf. Figure B.5 in Appendix B).

Conclusion

As can be observed from the above discussion, the capital account liberalization was not a uniform process in the Sub-Saharan African region. In addition to the different starting dates among countries, diverse measures and different degrees of liberalization were adopted. While Kenya adopted the IMF's SAP in 1992 and had already abolished all exchange controls by the end of 1995, the WAEMU countries only engaged in capital account liberalization in 1999, lifted capital controls restrictions on only inward FDI and foreign borrowing by residents, and still had its currency anchored to the Euro. Moreover, South Africa lifted and reinstated certain restrictions between 1983 and 1992, from which year the liberalization process really took off. This process is still ongoing as controls on current transactions were only relaxed in 2016. Finally, Nigeria which kicked off its liberalization process as early as 1986, gradually implemented a series of measures over the years reaching full liberalization of foreign exchange controls in 1995. However, the country returned to tighter regulations on residents' accounts and the acquisition of foreign currency domestically for investment in foreign securities in 2016 to restrain flight of capital and the pressure on the naira created by adverse economic conditions.

Additionally, the trends in the balance of net financial accounts, net FDI inflows and net portfolio investment flows depicted for the three countries and the WAEMU zone between 1970 and 2015, did not attest to a considerable and immediate impact of the liberalization measures undertaken by the respective authorities on the capital/financial account. An exception was observed, however, in South Africa where the financial account balance came out of a decreasing trend in 1998 after implementation of exchange controls easing measures and both net inflow of FDI and net portfolio investment reached their highest level since 1970 in 2001 after the limit in foreign investment was raised.

3.2.3 Stock market liberalization

Introduction

Most of the stock exchanges currently existing in Sub-Saharan Africa were already established by the time the liberalization process started in the region. In effect, most developing economies started the process by opening their capital accounts, then liberalization of stock markets followed suit in early 1990s. These measures opened domestic stock markets to foreign investors and contributed considerably to the integration of these developing stock markets to the rest of the world.

The following sections will look more closely at the liberalization process in the four stock markets under consideration in this study.

WAEMU countries

The stock market was already established in Cote d'Ivoire when the liberalization process was initiated in 1990. Thus, liberalization encouraged the modernization of the exchange which was fully deregulated in 1998 and turned into a regional market for eight West African Countries. In that same year, foreign investors were permitted to participate in the capital market with all the benefit that such participation affords (Owusu, 2011). However, a declaration to the national ministry of finance must be made in case of sales of corporate securities to non-residents leading to the foreign control of domestic establishments. Furthermore, nonresidents are not allowed to list on the exchange, securities and mutual funds that were issued outside the WAEMU region. They must obtain prior authorization by the Regional Council on Public Savings and Financial markets in order to issue securities, real assets and money market instruments (Kireyev, 2015: 8).

Nevertheless, foreign companies are free to invest and list on the regional exchange which is based in Abidjan and dominated by Ivoirian and Senegalese firms. No significant limits have been set on foreign investment, and there are no differences in the treatment of foreign and national investors, either in terms of the level of foreign ownership or sector of investment. Additionally, no laws specifically require private firms to adopt articles of incorporation or association that limit or forbid foreign participation, investment, or control, and no such practices have been conveyed (U.S. Department of State, 2015: 6). In 2013, foreign participation in the market amounted to 44 percent of the total value traded against 56 percent for local investors' participation (ASEA, 2014).

Panel A to D of Table B.1 in Appendix B present yearly values of three stock market indicators (i.e. market size, liquidity and volatility) for the four markets included in the study. The market size, as measured by market capitalization as a percentage of GDP remained considerably small from 1989 and 2014, compared to other exchanges such as the JSE. Yet, it showed an average upward trend over the years, from 4.8 percent in 1989 to 34.4 percent in 2014 (cf. panel A in Table 1). Similarly, the market liquidity, as measured by the market turnover ratio, also appears to be relatively weak between 1989 and 2014. Only the years 1995 and 1996, before the exchange deregulation, saw a sharp increase in liquidity from 9.9 percent in 1994 to 32.9 percent and 30. 6 percent in 1995 and 1996, respectively. Since these years, liquidity has remained below the five percent level, even after the exchange was deregulated (cf. panel A in Table 1). Between 1999 and 2014, annual volatility levels as measured by the annualized 360-day standard deviation of the return on the composite index, ranged from a minimum of 0.07 to a maximum of 0.3.

South Africa

Early in the 1990s, South Africa received encouragement on its efforts to integrate its economy to the rest of the world, through the positive political developments that occurred (Tswamuno *et al.*, 2007). Measures such as the abolition of the financial rand and the lifting of all controls on foreign investors were implemented by the South African government in March 1995, in an attempt to boost economic growth. These new measures allowed non-resident investors full access to the JSE and the South African Bond Exchange (SABE) (Tswamuno *et al.*, 2007). Following the liberalization of the JSE, investment by foreign entities in domestic financial assets and stock turnover has registered a massive increase. The South African Reserve Bank reported that the liquidity level of the JSE has remained above 30 percent on average since 1998 (Tswamuno *et al.*, 2007). Furthermore, between 1994 and 1999 there was an increase in net purchase of equity by foreign investors from ZAR 0.2 billion to ZAR 40.6 billion, as well as a rise in purchases of net bond from ZAR 1.8 billion to ZAR 4.3 billion.

The Rand Commission also reported that over a third of the turnover on the JSE and over an eighth of the turnover on the SABE were attributed to non-residents, by the year 2002

(Tswamuno *et al.*, 2007). Since market de-regularization, foreign investors have been net buyers in excess of ZAR 9.3 billion, compared to only ZAR 0.185 billion in 1994 (Moolman and Du Toit, 2005). This demonstrates that foreign investment assumes a more critical role on the JSE, representing more than 20 percent of its market capitalization, and sometimes a far larger portion of its daily trading (Moolman and Du Toit, 2005). However, in recent year the share of foreign participation has considerably decreased. While local investors represented 63 percent of the total value traded and foreign investors 37 percent in 2007, foreign participation was reported to be 19 percent of the total value traded versus 81 percent of local investors in 2014 (ASEA, 2007; ASEA, 2014).

The market size of the JSE has seen some fluctuations but shows a steady increase from 62.4 percent in 1975 to 256.5 percent in 2014 (cf. panel B of Table 1). The market liquidity which is commonly known to be very low in developing markets was no different in South Africa before liberalization in 1995 when it was on average 5.1 percent. However, in 1996 there was a jump to the 2-digits liquidity level at 11.2 percent, and since then, a considerable change has been recorded with a maximum of 35.4 percent seen in 1999. It was recorded at 27.4 percent in 2014. Lastly, the annual volatility values between 1975 and 2014 are seen to be quite low. The highest volatility was recorded in 1998 at 0.41.

Nigeria

As part of the Structural Adjustment Programme (SAP), which was launched in 1986, the Nigeria Stock Exchange was restructured and fully deregulated in 1992. After the full liberalization of the exchange rate and financial markets in 1992, foreign participation in the capital markets was permitted but was still restricted. The year 1993 saw the elimination of these restrictions following the complete liberalization of capital account (Owusu, 2011). Following capital account liberalization and the deregulation of the exchange, the Federal government opened the capital market to the rest of the world by abolishing laws that prohibited foreign participation. Outside investors were thus free to participate in the market as both investors and operators, without any limits on the level of foreign holdings in any domestic company. The year 1995 saw the removal of restrictions on repatriation of loan servicing payments, profits, dividends, and remittance of proceeds on sale of stock and other financial products (Owusu, 2011). However, in 2015 the drop in the prices of crude oil which had a considerable effect on Nigeria's earnings, led to the re-establishment of restrictions on foreign exchange controls by the Central Bank of Nigeria (CBN). This was an attempt to ease the pressure on the country's foreign reserves and to protect the local currency. The measures consisted of, among others, a ban on access by 41 pre-identified items to foreign exchange from the official forex windows, the introduction of a demand management strategy in the allocation of forex, as well as impediments to financial account items such as the accumulation of portfolio assets abroad (i.e. Eurobonds, foreign currency bonds and share purchases). Since then, foreign participation in the market has dropped to less than 50 percent of total value of transactions, reaching 36.5 percent in February 2016 compared to 67 percent, 61 percent 51 percent and 58 percent reported in 2011, 2012, 2013 and 2014, respectively (Nigeria Stock Exchange, 2016; ASEA, 2014).

Similar to the BRVM, the size of the market in Nigeria remained relatively small between 1989 and 2014, ranging from a minimum of 3.8 percent in 1989 to a maximum of 35.8 percent in 1997, four years after the market was fully opened to the rest of the world. Since then, the market size only crossed the 30 percent mark in 2007 and 2008, and dropped down to 12.7 percent in 2014 (cf. panel C in Table 1). Panel C also confirmed the low level of liquidity known to be prevalent in developing markets. In fact, liquidity in the Nigeria Stock exchange ranged from a minimum of 0.4 percent reported in 1989 to a maximum of 29.4 percent in 2007. In 2014, liquidity was at 7.1 percent. Volatility between 2004 and 2014was also relatively low, with a maximum of 0.57 only recorded in 2010.

Kenya

In Kenya, the Nairobi Stock Exchange (NSE) was formally founded in 1954 as a voluntary association of stockbrokers registered under the Societies Act (1954). However, only the resident

European communities could trade in shares, while Africans and Asians were not permitted to deal in securities. After the opening of the market in 1995, there was an immediate rise in the level of foreign trade, and sales amounted to Kshs.101 million while foreign purchases of equity were recorded at Kshs. 1,644 million in 1997. Over the years there was an overall increase in total foreign turnover from its lowest level of Kshs. 695 million registered in 1996, to the highest level of Kshs.78,765 million registered at the end of 2011 (Nyang'oro, 2013). However, periods such as 2000 and 2001 indicated a pull of foreign funds from the Kenyan equity market, as foreign sales exceeded foreign purchases, with net portfolio investment flows amounting to US$ 58 million and US$ -32.7 million in 2000 and 2001 respectively. Nyang'oro (2013) argued that this may have been caused by high operation costs or the realization by investors that returns expectations cannot be met. Other periods of net outflows were recorded in 2002, 2005 and 2009, the latter which can be justified by the financial crisis prevailing worldwide during that period. In 2007 foreign participation in the market was reported to amount to only nine percent of the total value traded while local investors represented 91 percent (ASEA, 2007). Foreign interest in the exchange was restored as could be seen by the fact that the foreign share of total value traded increased to 51.9 percent in 2011. In the following three years, foreign participation decreased progressively to reach 32.37 percent of total value traded in 2014 (ASEA, 2014). As can be observed, foreign participation in the Kenyan equities market is not stable and has fluctuated considerably over the years.

Panel D of Table B.1 in Appendix B shows a similar trend in the Nairobi stock market size, to the ones observed in the BRVM and the Nigeria Stock exchange. In effect, the market remains considerably small, although it increased from 5.5 percent in 1989 to 25.4 in 2012. It achieved its biggest size of this period in 2007 when it was at 40 percent. Liquidity in this market also remains very low, ranging from a minimum 1.3 percent in 1993 (i.e. two years prior to the opening of the market to foreign participation) to a maximum of 14.8 percent in 2006. Finally, volatility, which could only be computed from 2009 due to the unavailability of data, has remained low.

Conclusion

From the above discussion, it can be concluded that all of the markets under consideration undertook stock market liberalization measures as part of their greater liberalization agenda. In fact, in most cases, these measures were adopted directly, or presented themselves as a direct result of the liberalization of capital accounts. Although it seemed to immediately increase foreign contributions to the respective domestic markets, it appeared to be short lived as domestic investors have been dominating the markets in recent years. Moreover, in the BRVM, Nigeria Stock exchange and Nairobi Stock exchange, the liberalization measures do not seem to have had a considerable impact on stock market size, since the markets remained considerably small up to date. The same can be said of market liquidity in all four markets as they are all still highly illiquid.

3.2.4 Financial sector liberalization

Introduction

Before the financial liberalization measures were undertaken, the financial systems in Sub-Saharan Africa were narrow and totally unprepared for a comprehensive banking sector reform process over a short period (Moyo, Nandwa, Oduor and Simpasa, 2014). The characteristics of the financial systems such as depth and sophistication of the financial markets are heterogenous across most Sub-Saharan African countries. The financial sector in the region is generally characterized as underdeveloped in terms of efficiency and depth as it is mostly dominated by foreign-owned banks, which are relatively small banks compared to other regions (Moyo *et al.*, 2014). According to Beck, Maimbo, Faye and Triki (2011), the total assets of an average bank in Sub-Saharan Africa amounts to US$ 200 million, while the total assets of a non-African bank average US$ 1 billion.

WAEMU countries

In 1962, Cote d'Ivoire joined seven other French speaking West African countries to form the West African Monetary Union (WAEMU). The union's Central Bank became responsible for the issuing of the local currency used by all of the union's member states (Owusu, 2011). Since then, the responsibility of establishing policies governing the financial system and interest rates in the countries is also incumbent on the WAEMU. After the creation of the union, the member states entered into an agreement with France guaranteeing the convertibility of the CFA Franc (i.e. the union's currency) to that of the French currency. Operational accounts were also established with the French treasury for each country for the centralization of their reserves. An agreement was also signed allowing free mobility of capital within the union. Since its foundation, the union has taken considerable steps towards granting more monetary autonomy to its African member countries. These steps include the reduction of the share of French votes on the board of directors from a third to one-seventh. Moreover, the headquarters of the union which were initially based in Paris were transferred to Dakar, Senegal. In 1975, changes were introduced for an increase of the managerial quota of Africans in their domestic economies and to assist member states for better resource allocation. Like many other Sub-Saharan African countries, Cote d'Ivoire implemented liberalization measures over the years, in a bid to encourage economic growth and development. These reforms consisted of interest rate deregulations, orientating credit to important sector and securing bank loans at interest rates below the market level for deficit financing. However, adverse results were seen on the domestic financial system, hence hindering economic growth.

The late 1980s were particularly hard on the Ivorian financial system as there was a fall in cocoa exports' earnings. A liquidity crisis thus ensued, with the subsequent closing of the Ivorian Bank for Construction and Public Works and the National Savings and Loan Bank in 1987. The early 1988s saw the closing of two additional banks. Owusu (2011) argued that local investment was also discouraged by controls on credit allocations. High liquidity was preferred by the banks, such that they only granted short and medium-term loans against short and medium-term funds. This effectively prevented loans from being directed to the entities which needed them the most, such as local and indigenous businesses. As a result, foreign investors were the main receivers of short and medium-term loans in the country before liberalization. That is why measures were adopted in 1990 to liberalize preferential discount rate and bank interest rate (Montiel, 1995). In Cote d'Ivoire, and in most African countries, financial liberalization measures focused primarily on the banking sector. These measures principally included strengthening of the banking supervision regime, restructuring and liquidation of banks and banks privatization. However, the 1990 liberalizations were still accompanied by a negative real interest rate. The year 1991 saw the removal of credit controls. The financial sector in Cote d'Ivoire is narrower than that of South Africa and Nigeria, as it currently has around 29 banks and financial institutions.

Table B.2 in Appendix B gives a summary of some financial indicators for the three countries and the union. Panel A in Table B.2 gives average values of the deposit, lending and real interest rates in the WAEMU from 2005 to 2015, due to the unavailability of data. It can be seen that while the post liberalization average deposit rate fluctuated during that period, it increased from 4.42 percent in 2005 to 5.23 percent in 2015, with the highest value recorded in 2013 at 5.40 percent. In contrast, the average lending rate followed a decreasing trend starting at 10.15 percent in 2005 and ending at 7.96 percent in 2015. The real interest rate, however, has known considerable fluctuations over the years. More striking was the period 2007 – 2009, where the real interest rate which was at 6.03 percent in 2007, fell to 0.80 percent in 2008 and jumped back up to 7.65 percent in 2009. In 2015, the real interest rate was at 5.74 percent.

Comparing the domestic credit provided by the financial sector as a percentage of GDP, domestic credit to private sector as a percentage of GDP and domestic credit to private sector provided by banks as a percentage of GDP pre- and post-liberalization of credit controls in 1991, it can be seen that they all fluctuated considerably during both periods. The domestic credit provided by the financial sector/ GDP which started at 12.11 percent in 1970, increased to 32.54 percent in 1983, then fell back to 29.84 percent in 1990. In 1992, a year after liberalization, there was a fall in the ratio from its value of 20.42 percent in 1991, to 19.67 percent. The decreasing trend continued until 2003 when it started increasing again until 2015. Both the domestic credit to private sector as a percentage of GDP and domestic credit to private sector provided by banks as a percentage of GDP followed the same trend. In 2015, the domestic credit provided by the financial sector as a percentage of GDP, domestic credit to private sector as a percentage of GDP and domestic credit to private sector provided by banks as a percentage of GDP were at 28.93 percent, 24.05 percent and 23.91 percent, respectively. Interestingly, the average amount of commercial banks and other lending was considerably higher at US$ 268.6 million before liberalization compared to an average of US$ 55.9 million after liberalization.

South Africa

In South Africa, where the financial system is commonly recognized as considerably developed and sophisticated compared to international standards and other developing countries, the Reserve Bank is the guiding authority behind the interest rates and controls liquidity (Precious *et al.*, 2014: 239). Interest rate controls were in place from the 1960s to 1970s, as was the case for other financial prices. Decisions were made by the government in 1970 firstly, to remove the upper limits compulsory on deposit rates payable on deposits of building societies and banks; and secondly, to apply subsidies on some interest rates (Precious *et al.*, 2014: 239). However, those restrictions were re-imposed in 1972, before the full liberalization of both the deposit and lending rates in 1980, allowing greater flexibility for banks, and encouraging competition. Similarly, in 1980 credit controls were liberalized through the abolishment of credit ceilings, and interest rate liberalization also occurred. Between 1983 and 1985 there was a substantial fall in the liquidity ratios of banks. In 1997 the country recorded 51 licensed banks, 11 of which were foreign banks' subsidiaries and eight were foreign banks' branches. There were also five community banks. Today, South Africa has 60 banks, with 13 foreign bank branches, as well as four community banks (Precious *et al.*, 2014: 239).

In panel B of Table 2, it can be seen that from 1970 until interest rates were liberalized in 1980, deposit rates followed a decreasing trend from eight percent in 1977 to 5.54 percent in 1980, while lending interest rates were increasing from 8.17 percent in 1970 to 12.50 percent in 1977, then down to 9.50 percent in 1980. However, in both cases there was a considerable increase the year after liberalization with 8.19 percent and 14 percent for the deposit and the lending rate, respectively. Since then, the rates have been fluctuating greatly with the highest deposit rate reached in 1990 at 18.86 percent and the highest lending rate at 22.33 percent in 1984. In 2015, the deposit rate was at 6.15 percent, while the lending rate was at 9.42 percent. The real interest rate fluctuated greatly between 1970 and 2015. The rate was quite low prior to liberalization and even had a value of -12.34 percent in 1980. The following year, however it jumped up to 3.70 percent. The highest rate was reached in 1998 at 12.99 percent. In 2015, the real interest rate was at 5.25 percent.

When analysing the domestic credit provided by the financial sector as a percentage of GDP, it can be seen that while that ratio was already quite high prior to liberalization at an average of 86.42 percent, it skyrocketed after liberalization, averaging 140.88 percent. Both the domestic credit to private sector as a percentage of GDP and domestic credit to private sector provided by banks as a percentage of GDP followed the same trend with pre-liberalization averages of 63.87 percent and 48.64 percent, respectively with post – liberalization averages of 113.89 percent and 61.51 percent, respectively. Due to unavailability of data, the commercial banks and other lending values are only presented from 1994. Until 2013, these values were relatively low and mostly negative. However, they increased from US$ 252.5 million in 2013 to US$ 3.5 billion in 2014 and US$ 9.9 billion in 2015.

Nigeria

In Nigeria, loan and deposit rates were fully liberalized following capital account liberalization in 1987. In 1998, banks were awarded expanded powers in the variety of assets and liabilities that they were allowed to acquire (Owusu, 2011: 130). Permission was also granted for them to acquire securities in non-financial firms, as well as to participate in insurance brokerage. Moreover, the deregulation of interest rates and the relaxation of the conditions for the licensing of new banks were implemented simultaneously. This led to a dramatic jump in the number of banks from a low of 40 in 1986 to 119 at the end of 1991. In 1988 the Nigerian Deposit Insurance Corporation was established with the aim of attracting bank deposits by protecting the depositors' interest and promoting public confidence in the safety of the banking system (Owusu, 2011: 130). This measure was meant to maintain financial stability while making progress in other aspects of financial sector reforms. Furthermore, the year 1989 saw the extension of the bank's power by granting it the ability to make interest payments on deposits. This was in a bid to remove excess liquidity in the financial system. Also, cash reserve requirement was increased by prohibiting the practice of granting loans through foreign exchange deposits held domestically or abroad as collateral (Owusu, 2011: 130). The eventuality of removing restrictions on direct credit motivated authorities to launch the auctioning of Treasury Bills. The following year a series of reforms consolidating bank regulation and supervision were devised as a result of the mushrooming of financial institutions and the perceived greater risk of bank crisis. The first of these measures involved the enforcement of a risk-weighted measure of the capital adequacy of banks. In 1990 prudential regulations were issued to improve the quality of the risk assets and the soundness of the operations of licensed banks. This included, but was not limited to, the requirement of all banks to adequately make provision for perceived losses on the basis of portfolio classification in order to indicate their exact financial positions (Owusu, 2011: 131). In 2004 a program for the recapitalization of banks was announced by the Central Bank of Nigeria aimed at strengthening the banks' ability to offer credit to the private sector. The minimum paid up capital of the banks was increased and the following year the Central Bank introduced a new micro financing policy (Owusu, 2011: 131).

As can be observed from panel C in Table 2, the deposit and lending rates were relative prior to liberalization compared to the period post-liberalization. The deposit rate followed an increasing trend from three percent in 1970 to 13.09 percent in 1987, the year interest rates were liberalized. However, the following year the rate decreased slightly to 12.95 percent and increased later to 14.68 percent. In the post-liberalization period, the deposit rate has seen substantial fluctuation with a maximum of 2.24 percent reached in 1993, but never below the minimum of 5.70 reached in 2011. In 2016 the deposit rate was at 7.5 percent. The lending rate also followed a similar trend before pre- and post-liberalization. It started at a value of seven percent in 1970 and reached 13.96 percent in 1987 after which it increased considerably reaching a peak of 31.65 percent in 1993. The lending rate which never went below 15 percent after liberalization was recorded at 16.87 in 2016. Similar to the South African case, the real interest rate in Nigeria fluctuated greatly between 1970 and 2015. As can be seen from panel C in Table B.2, the rate was relatively low and generally negative before 1987 during which it was registered at -31.92 percent. After liberalization, the rate was still highly volatile and reached its highest negative value of -43.57 in 1995. In 2015, the rate was recorded at 13.60 percent.

Still from panel C of Table B.2 in Appendix B, it can be seen that by the time the prudential reforms were undertaken in 1990 to liberalize the banking sector as well as credit allocation, domestic credit provided by the financial sector had fallen to 21.90 percent from its highest value of 48.67 percent achieved in 1986. During the post-liberalization period, the average domestic credit provided by the financial sector was 3.02 percentage point lower than it was before liberalization at 24.27 percent. Conversely, the average domestic credit to the private sector as a percentage of GDP and domestic to the private sector by banks, were substantially higher at 15.21 and 15.13 percent after liberalization respectively than they were at 11.05 and 10.77 percent respectively before liberalization. Three years after, the program of recapitalization of banks was implemented to strengthen the banks' ability to offer credit to the private sector, there was a three-year upward trend in both domestic credit to the private sector/GDP and domestic to the private sector by bank/GDP, reaching 38.39 percent and 38.35 percent, respectively in 2009. The year after the implementation of the program, there was also an increase in the value of commercial banks and other lending institutions from US$ 539.8 million in 2004 to US$ 1.9 billion in 2005.

Kenya

The financial sector in Kenya had been facing some challenges since the mid-1970s, a situation recognized by the government which did not take any action until the late 1980s. Already in the early 1980s, the pressure was growing to keep real interest rates at a positive level and for the promotion of monetary stability and economic growth using interest rate (Ngugi and Kabubo, 1998: 12). The year 1989 saw the launch of a comprehensive financial sector adjustment program which had the principal objective of improving mobilization and distribution of domestic resources. These reforms, which were institutional as well as policy related, started with the approval of the Financial Sector Adjustment Programme (FSAP) credit in June 1989 followed a month later by the instigation of FSAP credit effective and indirect monetary policy measures. In November of the same year, there was an increase of 0.5 percent in the minimum saving deposit rate payable by banks and non-bank financial institutions. The maximum lending rate for loans and advances not exceeding three years was also increased to 15.5 percent (Ngugi and Kabubo, 1998: 40). One institutional reform was the passing by parliament, in November 1989, of the legislation governing the establishment of the Capital Market Authority, subsequently established in January 1990. These institutional reforms were aimed at restoring public confidence in the financial system, as well as upgrading the skills essential to the supervision and regulation of financial institutions. Other institutional reforms such as the execution of the Consolidated Bank of Kenya Act in June 1991 which provided for the transfer to the Consolidated Bank of Kenya of assets and liabilities of banks and non-bank financial institutions with solvency issues were instituted. This was part of the restructuring programs that were developed and implemented to assist the weak and solvent financial institutions (Ngugi and Kabubo, 1998: 40). In January 1992, some prudential guidelines were prepared regarding code of conduct, duties and responsibilities of appointed personnel and external auditors, in an attempt to encourage self-regulation. In May 1993, more flexibility was awarded to commercial banks as further liberalization of foreign exchange systems allowed them to execute foreign payments for private clients independently of the Central Bank.

In terms of policy reforms, the Treasury bill rate was fully liberalized in November 1990 and in July of the following year, the interest rate was fully liberalized. In November 1993, the credit guidelines were abolished. The year 1994 also saw the removal of restrictions on local borrowing by foreign controlled companies. The aim of these policy reforms was, among others, to remove the distortions in the mobilization and allocation of financial resources and to improve efficiency of financial intermediation (Ngugi and Kabubo, 1998: 43). In 2016, the Central Bank of Kenya listed 86 foreign exchange bureaus, 42 commercial banks, 14 money remittance providers, 12 microfinance banks, eight representative offices of foreign banks, three credit reference bureaus, as well as one mortgage finance institution.

In panel D of Table B.2 in Appendix B, it is observed that the lending rate and deposit rate were higher in the years following liberalization. From 3.50 percent in 1970, the deposit rate rose to a maximum of 18.40 percent in 1998. Likewise, from its lowest value of nine percent in 1971, the lending rate increased to 36.24 percent in 1994, it highest value between 1970 and 2016. In 2016, the deposit and the lending rate were at 8.69 and 16.56 percent respectively. In the case of Kenya, the real interest rate was mostly positive and relatively high in comparison to the WAEMU, South African and Nigerian rates. Most of the negative values were observed before the full interest rate liberalization occurred in 1991 and the highest values were recorded between 1994 and 2002. In 2015, the real interest rate was at 6.36 percent.

Panel D of Table 2 also shows the increasing trend exhibited by the domestic credit provided by the financial sector/GDP, domestic credit to the private sector/GDP and domestic to the private sector by bank/GDP during the period 1970 – 2015. After the removal of credit controls in 1993, the average domestic credit provided by the financial sector/GDP jumped to 37.85 percent from an average of 29.88 percent before 1993. Similarly, the average domestic credit to the private sector/GDP and domestic to the private sector by bank/GDP both increased from 18.97 percent to an average of 26.12 and 26 percent respectively. The values of commercial banks and other lending institutions which were relatively low before the removal of restrictions on local borrowing by foreign controlled companies in 1994, still remained low and afterwards even became mostly negative.

Conclusion

Financial sector liberalization in the four economies considered in this study occurred from the 1980s to the early 1990s. In all four cases, interest rates were fully liberalized and credit controls were abolished by 1993. While undertaking these financial reforms, these governments showed commitment to deepen their financial systems, adopt sound monetary policy and boost economic growth through the encouragement of investment. However, the results of these efforts did not transpire through the level of domestic credit provided to the private sector which remains relatively low and volatile. Moreover, the values of commercial banks and other lending institutions, which is still quite insignificant in these economies, may suggest that the abolishment of credit controls requires to be paired with additional measures in order to boost investment in the region and improve financial integration.

3.2.5 Conclusion

As can be seen from the above discussion, financial liberalization was not a uniform process across the Sub-Saharan African region. Most economies joined the movement in the 1980s, and while some undertook many reforms in the same year, others adopted a gradual method of liberalization by implementing only a couple of measures per year. Although most countries have taken considerable steps towards liberalization since 1980, in 2014 a great number of them are still found with a low liberalization index. Additionally, one can argue that the reforms initially adopted have been reversed after they had more adverse effects on economic growth and development than what was initially expected, as was the case in South Africa between 1970 and 1972.

3.3 LITERATURE REVIEW

3.3.1 Introduction

The study aims to investigate the effect of financial liberalization on the development of stock markets in Sub-Saharan Africa. Thus, this section will review the theory underlying the link between the different financial reforms and the advancement made in the stock markets; as well as the empirical studies already existing on the topic. The structure is as follows. Section 3.3.2 presents the theoretical literature on financial liberalization. Section 3.3.3 gives a review of the empirical literature. Finally, Section 3.3.4 provides a conclusion to the chapter, identifying the gaps in the reviewed literature and the measures taken in this study to counter the identify weaknesses.

3.3.2 Theoretical Literature

McKinnon (1973) and Shaw (1973) pioneered the notion of financial repression, and demonstrated that a repressed financial sector discourages both saving and investment since the rates of return are lower than the ones obtained in competitive markets. According to McKinnon (1973: 5), government intervention is generally recommended as the appropriate solution to a badly functioning market. However, this need for government to intervene only stems from the inefficiency prevailing in underdeveloped economies that are severely fragmented[3] . Thus, there cannot be any presumption by authorities that the private sector will seize socially profitable investment opportunities, as market prices are not necessarily a reflection of real economic scarcity for large portions of the population. It is thus in an attempt to counterbalance political and economic colonialism, as were observed in Asia, Africa and Latin America in the 19th and 20th century, that the newly independent governments felt bound to intervene. Yet, these interventions may have worsened the market mechanism as an indicator of social advantage,

[3]Fragmentation relates to the fact that households and firms operate in such isolation that they cannot access the same technologies and encounter differences in the effective prices of land, labour, capital and produced output McKinnon (1973: 5).

since they were directly targeting specific individuals or sectors of the economy at the expense of the others McKinnon (1973: 6). This has historically been the case in many developing countries, especially, where there is restricted competition in the financial sector with government interventions and regulations (McKinnon, 1973; Shaw, 1973). Hence, financial intermediaries, prevented to function at their full capacity are unable to efficiently channel saving into investment, thereby hindering the development of the overall economic system (McKinnon, 1973; Shaw, 1973). McKinnon (1973: 8), thus advocates for an explicit policy aimed at refining the operation of factor markets which is necessary to convince governments to refrain from becoming involved in commodity markets operations. Well-thought-out liberalization measures in all sectors can then be implemented not only to correct the more noticeable errors of the immediate past (i.e. the issues caused by the financially repressive policies of developing economies), but also mitigate the real reservations created by pure laissez-faire.

Furthermore, McKinnon (1973: 8) posits that there exist substantial discrepancies in rates of returns in underdeveloped economies where some physical and financial assets receive negative returns while some potentially lucrative investment opportunities are passed on. In these cases, it becomes erroneous to look at the accumulation of capital of equal productivity as a simple measure of development. Yet, this has been common practice for economic growth theorists and econometricians generally incorporating this assumption into production functions; as well as international agencies computing the underdeveloped economies' foreign aid requirements while keeping output-capital ratios in those countries fixed (McKinnon, 1973: 9). Therefore, McKinnon hypothesized that in order to eliminate fragmentation, capital markets should be unified which will widen exploitable investment opportunities and consequently increase the rates of return to domestic savers. Interest rate ceilings should, therefore be abolished so that real interest rates will be determined by market forces.

McKinnon's (1973) and Shaw's (1973) arguments strongly reject the theory of financial repression through interest rate controls and government intervention advanced by Keynes (1936) and Tobin (1965). Their model, whose basis is an inside money framework, includes investors, savers and financial intermediaries. This is due to the backing of loans to the private sector by the latter's domestic debt, whereby the real interest rate is kept at a lower level than equilibrium by holding the nominal rate fixed. The model suggested by McKinnon (1973) and Shaw (1973) presents saving as a positive function of the real rate of interest, while investment is a negative function of the real rate of interest. In this case, there is expectation of a drop in the level of savings if there is a fall in real interest rate due to accelerating inflation or a fall in fixed nominal rate of interest. The argument is that as land ownership serves to offset the inflation effect, a fall in the real rate of interest will boost the demand for land; capital deposits within the financial system becoming less appealing (McKinnon, 1973; Shaw, 1973).

Although redirecting savings from the financial sector to the purchase of land will lead to a faster increase in land prices compared to the general price level, the induced wealth effect will drive consumption up, thus, reducing investment and savings. Moreover, in a situation of financial repression with nominal interest rate fixed below equilibrium, there will either be a substantial interest rate spread if deposit rates are fixed, or credits will be rationed if both deposit and lending rates are fixed. Hence, instead of focusing on expected investment productivity, the allocation of credit will follow certain criteria, namely the perceived default risks, transaction costs, quality of collateral, reputation and political influence of the borrower, amongst others (McKinnon, 1973; Shaw, 1973). Furthermore, investments may become in average less efficient as the lower fixed lending rate may increase the profitability of opportunities with lower returns. This may also have a negative impact on the risk-taking behaviour of participants in the financial sector stemming from their inability to apply the fitting risk premium. That is why McKinnon (1973) and Shaw (1973) prescribe the abolishment of all institutional constraints on the nominal rate of interest, as well as the reduction of inflation.

Even though the same conclusions were reached, McKinnon (1973) and Shaw's (1973) theoretical models were quite distinct. The model used by McKinnon (1973), the complementarity model, assumes that firstly all agents are limited to self-financing, and secondly that investment activities have important indivisibilities. With no distinction made between investors and savers, McKinnon (1973) argued that money balances or other financial assets must be accumulated in advance by an investor for investment activities to be undertaken at a later stage. He, therefore, identified an intertemporal complementarity between physical capital and demand for money. That is, there is a positive relationship between money and the propensity to save/invest. According to Fry (1995), McKinnon's (1973) model is considered to be outside money, as investors rely on self- finance and cannot borrow to invest. Contrary to inside money models which are backed by the private sector's internal debt, government borrowings are the backing of outside money models. In this case, government bonds are held by banks and no loans are made to the private sector (Fry, 1995).

Conversely, Shaw (1973) does not see a need for complementarity in his debt intermediation model since investors are not restricted to self-finance. He suggests that the lending potential of financial intermediaries is expanded through the accumulation of deposit sustained by increasing the real rate of interest to savers. On the investors' side, Shaw (1973) postulates that the real cost of lending is lowered by intermediaries who use tools such as economies of scale in lending, lower information costs to investors and savers, improved operational efficiency, accommodation of liquidity preference, and risk diversification. Contrary to McKinnon's (1973) model, Fry (1995) classifies Shaw's model as an inside money model.

Since both internal and external sources may finance investment, there is no essential contradiction between the debt intermediation hypothesis developed by Shaw and the complementarity hypothesis presented by McKinnon. While Shaw's analysis is mainly concerned with advanced economies with developed financial systems, McKinnon's work focuses principally on developing economies. Over the years several models have been developed in support and as extension of McKinnon (1973) and Shaw's (1973) work. Generally, these models pay more attention to the effects of financial liberalization on the quality or the quantity of investment. For example, the free market neoclassical ideas suggest that financial sector liberalization enhances the mobilization of savings and the channeling of capital into the most appropriate sectors of the economy (Yusuf *et al.*, 2014). This implies an improvement of the amount of physical capital and its productive uses and an increase in the level of economic growth. Economic growth, in turn, raises the level of income thus reducing the level of poverty.

There is a consensus among economists that the sequencing of liberalization measures should start with the domestic real sector, followed by liberalization of the domestic financial sector, and end with liberalization of the capital account (Owusu, 2011: 47). The rationale is that liberalizing the domestic financial sector prior to liberalizing the domestic real sector will direct the flow of credits to the real sector which is regarded as more profitable, due to the distortion of relative prices. However, if the external financial sector is liberalized after the domestic financial sector, the flow of credits will be directed towards the commerce sector, profitable solely due to trade barriers. Yet, if liberalization of the domestic financial sector does not occur before trade and commerce take place, domestic industries could be ill-equipped in their competition on the international market. Finally, liberalizing the external financial sector before domestic financial sector will lead to significant capital flights as the domestic interest rates will still be lower than world interest rates. Thus, domestic banks will be unable to compete with foreign banks (Owusu, 2011: 47).

According to Rancière, Tornell and Westermann (2008), financial liberalization denotes the liberalization of the capital account and the deregulation of domestic financial markets. Concretely this involves measures such as removing restrictions on capital inflows and outflows, allowing foreign investors to purchase and hold domestic equity and to freely repatriate capital, dividends and interests, abolishing directed credit allocation, denationalizing banks, liberalizing interest rate, liberalizing entry to the banking sector, as well as strengthening prudential regulations. These measures can be regrouped into three different forms of liberalization, namely capital account liberalization, stock market liberalization and financial sector liberalization.

Capital account liberalization generally involves a decision by central authorities to eliminate limits on capital inflows and outflows. The proponents of this form of liberalization postulate that the abolishment of capital flows restrictions will create an unlimited flow of international capital, through which the cost of capital will be lowered, risk diversification will be possible, and investment in projects yielding higher returns will be encouraged (Tswamuno *et al.*, 2007: 76). Hence, the implementation of capital account liberalization measures will offset low savings levels and boost the level of investment, employment as well as economic growth.

One argument in favour of capital account liberalization, namely Allocation efficiency, is based on the standard neo-classical model developed by Solow (1956). According to Solow's model, when the capital account is liberalized, allocation of international resources becomes more efficient. This in turn positively affects economic activities leading to economic growth. There is thus a flow of resources from capital abundant countries with low return on capital, to capital deficient countries with high return on capital. With the inflow of resources to the capital deficient countries, there is a temporary increase in investment and economic growth. This also creates a permanent increase in the countries' standard of living. However, the theory of allocation efficiency based on the neo-classical model only represents an extension of the benefits of international trade in goods to trade in assets. This theory will only hold in cases where barriers to free capital flows are the only existing distortions to the economy (Owusu, 2011: 48).

Another argument in favour of the liberalization of capital account is based on the theory of international asset pricing model. It stipulates that following liberalization; segmented markets will be integrated and the cost of equity and debt capital will fall. In effect, when global assets bearing similar or identical risks yield the same expected return no matter where they are traded, integration will be achieved (Owusu, 2011: 48). Furthermore, differential risk across markets could be eliminated through liberalization as the cross-border capital flow to isolated countries would balance the price of risk across all markets. Also, liberalization leads to an improvement of stock market liquidity as investors are confident in their ability of exiting the market as easily as they can enter it. This positively affects the development of the underlying market (Levine and Zervos, 1998).

Stock market liberalization, which is one particular form of capital account liberalization is a policy undertaken by authorities to open a domestic equity market to foreign investors (Henry, 2000: 3). Henry (2000:3) emphasizes the important implications of such a policy for real investment by considering the calculation of a firm's Tobin's q. In effect, Tobin's q, which is the ratio of the market value of a firm's capital to its replacement cost, determines the firm's optimal capital stock and the basis for all investment decisions. Thus, since the market value of a stock is part of the ratio's numerator, a direct link can be identified between investment and stock prices. Henry (2000: 5) explains that stock market liberalization follows a gradual process subsequently involving liberalization reforms paired with beneficial unforeseen macroeconomic events. Considering that a country's stock market value is represented by the present value of its future output added to a sum of risk adjustments reflecting the stock's contribution to consumption insurance on a separate later date. When a market is opened to international trade through financial openings and other economic reforms, there may be a change in the country's expected output stream as both domestic and foreign preferences and endowments now jointly determine the marginal conditions on consumption (Henry, 2000: 5). Thus, after liberalization the price of equity in that country becomes greater at the integrated equilibrium than it was in autarky. That is likely to occur if, firstly, the autarky discount rates are strictly higher than world discount rates; and secondly, the expected value of future output streams is greater after liberalization. Therefore, the discount rate of future dividend payments will change and aggregate risk-sharing among foreign and domestic investors will increase, reducing risk premium and positively impacting stock prices. The lower cost of equity capital improves physical investment after liberalization. However, an element of risk is introduced in emerging and frontier markets with their high level of volatility; investors are unable to make informed decisions. While unsystematic risks are dealt with through diversification, these additional risks are factored by the markets as systematic risk accounted through the change in stock prices (Henry, 2000: 5).

As a theoretical argument against liberalization, Taylor (1983) presents the two accounts on which the McKinnon-Shaw theory may be erroneous. The first account exposes a Keynesian viewpoint according to which aggregate demand falls as a result of the increase in the predisposition to save. This is more likely to create economic contraction rather than economic growth. The second account explains that the increase in real deposit rate may lead to a rise in the level of bank deposit. Depending on the origin of these deposits, the availability of credit will be affected in diverse ways. The availability of credit will be positively impacted if the bank deposits are redirected from assets of the less-productive sector. However, there will be a contraction in the supply of credit if bank deposits originate from the informal sector since informal operators are not subjected as the banks are to reserve requirements. Taylor (1983) thus identifies financial liberalization as stagflation and proposes a more direct approach to boosting capital accumulation in developing countries, which involves the increase of capital utilization and the creation of an atmosphere of confidence favourable to investment.

The post Keynesians also advanced arguments against the McKinnon-Shaw hypothesis focusing on the function of effective demand (Owusu, 2011: 29). They reason that effective demand is influenced by income distribution. Therefore, in contrast to the McKinnon-Shaw hypothesis, investment and savings have distinct functions with typical Keynesian features. This implies that the liberalization of interest rate could engender a drop in production and growth, and lead to financial instability (Owusu, 2011: 29).

According to Stiglitz (2000: 1077), the proponents of capital market liberalization base their reasoning on standard efficiency arguments, making use of a traditional neoclassical model, without considering the specific differences between capital and financial markets and markets for common goods and services. Disregarding the distributional consequences of capital markets' efficiency effects, they believe that if liberalization produces large enough gains either the benefits would spill over to the poor, or active measures would be taken by authorities to protect the poor. However, critics maintain that the standard efficiency argument is far from the reality of capital account policy. Capital and financial markets are inherently different from markets for common goods and services, since the main function of financial and capital markets is to gather information, essentially to assess the profitability of projects and firms, as well as to monitor and ensure the appropriate use of funds (Stiglitz, 2000: 1079). Even that seldom applies to developing countries where information asymmetries are endemic to financial markets and transactions. These markets are thus unable to gather enough relevant information to ensure the flow of capital to sectors where its marginal productivity tops opportunity costs.

Additionally, some critics of the financial liberalization theory argue that numerous conditions have to be met prior to liberalization, and that the benefits of financial liberalization cannot be established as long as countries disregard the importance of reform complementarities. For example, if financial liberalization reforms are implemented in a setting where the poor human capital is ill-equipped to appropriately embrace the inflow of foreign capital and the associated technology, the impact of financial liberalization on growth can be dissatisfying (Njikam, 2017: 2).

3.3.3 Empirical literature

The empirical literature on the effect of financial liberalization has evolved over time. While some studies found a positive relationship between financial liberalization and economic growth or financial development, others found that the effect of liberalization can be significantly positive if the reforms are coupled with other macroeconomic measures.

A number of studies were conducted to examine the linkage between financial liberalization, economic growth and poverty reduction. In the case of Sub-Saharan African countries, a few researchers, namely Yusuf *et al.* (2014) and Fowowe (2008) found a positive causality relationship between financial liberalization and economic growth. Fowowe (2008) who covered the period 1978 – 2000, constructed two financial liberalization indices taking into consideration the gradual evolution of liberalization policies. The first index (FINDEX1) is derived by previously identifying five key moves towards liberalization, namely free entry into banking, bank denaturalization and restructuring, directed credit abolition, prudential regulation, and interest rate liberalization. Numerical values were allocated taking the value of zero before liberalization and one and above after liberalization according to the progress made for the different liberalization policy. Thus, a matrix of five variables was created and principal components' analysis was applied (Fowowe, 2008: 7). In the construction of the second index, a numerical value was assigned to the progress made with each of the five key moves towards liberalization (Fowowe, 2008: 7). These two indices and a dummy variable for financial liberalization were separately introduced in growth equations including control variables such as initial income per capita (i.e. measuring convergence), investment, life expectancy (i.e. measuring human capital), the ratio of imports and exports to GDP (i.e. measuring the degree of openness, and the debt service ratio (i.e. measuring macroeconomic uncertainty). Furthermore, both the fixed effects and the dynamic panel estimators are employed; the former to control for unobservable country specific effects, and the latter to control for the potential endogeneity of financial liberalization. The study, which covered 19 Sub-Saharan African countries, found that in all cases economic growth was positively affected by financial liberalization (Fowowe, 2008: 3).

However, using panel cointegration and panel causality on data collected from six countries, namely Botswana, Cameroun, Cote d'Ivoire, Gambia, Ghana and Nigeria, Yusuf *et al.* (2014) showed that as the coefficients of financial liberalization are not significant in the poverty equation, financial liberalization does not directly impact poverty reduction in the Sub-Saharan African countries studied. The data sample covering the period 1996 – 2011, consisted of the head count index (i.e. the percentage of the population under the level of one dollar of daily income) as a measure of poverty, growth of real GDP per capita as a measure of economic growth, and the Chinn – Ito index as a measure of financial openness. To justify the use of the chosen methodology, Yusuf *et al.* (2014: 170) pointed out that the common mistake made in panel time series analysis is to assume cross-sectional interdependence or slope homogeneity, leading to the causal inferences being incorrect. The authors concluded from their analysis that without maintaining supervisory and regulatory frameworks, macroeconomic stability, as well as sound institutions and policies in the Sub-Saharan African economies, the implementation of financial liberalization reforms may exacerbate the living standard of the poor segment of the society (Yusuf *et al.*, 2014: 173).

Furthermore, Reinhart and Tokatlidis (2000), in their analysis of financial liberalization reforms on financial development in Africa, found that financial liberalization on the continent was not followed by financial deepening as was the case in other regions of the world. In effect, while there was an improvement in the monetary aggregates, the credit aggregates remained the same. Many African countries even experienced a credit crunch. This prompted the idea that liberalization in Africa has not been accompanied by the kind of fiscal discipline that allows credit to flow to the private sector, as was the case in other regions of the world (Reinhart and Tokatlidis, 2000). Moreover, while many developing countries appeared to have greater access to international capital markets after financial liberalization occurred, this was not the case for African countries where capital account liberalization has been more slow-moving. However, Reinhart and Tokatlidis (2000) concluded that even though liberalization does not guarantee financial deepening for Africa as a whole and for the low-income countries especially, it is still important to liberalize because, given the track record of financial repression, liberalization still appears to dominate the alternative.

When examining the determinant of financial development, Law and Habibullah (2009) narrowed their analysis down to three determinants, namely trade openness, institutional quality and financial liberalization. The panel data analysis was conducted using data from 27 economies selected from the G-7, East Asia, Europe and Latin America and covered the period 1980-2001. According to Law and Habibullah's (2009) findings, domestic financial sector liberalization promotes banking sector development, while stock market development is encouraged by stock market liberalization measures. However, these results also show that developed economies are more responsive to financial liberalization measures than developing economies.

A similar study by Karikari (2010) focused on examining the effect of governance and financial liberalization on financial development in 37 Sub-Saharan African countries for the period 1996 – 2008. The author ran a series of simple regressions including variables such as the ratio of private credit by deposit banks to the GDP as a measure of financial development, the Chinn-Ito index as a measure of financial liberalization, the World Bank's Worldwide Governance Indicators as a measure of governance, the University of Ottawa's World Legal Systems Research Group data on the origin of legal system, as well as a number of control variables capturing macroeconomic conditions and other conditions which may affect financial development. These variables are net official development aid, government expenditure, inflation rate and real GDP per capita. Two dummy variables were also included in the model; one in order to control for the likely continuous effects of the banking crises experienced by many countries in the late 1980s and early 1990, and the other to identify oil-exporting countries as the vulnerability of their incomes to fluctuations in the international crude oil prices may adversely affect financial development (Karikari, 2010: 14).

Karikari's (2010: 21) results confirmed the argument derived from previous studies maintaining that financial liberalization alone does not lead to development. In effect, the author found that improvement in financial liberalization lowered financial development in the Sub-Saharan African countries during the period 1996 – 2002, and argued that the effect of liberalization on financial development may lie on the level of institutional quality. Moreover, as improved governance had a similar effect on financial development, the large number of generally state-owned faulty banks being tolerated by most governments was suggested as a possible explanation for this adverse result for that period. However, the study also found an improvement in the impact of governance as well as financial liberalization on financial deepening in the period 2003 –

2008. Karikari (2010: 22) concluded that the practice of good governance in the Sub-Saharan African countries could have contributed to the success of the massive financial liberalization undertaken in those countries in the late 1980s and early 1990s. In addition, rule of law seemed to have less power on financial development than political stability.

Interestingly, Moyo *et al.* (2014) investigated the hypothesis that an increase in banking sector competition because of financial liberalization boosts to financial stability in 16 Sub-Saharan African countries during the period 1995 - 2010. The methodology chosen for this study was the survival model with time-varying covariates, as it is able to identify the time varying nature of the probability that a bank may become distressed depending on macroeconomic, country specific and bank specific conditions. Moreover, this model allows distinguishing between failing and surviving firms which is crucial as bank insolvencies and closure carry high regulatory costs. Thus, the bank's financial ratios are used to assess the risk of bank distress, and the contagion effects are measured through banking aggregate variables (Moyo *et al.*, 2014: 26). The variables included in the model are the ratio of equity capital and loan loss reserve to gross assets measuring capital adequacy, loan asset ratio measuring asset quality, trading income ratio measuring management, cost income ratio measuring earnings, and provisions to loans ratio measuring liquidity. The sample dataset was split between ex-ante and ex-post financial reform regimes, and the Panzer and Rosse (1987) H-statistic was used to measure competitive conditions in the banking sector. Finally, macroeconomic variables such as exchange rate volatility, budget deficits, terms of trade shocks, inflation, excessive credit growth and interest rate volatility were included as explanatory variables. Likewise, some institutional variables such as economic freedom, rule of law, civil conflict, corruption, legal origin, bureaucracy in licensing and regulation, and the ease of doing business were also included as independent variables (Moyo *et al.*, 2014: 28).

The results of the analysis showed that firstly, economic freedom, easing of restrictions and entry of foreign banks all contributed to improving competition in the banking sector; and secondly, in the period after implementation of financial liberalization reforms, an increase in competition was associated with an increase in the lead time to episodes of bank distress (Moyo *et al.*, 2014: 36). However, Moyo *et al.* (2014: 36) emphasized that the government's pursuit of sound macroeconomic policies and enhancement of the effectiveness of institutions allowing the success of the banking industry are crucial to stabilize the banking system in a competitive and liberalized economy.

Nwadiubu, Sergius and Onwuka (2014) conducted an analysis of the effect of financial liberalization on economic growth in the case of Nigeria during the period 1987 – 2012. Employing the Johansen cointegration method and the Error Correction model (ECM), the authors set the country's annual non - oil GDP, a proxy for economic growth, as the dependent variable and financial liberalization indicators, as well as some macroeconomic measures of uncertainty as the independent variables. The financial liberalization indicators included the degree of openness and the ration of M2 to GDP as a measure of financial deepening. The macroeconomic indicators included inflation, the lending rate and the exchange rate (Nwadiubu *et al.*, 2014: 128).

The results of the analysis showed that economic growth in Nigeria has been positively impacted by financial liberalization measures. In fact, the binding constraints on investment funding have been eased through interest rate deregulation which encouraged investors to request funding from the domestic financial institutions. Contrary to a priori expectations, a positive relationship was found between GDP (i.e. economic growth) and exchange rate. Thus, the deregulation of the exchange rate as part of the financial liberalization measures may improve the country's competitiveness on international markets which had a positive effect on economic growth between 1987 and 2012 (Nwadiubu *et al.*, 2014: 133). Another unexpected result would be the effect of the economy's inflationary trend on growth during the study period. The authors argued that the positive effect that that inflation had on economic growth may be explained by an increase in investment in anticipation of promising prices and income, which could have led to an improvement of the employment rate and income level. Lastly, while the degree of openness had a positive impact on economic growth in the country, financial deepening had the opposite effect. This was argued to be caused by the sequencing of liberalization and the financial instability prevailing in the country over the years (Nwadiubu *et al.*, 2014: 133).

Similar to Nwadiubu *et al.* (2014), the investigation of the impact of financial liberalization on economic growth in South Africa was conducted by Precious *et al.* (2014) using the Johansen cointegration method and the vector error correction model in order to obtain long run and short run parameters. The model specified included the GDP growth rate as the endogenous variable, inflation, the lending rate, the real effective exchange rate and financial deepening (i.e. M2/GDP) as the exogenous variables. For the sample period 1990-2011, the results indicated a positive relationship between financial deepening, lending rate and inflation and economic growth in the long-run, while a negative relationship was found between economic growth and exchange rate (Precious *et al.*, 2014: 244).

Tswamuno *et al.* (2007) also explored the effect of financial liberalization on economic growth in South Africa by focusing on the reforms implemented on equity and bond markets. The sample data covered the period from the third quarter of 1975 to the first quarter of 2005. The authors employed a comprehensive and fully interacted growth model including the logarithm of real GDP per capita as the endogenous variable, and some capital account liberalization proxies as the exogenous variables. These are the logarithm of stock market turnover as a proxy for stock market liquidity, the logarithm of foreign portfolio investment as a proxy for the level of foreign participation in the domestic financial markets, and the logarithm of total bank claims as a proxy for banking sector development (Tswamuno *et al.*, 2007: 78). The model also controlled some macroeconomic conditions such as the level of human capital measured by the logarithm of the ratio of household health expenditure to total household expenditures, and the effect of macroeconomic policy on growth measured by the logarithm of openness to trade (i.e. the ratio of exports and imports to GDP). A time-based dummy variable was also included in order to identify the differential effect of the exogenous variables. The results of the regression indicated that capital account liberalization did not have a positive impact on economic growth during the period under consideration (Tswamuno *et al.*, 2007: 80). However, the authors acknowledged that the robustness of the model may have been affected by the exclusion of an important control variable, the political developments in South Africa, as it is closely connected to financial liberalization. The exclusion was due to multicollinearity in some of the potential proxies, and unavailability of data in the required frequency and time frame for others (Tswamuno *et al.*, 2007: 79).

Le Roux and Moyo (2015) extended the analysis of the relationship between financial liberalization and economic growth to the 15 SADC countries between 1985 and 2011. The annual growth rate of GDP was set as the dependent variable, while the independent variables were defined as follows: the growth rate of GDP per capita, the Chinn – Ito index (i.e. to measure financial openness), the ratio of gross fixed capital formation to GDP (i.e. to measure investment), the share of the sum of imports and exports in GDP (i.e. to measure trade), the ratio of domestic credit to the private sector to GDP (i.e. to measure the level of credit), the ratio of total external debt stocks to gross national income (i.e. to measure public debt), and the government expenditure on goods and services and compensation for government employees (i.e. to measure government spending) (Le Roux and Moyo, 2015: 15). Because GDP per capita is strongly persistent, the authors chose to specify a dynamic panel model including a one-period lag of the dependent variable as an independent variable. Moreover, the 2008 – 2009 financial crisis was taken into account by including a dummy variable taking the value of one for the years of crisis and zero for the other years. The analysis conducted using the fixed effects estimator, the GMM estimator and the fully-modified OLS cointegration tests, concluded that there is a positive relationship between financial liberalization and economic growth in the SADC region. Le Roux and Moyo (2015: 9) argued that increasing the level of financial liberalization could improve economic growth in the region.

A significant contribution was made by Owusu (2011) who conducted comprehensive case studies on the effect of capital account and interest rate liberalization measures on economic growth in three West African countries, namely Cote d'Ivoire, Nigeria and Ghana. The data sample included annual time series covering the period 1969 – 2008 for all three countries. Owusu (2011) constructed three financial liberalization indices using principal component analysis. The first index represents the implementation of interest rate liberalization reforms; the second one indicates the implementation of capital account liberalization measures, and the third one is a combination of the effect of both interest rate liberalization and capital account liberalization on growth. The autoregressive distributed lag (ARDL) bound testing method and the unrestricted error correction model (UECM) to cointegration analysis were used to examine the long run relationship between the liberalization variables and the real GDP per capita representing economic growth.

The results of the study showed that, in Cote d'Ivoire and Nigeria, interest rate liberalization boosted savings and investments, and ultimately induced rapid economic growth in the long run. In the case of Ghana, the increase in savings and investment was not transmitted into economic growth (Owusu, 2011: 262). Moreover, the evidence showed that only when capital account liberalization measures are coupled with improvements to foreign direct investment and credit to the private sector, there was a positive impact on economic growth in all the countries. Finally, it was found that factors such as increase in government spending, capital stock accumulation and credit to private sector, increase in labour productivity and increase in foreign direct investment were the key drivers of economic growth in the countries in lieu of financial liberalization policies and exports (Owusu, 2011: 262).

Most recently, Njikam (2017) conducted an analysis on 45 Sub-Saharan African countries to firstly investigate the effect of financial liberalization on economic growth and secondly examine the role of complementary reforms in the financial liberalization – economic growth nexus. The study was based on an unbalanced panel dataset covering the period 1970 – 2010. The author attempted to control business cycles by structuring the data as a panel comprising eight observations for each country made up of non-overlapping 5-year averages for each variable. The equation specified in the study includes the log difference of GDP per capita as the dependent variable and the initial level of log GDP per capita at the start of each 5-year period, the Chinn-Ito index, a dummy variable for dates of financial liberalization events, the ratio of gross domestic investment to GDP and annual population growth rate as the independent variables (Njikam, 2017: 3).

In the analysis of policy complementarity, the variables used are the ratio of total secondary enrollment to the population of the age group that officially corresponds to the specific level of education (as a measure of the education level), the growth rate of the share of government spending in GDP, inflation rate, the number of main telephone lines per capita and the electricity production (as measures of public infrastructure), the annual growth rate of the foreign debt to GDP ratio (as a measure of external stability), the ratio of exports plus imports to GDP (as a measure of trade openness), and finally, the indicators of civil liberties and political rights from Freedom House (as a measure of governance) (Njikam, 2017: 3). Using the system – GMM estimator on a non-linear growth regression specification, it was found that there is no significant relationship between financial liberalization and economic growth in Sub-Saharan Africa. However, the link between financial liberalization and growth is positively affected by the level of human capital. Njikam (2017: 7) also concluded that the impact of financial liberalization on growth is contingent on a sound institutional framework, as well as macroeconomic and external stability.

Although extensive research exists on the relationship between liberalization and economic growth in Sub-Saharan Africa, the literature on the link between financial liberalization and stock market development in the region is rather scarce. One of the few studies that can be found is the Kinuthia and Etyang (2014) examination of the impact of stock market liberalization on stock market performance and economic growth in Kenya. The study employed secondary market level data on a quarterly frequency for the period January 1991 – December 2012. The variables, namely GDP per capita (measuring economic growth), the ratio of market capitalization to GDP (a proxy for liberalization), the turnover ratio (measuring stock market performance), and the ratio of gross fixed capital formation to GDP (a control variable representing investment), were entered into an unrestricted vector autoregressive (VAR) framework to investigate the link among them. The evidence indicated that the liberalization of the stock market in Kenya had a significantly positive influence on stock market performance and economic growth. In fact, stock market liberalization had a positive impact on investment and stock market liquidity, which in turn positively affected real GDP per capita (Kinuthia and Etyang, 2014: 207).

Prior to that, Dhir (2007) examined the impact of liberalizing the stock market on the volatility in 12 selected emerging stocks between February 1976 and December 2006. In each case, the author built a liberalization period in order to capture the identified openings in the markets. Dhir (2007: 13), firstly, used the univariate GARCH framework to investigate time-varying conditional volatility after the initial market opening. Secondly, the impact of liberalization on market volatility was examined still using a GARCH (1,1) specification but including control variables fundamentally affecting emerging market volatility in the conditional mean equation. These control variables are volatility in real output, market liquidity, volatility in exchange rate, inflation and world market volatility. Thirdly, a single equation model for volatility is specified, including the same control variables, to examine the impact of liberalization on volatility. In this case, volatility is estimated using an ARMA(1,1) – GARCH (1,1) model and country-specific time series regressions are run (Dhir, 2007: 26). The results of the analysis showed that there is no significant evidence of time varying impact of stock market liberalization on volatility. However, it is seen that for most countries, except Argentina and the Philippines, the opening of the markets had a differential effect on volatility both during and after the liberalization period. In some cases, the effect was significantly positive while in others it was significantly negative (Dhir, 2007: 52).

Likewise, Nyang'oro (2013) explored the impact of foreign portfolio flows on the performance of the stock market in Kenya. Focusing on the period April 1996 – December 2011, the author used a multifactor arbitrage pricing theory (APT) including the stock market return, market capitalization, volatility, change in exchange rate, treasury bill rate, world treasury bill rate, inflation, the returns in SCI world index, foreign portfolio flows and internal flows. The empirical analysis uncovered a relationship between stock market return and lagged unexpected flows, rather than contemporaneous flows values. In fact, a lag in unexpected flows is linked to a fall in equity prices (Nyang'oro, 2013: 30). Moreover, with inflow of foreign portfolio investments there was an increase in stock prices, potentially due to an increase in demand. However, there was no significant feedback effect found between foreign portfolio flows and stock returns. Nyang'oro (2013: 31) argued that it may be an indication of the fact that the market is attractive to foreign investors mainly for risk diversification purposes, and not for returns. Finally, there was a positive relationship between stock market returns and expected portfolio flows, suggesting that market performance is stimulated by an increase in expected portfolio flows which builds investors' confidence in the market (Nyang'oro, 2013: 32).

Balogun, Dahalan and Hassan (2016) extended the analysis of stock market liberalization and financial development on the development of stock markets to seven Sub-Saharan African economies, including Botswana, Cote d'Ivoire, Ghana, Kenya, Mauritius, Nigeria and South Africa. The study covered the period from 1990 to 2013 and ran a dynamic heterogeneous panel analysis through the use of Pesaran, Shin and Smith's (1999) Pooled Mean Group (PMG). The analytical model follows Yartey's (2008) argument but is modified to include the stock market liberalization index, total credit to the private sector as a percentage of GDP, real GDP and the foreign interest rate (measured by six months US Treasury bill rates) as exogenous variables, while the stock market development measured by market capitalization is the endogenous variable (Balogun *et al.*, 2016: 58). The stock market liberalization index was built using Kaminsky and Schmukler's (2008) chronology and the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions, in order to depict the intensity of stock market liberalization in the chosen countries. The conclusion drawn from the analysis was that liberalization of the stock market has a long-run positive impact on stock market development in the Sub-Saharan African countries under consideration. Moreover, liberalizing the stock markets improves financial development which also has a positive effect on the development of the stock market in the long run.

3.3.4 Conclusion

In conclusion, the financial liberalization theory advanced by McKinnon (1973) and Shaw (1973) encourages the removal of interest rate and credit controls, the free mobility of capital in and out of the economy and the opening of domestic capital markets to foreign investors. The argument maintains that this will lead to a rise in savings and investment, and ultimately boost economic growth and financial development. However, the arguments against liberalization stress the importance of policy complementarity, suggesting that liberalization cannot induce development as long as it is not coupled with other macroeconomic policies.

Empirically, a number of studies have been conducted to analyse the effect of financial liberalization on economic growth and financial development. Although some of the studies uncovered a positive relationship between liberalization and growth, others proved that liberalization measures on their own do not have a significant effect on growth and development. In fact, only when these reforms are associated with other macroeconomic variables such as governance and institutional quality, were they found to positively affect growth.

Although the literature on the relationship between financial liberalization and economic growth or financial development in Sub-Saharan Africa is quite rich, there is a lack of studies on the effect of liberalization measures on stock market development. Hence, this study aims at bridging this gap by focusing on the effect of each of the three forms of liberalization (i.e. capital control liberalization, stock market liberalization and financial sector liberalization) on the development of stock markets in Sub-Saharan Africa. In addition, the majority of the existing studies used cointegration tests and VECM models. In an attempt to explore better tools for this type of analysis, this study will rather make use of the Bayesian VAR, which is a more elaborate than the unrestricted VAR, and especially more appropriate when modelling large data sets. In effect, during the choice of variables, lag length selection, and specification of identification restrictions, the unrestricted VAR scantily makes use of a-priori information. This may lead to overfitting when there are a large number of parameters, weak sample information or a short data set. Typically, in-sample overfitting leads to poor quality unconditional and conditional (Canova, 2007: 351). These shortcomings can be addressed when using the Bayesian methods as less dramatic in-sample fitting can be made and out-of-sample performance is improved (Canova, 2007: 351).

3.4 METHODOLOGY

3.4.1 Introduction

As can be observed from the previous section, a number of tools have previously been used in the literature to examine the effect of liberalization measures on economic growth, financial development, as well as on stock market performance. While the majority of studies used cointegration frameworks and the VECM, some studies can also be found using a variety of VAR models, such as the unrestricted VAR (Kinuthia and Etyang, 2014). However, in a bid to explore an innovative methodology, this study will employ the Bayesian VAR (BVAR) that also addresses the shortcomings of the unrestricted VAR. Moreover, the BVAR which was initially developed to improve forecasting in the macroeconomics field, has evolved substantially over the years and is now applied for diverse purposes.

The following subsections will present the analytical framework, followed by the specification of the model, ending with the data specification and descriptive statistics.

3.4.2 Analytical framework

The Vector Autoregressive (VAR) models are atheoretical models used to capture and evaluate linear interdependence between time series (Woźniak, 2016: 1). Introduced by Sims (1972), they successfully capture stylized facts about time series such as dynamic linear interdependence, robust autocorrelations at annual frequencies, and the deteriorating pattern in the values of autocorrelations when the lag order increases (Woźniak, 2016: 1). When using the VAR model, it is not essential to specify variables as exogenous or endogenous as all variables are treated as endogenous. Furthermore, "each variable is defined as a linear function of its past lags and the lags of other variables included in the model" (Aye *et al.*, 2012: 6). Thus, they seem most appropriate when modelling data collecting vectors of observation for N variables for a time period t going from 1 to T.

A simple VAR equation in its general form is written as:

$$y_t = \mu + A_1 y_{t-1} + ... + A_k y_{t-k} + u_t \tag{3.1}$$

where y_t is a $Nx1$ vector of variables included in the model;μ is a $Nx1$ vector of the constant term; A is a NxN vector of autoregressive coefficients; and u_t is a $Nx1$ vector of error terms. u_t is assumed to be normally distributed with a zero mean and a covariance matrix Σ denoted as:

$$u_t \sim \mathcal{N}_N(0, \Sigma) \tag{3.2}$$

According to Woźniak (2016: 1), the dynamic interdependence between series which is analysed through the Granger causality hypothesis is efficiently captured by the VAR, making it a crucial tool for empirical macroeconomic research, based on the unrestricted VAR model other models such as Structural VAR models and the Vector Autoregressive Moving Average models. Additionally, with the introduction of an econometric technique named parameter shrinkage, the Bayesian VAR was developed.

Pioneered by Thomas Bayes, the Bayes' theorem was presented as an answer to the inverse probability problem. A simple representation of Bayes' rule is written as:

$$p(\theta|Y) = \frac{p(Y|\theta)p(\theta)}{p(Y)}, \tag{3.3}$$

where θ is a collection of all the parameters included in the model; Y is the data used for the estimation of the parameters; and p is some probability distribution.

The left-hand side of equation 3.3 gives the posterior distribution; that is, a conditional distribution of the collection of parameters θ given the data Y. This distribution is a full designation of the information gathered about the parameters of the model after observation of the data (Woźniak, 2016: 2). The first element of the numerator on the right-hand side of equation 3.3 presents the likelihood function. This is the conditional distribution of the data given the parameters of the model as:

$$p(Y, \theta) = p(Y|\theta)p(\theta) \tag{3.4}$$

The main differences between the Bayesian and frequentist[4] inference rules are highlighted when analysing the likelihood function. On the one hand, from the frequentist perspective, the data generating process represents the model, and when the process and its parameters θ are known, the data can be randomly drawn from the conditional distribution of the data given θ. Thus, the frequentists suggest that an estimation being a function of the data is random, as Y (i.e. the available data) is solely a single representation of the data generating process. The parameters θ are not random, even though their values are unidentified (Woźniak, 2016: 2). On the other hand, the Bayesian approach considers the observed data as given and non-random. Alternatively, the parameters and all the unknown values are random, and are therefore characterized by a probability distribution (Woźniak, 2016: 2).

Hence, returning to equation 3.3, the second element of the numerator on the right-hand side represents the prior distribution of the parameters θ. This symbolizes the uncertainty about θ before the data is observed; and is outlined as a marginal distribution of θ. The specification of this distribution by an investigator is required, as it is the information about the parameters that is being included in the statistical inference. When both the prior and the likelihood functions are known for all hypothesis the exact posterior can be computed using Bayes' formula. However, in most cases the prior probabilities are unknown and they have to be made up as subjective beliefs about the parameters. While the Bayesian inference lies on the prior and the likelihood of the observed data, the frequentist inference solely relies on the likelihood function for both unobserved and observed data. In frequentist inference, a prior is not required and the probability of hypothesis is never given. Instead, the frequentists seek to maximise the likelihood which is believed to approach the one true θ as the data sample grows. However, the Bayesian view considers that there is not just one model but many, over which a prior probability is formed and the data is used to form a posterior. Importantly,

[4]The frequentist is the school that only employs conditional distributions of data given specific hypotheses (Orloff and Bloom, 2014)

the subjectivity of the interpretation of probability does not render the inference subjective (Woźniak, 2016: 3).

In equation 3.3, the computation of the posterior distribution involves the division of the joint distribution of the data and the parameters by a denominator called the marginal data density (or marginal likelihood in statistics). This is the total probability of the data considering all the possible hypotheses that substantiate the model embodied in the data. The marginal density can be obtained from an integral of the joint distribution of the data and the parameters, with respect to the parameters. This is written as:

$$p(Y) = \int p(Y|\theta)p(\theta)d(\theta) \tag{3.5}$$

From the above equation, it can be seen that the marginal data density is a normalising constant of the essence of the posterior distribution (i.e. the product of the prior distribution and the likelihood function). Although it does not integrate to one, it is only a fundamental part of the posterior distribution and not a probability density function. Hence, Bayes' rule could alternatively be formulated as:

$$p(\theta|Y) \propto L(\theta; Y)p(\theta) \tag{3.6}$$

where $\propto$ represents the proportionality up to the marginal likelihood.

The likelihood function of an m variable VAR(q)

In this section, it is assumed that the VAR is of the form:

$$y_t = A(L)y_{t-1} + C\bar{y}_t + e_t, \quad e_t \sim (0, \Sigma_e) \tag{3.7}$$

where y_t includes m variables with q lags each; and $\bar{y}_t$ is a $m_c x1$ vector of the constant and other deterministic variables.

Thus, there are $k = mq + m_c$ number of regressors in each equation and the VAR has mk coefficients.

The VAR can also be rewritten in two alternative formats:

$$\mathbf{Y} = \mathbf{XA} + \mathbf{E} \tag{3.8}$$

$$y = (I_m \otimes X)\alpha + e \quad\quad e \sim (0, \sigma_e \otimes I_T) \tag{3.9}$$

where $\mathbf{Y}$ and $\mathbf{E}$ are $T \times m$ matrices; $\mathbf{X}$ is a $T \times k$ matrix; $\mathbf{X}_t = [y'_{t-1}, ..., y'_{t-q}, \bar{y}'_t]$; y and e are $mT \times 1$ vectors; I_m is the identity matrix of dimension m, and $\alpha = vec(\mathbf{A})$ is a $mk \times 1$ vector.

Based on equation 3.9, the likelihood function is:

$$L(\alpha, \Sigma_e) \propto |\Sigma_e \otimes I_T|^(- 0.5)exp{-}0.5(y - (I_m \otimes X)\alpha)'(\Sigma_e^(- 1) \otimes I_T)(y - (I_m \otimes X)\alpha) \tag{3.10}$$

After careful decomposition, equation 3.10 becomes:

$$\begin{aligned}
L(\alpha, \Sigma_e) \propto\ & |\Sigma_e \otimes I_T|^{-0.5} exp\{-0.5(\alpha - \alpha_{ols})'(\Sigma_e^{-1} \otimes X'X)(\alpha - \alpha_{ols}) \\
& - 0.5[(\Sigma_e^{-0.5} \otimes I_T)y - ((\Sigma_e^{-0.5} \otimes X)\alpha_{ols})'][(\Sigma_e^{-0.5} \otimes I_T)y - ((\Sigma_e^{-0.5} \otimes X)\alpha_{ols})]\} \\
& = |\Sigma_e|^{-0.5k} exp{-}0.5(\alpha - \alpha_{ols})'(\Sigma_e^{-1} \otimes X'X)(\alpha - \alpha_{ols}) \\
& \times |\Sigma_e|^{-0.5(T-k)} exp\{-0.5tr[(\Sigma_e^{-0.5} \otimes I_T)y - ((\Sigma_e^{-0.5} \otimes X)\alpha_{ols})'(\Sigma_e^{-0.5} \otimes I_T)y \\
& - (\Sigma_e^{-0.5} \otimes X)\alpha_{ols}]\} \\
& \propto \mathbb{N}(\alpha | \alpha_o ls, \Sigma_e, X, y) \times \mathbb{W}(\Sigma_e^{-1} | y, X, \alpha_{ols}, T - k - m - 1)
\end{aligned} \tag{3.11}$$

where tr is the trace of a matrix.

From equation 3.11, it is observed the possibility to decompose the likelihood function of a VAR(q) into the product of a Normal density for α, conditional on its OLS estimate α_{ols} and on Σ_e, and a Whishart density for Σ_e^{-1}, also conditional on α_{ols}, with (T–k–m–1) degrees of freedom and $[(y - (I_m \otimes X)\alpha_{ols})'(y - (I_m \otimes X)\alpha_{ols})]^{-1}$ as a scale matrix.

Consequently, with a combination of the appropriate prior restrictions, the conditional posterior distribution for the VAR coefficients and the covariance matrix of the reduced form shocks can be analytically derived. Under the assumptions of the Normal-Wishart prior, which combines the two blocks of the likelihood, the conditional posterior of Σ_e^{-1} will be Wishart, while the conditional posterior of α will be Normal (Canova, 2007: 353). There also exist other prior assumptions that permit analytical computation of conditional posteriors.

Priors for the VARs

Canova (2007: 354) focuses on four alternative types of prior specification which are: (i) a Normal prior for α with fixed Σ_e; (ii) a non-informative prior for both α and Σ_e; (iii) a Normal prior for α and a non-informative prior for Σ_e; and (iv) a Conditionally conjugate prior, that is a Normal prior for α and a Wishart for Σ_e^{-1}.

When examining the derivation of the posterior distribution for the VAR coefficients in the first alternative prior specification, let the prior be $\alpha = \bar{\alpha} + v_a, \;\; v_a \sim N(0, \bar{\Sigma}_a)$, where $\bar{\Sigma}_a$ is fixed. In this case,

$$\begin{aligned} g(\alpha) &\propto |\bar{\Sigma}_a|^{-0.5} exp[-0.5(\alpha - \bar{\alpha})' \bar{\Sigma}_a^{(} - 1)(\alpha - \bar{\alpha})] \\ &\propto |\bar{\Sigma}_a|^{-0.5} exp[-0.5(\bar{\Sigma}_a^{-0.5}(\alpha - \bar{\alpha}))' \bar{\Sigma}_a^{-0.5}(\alpha - \bar{\alpha})] \end{aligned} \tag{3.12}$$

Let $Y = [\bar{\Sigma}_a^{-0.5}\bar{\alpha}, (\Sigma_e^{-0.5} \otimes I_T)y]'$; $X = [\bar{\Sigma}_a^{-0.5}, (\Sigma_e^{-0.5} \otimes X)]'$. Hence:

$$\begin{aligned} g(\alpha|y) \propto\; & |\bar{\Sigma}_a|^{-0.5} exp{-0.5}(\bar{\Sigma}_a^{-0.5}(\alpha - \bar{\alpha}))' \bar{\Sigma}_a^{-0.5}(\alpha - \bar{\alpha}) \times |\Sigma_e \otimes I_T|^{-0.5} \\ & exp((\Sigma_e^{-0.5} \otimes I_T)y - (\Sigma_e^{-0.5} \otimes X)\alpha)'((\Sigma_e^{-0.5} \otimes I_T)y - (\Sigma_e^{-0.5} \otimes X)\alpha) \\ & exp{-0.5}(Y - X\alpha)'(Y - X\alpha) \\ & exp{-0.5}(\alpha - \tilde{\alpha})' X' X(\alpha - \tilde{\alpha}) + (Y - X\tilde{\alpha})'(Y - X\tilde{\alpha}) \end{aligned} \tag{3.13}$$

where

$$\tilde{\alpha} = (X'X)^{-1}(X'Y) = [\bar{\Sigma}_a^{-1} + (\Sigma_e^{-1} \otimes X'X)]^{-1}[\bar{\Sigma}_a^{-1}\bar{\alpha} + (\Sigma_e^{-1} \otimes X)'y] \tag{3.14}$$

Because Σ_e and $\bar{\Sigma}_a$ are fixed, then the second term in equation 3.13 is an independent constant of α and

$$g(\alpha|y) \propto exp[-0.5(\alpha - \tilde{\alpha})'X'X(\alpha - \tilde{\alpha})] \propto exp[-0.5(\alpha - \tilde{\alpha})'\tilde{\Sigma}_a^{-1}(\alpha - \tilde{\alpha})] \tag{3.15}$$

Therefore, α has a Normal posterior density with mean $\tilde{\alpha}$ and variance $\tilde{\Sigma}_a = [\bar{\Sigma}_a^{-1} + (\Sigma_e^{-1} \otimes X'X)]^{-1}$. Both Σ_e and $\bar{\Sigma}_a$ are needed in order for equation 3.15 to be operational. Naturally, $\bar{\Sigma}_a$ is chosen arbitrarily while $\Sigma_{e,ols} = \frac{1}{T-1}\Sigma_{t=1}^{T} e'_{t,ols}e_{t,ols}$, $e_{t,ols} = y_t - (I_m \otimes X)\alpha_{ols}$, for example, is used in the formulas (Canova, 2007: 354).

The Minnesota prior

This is a commonly used class of prior distribution. It is a special case of the first alternative type of prior distribution explained above. In this case, α and Σ_α are functions of a small number of hyperparameters (Canova, 2007: 355). Particularly, the assumption of the Minnesota prior is that $\bar{\alpha} = 0$ except for $\bar{\alpha}_{i1} = 1, i = 1, ..., m$; that Σ_a is diagonal, and it also assumes that the $\sigma_{ij,l}$ element that corresponds to lag l of variable j in equation i is of the form:

$$\begin{aligned}\sigma_{ij,l} &= \frac{\phi_0}{h(l)} \text{ if } i = j, \forall l \\ &= \phi_0 \times \frac{\phi_1}{h(l)} \times (\frac{\sigma_j}{\sigma_i})^2 \text{ otherwise when } i \neq j, j \text{ endogenous, } \forall l \\ &= \phi_0 \times \phi_2 \text{ for } j \text{ endogenous.}\end{aligned} \tag{3.16}$$

In this case, the hyperparameters are ϕ_i, $i = 0, 1, 2$; the scaling factor is $\frac{\sigma_j}{\sigma_i})^2$; and $h(l)$ represents a deterministic function of l. The features of interest are captured in the prior (i.e. equation 3.16). These are, the tightness of the variance of the first lag as represented by ϕ_0; the relative tightness of the exogenous variables as represented by ϕ_2; and the relative tightness of the variance of lags other than the first one as represented by $h(l)$. Generally, either a harmonic decay $h(l) = l^{\phi 3}$ or a geometric decay $h(l) = \phi_3^{-l+1}, \phi_3 > 0$, is assumed. With $\sigma_i, i = 1, ..., m$ being unknown, equation 3.16 makes use of consistent estimates of standard errors of the variables i, j.

Canova (2007: 356) explains that the logic of a prior can be understood by noting the fact that the m time series are a-priori characterized as random walks. This is due to the typical appropriateness of univariate random walk models when forecasting macroeconomic time series. However, while the imposition of the random walk hypothesis is done a-priori, each time series may represent a more complex process a posteriori, if the data contains sufficient information to require it (Canova, 2007: 356).

A priori, the variance-covariance matrix is characterized as diagonal. As a result, the coefficients of various VAR equations are not related. Because of the expectation more information about a variable's current value is contained in the most recent lags of a variable than in earlier lags, the variance of the first lag would be bigger than the variance of the second lag if $l_1 < l_2$ for every of the model's endogenous variables (Canova, 2007: 356). Moreover, $\phi_1 \leq 1$ because a variable's own lags typically have more information than the lags of other variables. Notably, the VAR is a-priori folded into a vector of univariate models if $\phi_1 = 0$. Additionally, the relative importance of the information carried by the independent variables is regulated by ϕ_2; and the relative importance of sample and prior information is controlled by ϕ_0. Therefore, it can be concluded from equation 3.14 that, while a small ϕ_0 proves the dominance of prior information; a large ϕ_0 means that prior information disperses such that the posterior distribution reflects sample information (Canova, 2007: 356).

Substantial advantages are drawn from the specification of $\bar{\Sigma}_a$ as being a diagonal. With similar variables found on the right-hand side of each equations, such specification of $\bar{\Sigma}_a$ infers a diagonal $\tilde{\Sigma}_a$, leading to a similar $\tilde{\alpha}$ as the vector of $\tilde{\alpha}_i$ calculated equation by equation. Other prior specifications, irrespective of the assumption made on the variance-covariance matrix, lose this property. Furthermore, the Minnesota prior makes the typically large dimension of α for moderate VARs reliant on a smaller vector of hyperparameters. This allows the expectation of a better precision, since the dimensionality is reduced, and this also improves out-of-sample forecasts. Even in the event that the prior is inaccurate and is a bad reflection of the sample information, the Minnesota prior still lessens the MSE of the estimates. Since it has been proven that superior forecasts are produced using VARs with Minnesota prior, compared to traditional multivariate simultaneous equations or univariate ARIMA models, for instance, the BVARs are regularly employed in international institutions and central banks for short-term macroeconomic forecasting (Canova, 2007: 358).

It is important to note that, in dealing with the "curse of dimensionality", restrictions are introduced by the Minnesota prior in a versatile manner by imposing probability distributions on the coefficients of the VAR, effectively reducing the dimensionality of the issue while simultaneously reasonably accounting for the uncertainty faced by the researcher (Canova, 2007: 358). Besides, it is crucial to choose the appropriate $\phi = (\phi_0, \phi_1, \phi_2, \phi_3)$, as a prior that is too loose will make it harder to avoid overfitting and a prior that is too tight, will not allow the data to speak. Thus, three approaches may be used. The first two approaches obtain estimates of ϕ which are plugged into expressions for $\bar{\Sigma}_a$ and $\bar{\alpha}$. Equation 3.14 is then used in an Empirical Bayes way to obtain the posterior distribution of α, based on the ϕ estimates. For instance, experience or simple rules of thumbs could be used to choose ϕ; such as the RATS manual suggesting $\phi_0 = 0.2, \phi_1 = 0.5, \phi_2 = 10^5$ as default values; and $\phi_3 = 1$ or 2 in a harmonic specification of $h(l)$. This implies that the prior on the VAR coefficients is relatively loose and the one on the exogenous variables is uninformative (Canova, 2007: 359). These values are advised as a benchmark or starting points for further examinations, as they produce reasonably good results in a number of financial and macroeconomic forecasts.

Another alternative would be to employ the information carried by the data in the estimation of ϕ. More specifically, one could use the predictive density $f(\phi|y) = \int L(\alpha|y, \phi)g(\alpha|\phi)d\alpha$, built on a training sample $(-\tau, ..., 0)$. Finally, the third approach has ϕ treated as random, assuming a prior distribution and computing completely hierarchical posterior estimates of α.

3.4.3 Model Specification

The three measures of financial liberalization that are considered in this model are the capital account liberalization index (CAPLIB), stock market liberalization index (STOCKLIB) and the financial sector liberalization index (FINLIB). The effect of these measures of financial liberalization on stock market development are examined including a stock market development index (DEVINDEX) and two control variables, namely inflation (INF) and investment (INV).

When examining the effect of each of these forms of liberalization in isolation for the four selected markets, the BVARs estimated can be written as three systems of four equations of the same form as equation 3.7:

$$y_{i,t} = A(L)y_{i,t-1} + C\bar{y}_{i,t} + e_{i,t}, \; e_{i,t} \sim (0, \Sigma_e) \tag{3.17}$$

where

$$y_{i,t} = \begin{bmatrix} DEVINDEX_{i,t} \\ CAPLIB_{i,t} \\ INF_{i,t} \\ INV_{i,t} \end{bmatrix}, \text{ for country } i \text{ in Model one;}$$

$$y_{i,t} = \begin{bmatrix} DEVINDEX_{i,t} \\ STOCKLIB_{i,t} \\ INF_{i,t} \\ INV_{i,t} \end{bmatrix}, \text{ for country } i \text{ in Model two;}$$

and

$$y_{i,t} = \begin{bmatrix} DEVINDEX_{i,t} \\ FINLIB_{i,t} \\ INF_{i,t} \\ INV_{i,t} \end{bmatrix}, \text{ for country } i \text{ in Model three.}$$

After the stationarity tests have been run and the models estimated, the impulse-response functions and variance decompositions are estimated.

3.4.4 Data and descriptive statistics

The data sample consists of quarterly values of the variables included in the model for different time periods specific to each country considered. The difference in the period covered by the data samples stems from the unavailability of data in some of the countries. The sample period for each country is given in Table 3.3. Moreover, the study focuses on four Sub-Saharan African stock markets, namely the Nigeria Stock Exchange, the Nairobi Stock Exchange, the Johannesburg Stock Exchange and la Bourse Regionale des Valeurs Mobilieres (BRVM).

To examine the relationship between financial liberalization and the development of stock markets, the study employs four indicators of stock market development, as defined in Levine and Zervos (1998). The market size (SIZE) is measured by the market capitalization ratio and is calculated by dividing the value of listed shares by the GDP. Despite the fact that taxes may hinder the motivation to list companies and that large markets are not necessarily well-functioning, the market capitalization ratio is usually an indicator of market development, assuming that there is a positive correlation between the stock market size and capital mobilization and risk diversification abilities (Levine and Zervos, 1998: 1170).

Market liquidity is measured using both the value traded ratio (VTR) and the market turnover ratio (MTR). The value traded ratio, which is calculated by dividing the total value of trades on the exchange by the country's GDP, measures the share of organized trading of firm equity in the national output level. Although it does not directly measure the trading costs or the uncertainty involved in trading on a particular market, it is assumed to be a positive reflection of liquidity on an economy-wide basis. There is a complementarity between the market capitalization ratio and the values traded ratio as a large market may still have few trading activities. That is why considering both the market capitalization ratio and the value traded ratio simultaneously gives more information about the market than one of them in isolation (Levine and Zervos, 1998: 1171). Moreover, the market turnover ratio is computed by dividing the value of total shares traded by the market capitalization. Although not a direct measure of theoretical liquidity either, it is often considered that high turnover indicates low transactions costs. The market turnover ratio is also seen as complementing market capitalization as a market that is large but inactive combines a large market capitalization ratio with a small turnover ratio. Additionally, both turnover ratio and the value traded ratio also complement each other, as turnover captures trading with regards to the size of the stock market, while the value traded measures trading with regards to the size of the economy (Levine and Zervos, 1998: 1171). Volatility in the market is measured as a 12-month rolling standard deviation estimate based on the daily returns of the All share index. This measure is included due to the growing interest in market volatility. The data for these variables was collected from the Federal Reserve of St Louis database and the World Bank's World Development Indicators (WDI) database.

The rate of inflation is measured by the percentage change in the consumer price index and the level of investment is measured by the ratio of gross fixed capital formation to GDP. Quarterly values of the CPI were collected from the IMF International Financial Statistics database, while annual values of the gross fixed capital formation/GDP were collected from the World Bank's WDI database.

Due to the limited amount of data available for the selected countries, the four indicators of stock market development are used to construct an overall index of stock market development (DEVINDEX). This index thus incorporates information on the market size, turnover ratio, value traded ratio and volatility. It was calculated by taking a simple average of the values of the market size, turnover ratio, value traded ratio and volatility for each period in the sample.

The Chinn-Ito index is used to represent capital account openness and is used in this study as a measure of capital account liberalization (CAPLIB). This index introduced by Chinn and Ito (2006) measures a country's degree of capital account openness and is based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (Chinn and Ito, 2006). The financial sector liberalization index (FINLIB) is extracted from the New Database of Financial Reforms constructed by Abiad, Detragiache and Tressel (2010). The index takes into account seven different dimensions of financial sector policy, namely credit controls and excessively high reserve requirements, interest rate controls, barriers to entry into the financial system of new domestic banks or other potential competitors, state ownership in the banking sector, financial account restrictions, prudential regulations and supervision of the banking sector, and securities market policy. For each dimension included, a final score on a graded scale from zero to three is given, where 0=fully repressed, 1=partially repressed, 2=partially liberalized, 3=fully liberalized. After equal weight is assigned to each dimension, the final scores for all dimensions are added to get the aggregate index for each country for every year. The index then takes values between 0 and 21.

These two indexes that are presented in annual frequency have been transformed into quarterly frequency using information on the specific reforms dates provided by the IMF Annual Report on Exchange Arrangements and Exchange Restrictions. Moreover, the Abiad *et al.* (2010) database only provides data up to 2005. Thus, information from the IMF AEAER and central bank reports was used to extend the dataset until 2014.

Furthermore, the stock market liberalization index (STOCKLIB) was built following the same methodology as used by Abiad *et al.* (2010). Four dimensions of stock market liberalization were included in the index. These are: local purchase of equity by non-residents, equity sales or issue locally by non-residents, purchase of equity abroad by residents and equity sale or issue abroad by residents. A final score on a graded scale from 0 to 3 is given to each dimension; and the final scores for all dimensions are added to get the aggregate index for each country for every year. Because the index includes only four dimensions, it then takes values between 0 and 12.

Additionally, due to the unavailability of the required stock market development data in higher frequency than annually, an interpolation method had to be used to transform the datasets from annual to quarterly frequency. This was done to avoid the issues that the study could encounter when using a sample that was too small. The method used for the interpolation is Newton's method with divided differences. Since interpolating high degree polynomials with such volatile data as financial data is usually difficult, each interpolated point was constrained to the bounds of known values (i.e. the annual values).

Table 3.1 below, gives a summary of the descriptive statistics of the six variables included in the models for every country. The table shows statistics such as the mean, maximum, minimum, standard deviation for the six datasets for each market.

While Nigeria is seen to rank among the top two markets in terms of stock market development (DEVINDEX), financial sector liberalization (FINLIB) and Stock market liberalization (STOCKLIB), it has the lowest average level of real investment and the highest level of inflation for the sample period. Moreover, the six variables exhibit substantial variability both across indicators within the same country and across countries, with high standard deviations reported for all indicators during the sample periods. The highest standard deviation was seen in the stock market development index for South Africa.

Table 3.1: Descriptive statistics

Panel A: WAEMU

	DEVINDEX	INF	INV	FINLIB	CAPLIB	STOCKLIB
Mean	7.750	0.946	11.473	13.269	-1.066	4.923
Maximum	15.517	4.899	19.277	14.000	-0.126	8.000
Minimum	1.442	-2.339	8.253	7.750	-1.189	0.000
Std Deviation	4.290	2.159	2.857	1.689	0.341	3.633
Period covered	1989Q1 - 2014Q4					

Panel B: SOUTH AFRICA

	DEVINDEX	INF	INV	FINLIB	CAPLIB	STOCKLIB
Mean	51.265	2.328	21.131	13.744	-1.294	5.675
Maximum	116.342	6.137	32.103	19.250	-0.126	10.000
Minimum	19.594	-1.196	15.150	3.000	-1.895	0.000
Std Deviation	23.864	1.274	4.796	5.268	0.484	3.463
Period covered	1975Q1 - 2014Q4					

Panel C: NIGERIA

	DEVINDEX	INF	INV	FINLIB	CAPLIB	STOCKLIB
Mean	9.894	4.582	10.557	14.731	-1.094	8.346
Maximum	22.151	22.296	16.555	18.000	-0.597	11.000
Minimum	1.589	-4.682	5.459	8.750	-1.895	1.000
Std Deviation	5.327	5.473	3.258	3.237	0.581	3.780
Period covered	1989Q1 - 2014Q4					

Panel D: KENYA

	DEVINDEX	INF	INV	FINLIB	CAPLIB	STOCKLIB
Mean	8.982	3.146	18.184	12.583	0.308	7.146
Maximum	19.522	17.401	21.386	15.500	1.091	9.000
Minimum	2.627	-3.287	15.388	6.750	-1.895	4.000
Std Deviation	4.384	3.691	1.852	3.073	1.241	1.914
Period covered	1989Q1 - 2012Q4					

Source: Author's estimations

Table 3.2 presents the correlations and the corresponding p-values of the six variables for each market considered. As can be observed from Table 3.2, stock market development is negatively related to inflation and positively related to STOCKLIB and FINLIB in all four markets. While in the WAEMU and Kenya, DEVINDEX is also positively related to investment, it is the opposite in South Africa and Nigeria where it is negatively related. In almost all the markets, inflation is negatively related to all three forms of liberalization, except in the WAEMU, where there is a significantly positive correlation between inflation and CAPLIB. Investment is also negatively related to all three forms of liberalization in all markets except in the WAEMU where there is significant positive relationship between investment and CAPLIB. The next section will present the empirical analysis conducted and will give the interpretation of the findings.

Table 3.2: Correlations and p-values

Panel A: WAEMU

VARIABLES	DEVINDEX	INF	INV	CAPLIB	FINLIB	STOCKLIB
DEVINDEX	1.000					
INFLATION	-0.083	1.000				
	(0.399)					
INVESTMENT	0.520	0.008	1.000			
	(0.000)	(0.939)				
CAPLIB	-0.076	0.411	0.140	1.000		
	(0.446)	(0.000)	(0.157)			
FINLIB	0.552	0.146	0.374	0.050	1.000	
	(0.000)	(0.138)	(0.000)	(0.6173)		
STOCKLIB	0.583	-0.179	0.095	-0.492	0.592	1.000
	(0.000)	(0.069)	(0.339)	(0.000)	(0.000)	

Panel B: SOUTH AFRICA

VARIABLES	DEVINDEX	INF	INV	FINLIB	CAPLIB	STOCKLIB
DEVINDEX	1.000					
INFLATION	-0.556	1.000				
	(0.000)					
INVESTMENT	-0.511	0.407	1.000			
	(0.0000)	(0.0000)				
FINLIB	0.855	-0.568	-0.777	1.000		
	(0.000)	(0.000)	(0.000)			
CAPLIB	0.205	-0.408	-0.102	0.251	1.000	
	(0.009)	(0.000)	(0.201)	(0.001)		
STOCKLIB	0.879	-0.568	-0.707	0.973	0.217	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	

Panel C: NIGERIA

VARIABLES	DEVINDEX	INF	INV	FINLIB	CAPLIB	STOCKLIB
DEVINDEX	1.000					
INFLATION	-0.312	1.000				
	(0.001)					
INVESTMENT	-0.313	-0.028	1.000			
	(0.001)	(0.779)				
FINLIB	0.638	-0.482	-0.127	1.000		
	(0.000)	(0.000)	(0.199)			
CAPLIB	0.590	-0.475	-0.017	0.930	1.000	
	(0.000)	(0.000)	(0.865)	(0.000)		
STOCKLIB	0.620	-0.440	-0.219	0.939	0.922	1.000
	(0.000)	(0.000)	(0.025)	(0.000)	(0.000)	

Panel D: KENYA

VARIABLES	DEVINDEX	INF	INV	FINLIB	CAPLIB	STOCKLIB
DEVINDEX	1.000					
INFLATION	-0.043	1.000				
	(0.679)					
INVESTMENT	0.425	-0.001	1.000			
	(0.000)	(0.996)				
CAPLIB	0.317	-0.330	-0.104	1.000		
(0.002)	(0.001)	(0.313)				
FINLIB	0.482	-0.336	-0.068	0.929	1.000	
	(0.000)	(0.001)	(0.507)	(0.000)		
STOCKLIB	0.468	-0.346	-0.158	0.889	0.952	1.000
	(0.000)	(0.001)	(0.125)	(0.000)	(0.000)	

Note: p-values in parenthesis

Source: Author's estimations

3.5 EMPIRICAL ANALYSIS AND FINDINGS

3.5.1 Introduction

The main objective of this section is to present the empirical analysis conducted in this study using the Bayesian Vector Autoregressive (BVAR) model explained in the previous section. First, the unit root test will be conducted on all variables included in the models for each market considered. Then, for every form of liberalization studied the unit root test and optimal lag order will be selected for each market. After the model selection, the model parameters will be estimated and the posterior probability matrices will be presented. Finally, the impulse response functions and variance decompositions will be analysed. The last subsection concludes the section.

3.5.2 Unit root tests

Each variable is subjected to the Augmented Dickey Fuller (ADF) test to examine stationarity. The test equation included both an intercept and a trend, and the AIC was used for the optimal lag order in the ADF test. The results are presented in Table 3.3 below.

For the four markets, almost all the variables are found to be $I(1)$. In other words, DEVINDEX, INV, CAPLIB, STOCKLIB in level form were non-stationary at the five percent level of significance; while their first differences were stationary at the one percent level of significance, for all four markets. FINLIB was also non stationary at the five percent level of significance for all markets, except WAEMU where it was found to be $I(0)$. INF in level form is stationary at the one percent level of significance for all countries, except for Nigeria where it was found to be $I(1)$. The literature suggests that the inclusion of non-stationary variables in a VAR model could lead to spurious regressions, and that the estimated parameters cannot be trusted. However, as argued by Sims (1980) and Sims, Stock and Watson (1990), non-stationary variables in their level form can be used in the VAR in cases where the investigator is not interested

Table 3.3: Results of the unit root tests

In levels				
Variables	WAEMU	South Africa	Nigeria	Kenya
DEVINDEX	-2.806(0.199)	-2.655(0.257)	-1.132(0.918)	-1.264(0.891)
INF	-4.350(0.004)***	-8.118(0.000)***	-3.149(0.101)	-3.826(0.019)**
INV	-0.994(0.939)	-1.017(0.938)	-1.561(0.801)	-2.522(0.317)
FINLIB	-4.110(0.008)***	-2.100(0.541)	-1.233(0.898)	-0.944(0.946)
CAPLIB	-2.513(0.321)	-3.333(0.068)*	-1.557(0.803)	-1.758(0.717)
STOCKLIB	-1.565(0.800)	-2.114(0.534)	-1.109(0.922)	-1.479(0.830)
First differences				
Variables	WAEMU	South Africa	Nigeria	Kenya
DEVINDEX	-10.931(0.000)***	-10.807(0.000)***	-10.918(0.000)***	-9.310(0.000)***
INF	-11.885(0.000)***	-12.099(0.000)***	-11.312(0.000)***	-12.960(0.000)***
INV	-9.904(0.000)***	-11.490(0.000)***	-10.635(0.000)***	-9.176(0.000)***
FINLIB	-2.513(0.321)	-5.549(0.000)***	-10.396(0.000)***	-4.142(0.008)***
CAPLIB	-9.958(0.000)***	-12.541(0.000)***	-10.157(0.000)***	-9.615(0.000)***
STOCKLIB	-10.130(0.000)***	-12.708(0.000)***	-10.421(0.000)***	-9.731(0.000)***

Source: Author's estimations

Note: The MacKinnon (1996) one sided p-values are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

in point estimates of the variables. In other words, if the end-purpose of the analysis is to capture the dynamic responses of non-policy variables as a result of unexpected shocks in the policy variables, there is no issue in incorporating the non-stationary variables in levels. In that case when estimating the impulse response functions, the shocks can be identified by using the Cholesky decomposition method where a recursive structure is imposed on the model. An alternative option would be to identify the policy shocks through the imposition of theory-backed restrictions on the cotemporaneous relationships between the variables under consideration in the model. Hence, the crucial dynamic relationships between variables are well captured when using non-stationary variables in level form in the VAR model, thus providing valuable insights on policy analysis. Therefore, the non-stationary variables will be used in level form throughout this study.

3.5.3 Capital account liberalization and stock market development

In this section, the effect of capital account liberalization on stock market development is analysed using the Bayesian VAR method. For each market considered, the optimal lag length is selected and the BVAR model is estimated. This model is referred to as Model one and will include four variables, namely DEVINDEX, INF, INV and CAPLIB, for each market. Finally, the impulse response functions and variance decompositions are estimated.

Optimal lag length selection

Table 3.4 presents the optimal lag order selection criteria for Model one for the four countries. The results focus on only three criteria, namely the Akaike Information Criterion (AIC), Schwartz Information Criterion (SC) and the Hannan-Quinn Information Criterion (HQ).

As can be observed from Table 3.4 for all four markets the optimal lag order was found to be 1. Thus in the four cases, BVAR(1) models are estimated next as Model one. A Minnesota/Litterman prior is specified in all cases, with univariate AR as the initial residual covariance matrix, degrees of freedom correction, and hyper-parameters $\mu = 0$, $\lambda_1 = 0.1$, $\lambda_2 = 0.99$ and $\lambda_3 = 1$. The results are presented in Table B.3 in the Appendix B.

Impulse-response functions

The impulse response functions reveal the responsiveness of the non-policy variable (i.e. the dependent variable) to a shock (i.e. a one-unit increase) to a policy variable (i.e. the independent variable). Since the objective of Model one is to identify the effect of capital account liberalization on stock market development, only the functions of the response of DEVINDEX to a shock to each of the other three variables (i.e. CAPLIB, INF and INV) will be presented. Moreover, the impulse definition included a Cholesky decomposition with the ordering set as $\begin{bmatrix} CAPLIB \\ INF \\ INV \\ DEVINDEX \end{bmatrix}$. This Cholesky ordering assumes that CAPLIB has a contemporaneous effect on INF, INV, and DEVINDEX but the reverse does not apply. Similarly, INF has a contemporaneous effect on INV and DEVINDEX but the reverse does not apply; and INV has a contemporaneous effect on DEVINDEX but the reverse does not apply.

Figure 3.1 presents the impulse response functions for Model one for the four stock markets considered. From the figure, it can be seen that a unit shock to CAPLIB produces similar responses

Table 3.4: Lag order criteria for Model one

Panel A: WAEMU

Lag	AIC	SC	HQ
0	15.36882	15.47567	15.41201
1	**9.696432***	**10.23067***	**9.912381***
2	9.787042	10.74867	10.17575
3	9.881800	11.27082	10.44327
4	9.881658	11.69807	10.61588
5	9.717124	11.96093	10.62411
6	9.754591	12.42579	10.83433
7	9.960554	13.05914	11.21305
8	9.931423	13.45740	11.35668

Panel B: SOUTH AFRICA

Lag	AIC	SC	HQ
0	18.52152	18.60109	18.55384
1	**9.451859***	**9.849738***	**9.613491***
2	9.575078	10.29126	9.866016
3	9.700509	10.73499	10.12075
4	9.826144	11.17893	10.37569
5	9.798682	11.46977	10.47754
6	9.866660	11.85606	10.67482
7	10.03309	12.34079	10.97056
8	10.10560	12.73160	11.17237

Panel C: NIGERIA

Lag	AIC	SC	HQ
0	18.24659	18.35344	18.28978
1	10.15300	**10.68724***	**10.36895***
2	10.20369	11.16532	10.59240
3	10.26019	11.64922	10.82166
4	10.28423	12.10065	11.01846
5	**10.14142***	12.38523	11.04840
6	10.31078	12.98197	11.39052
7	10.41041	13.50900	11.66291
8	10.55542	14.08140	11.98068

Panel D: KENYA

Lag	AIC	SC	HQ
0	18.00474	18.11734	18.05010
1	11.82014	**12.38317***	**12.04697***
2	11.74982	12.76327	12.15811
3	**11.65983***	13.12371	12.24959
4	11.75635	13.67066	12.52758
5	11.78524	14.14997	12.73793
6	11.85942	14.67457	12.99357
7	11.83736	15.10294	13.15298
8	11.92001	15.63602	13.41710

Note: * indicates the lag order selected by the criterion
Source: Author's estimations

of DEVINDEX in Nigeria and Kenya. In effect, there is a negative response of DEVINDEX in the first quarter after the shock occurred. Although the response was considerably small, it increases in subsequent periods and become positive by the third quarter. Up to the 20th quarter, the response stays positive but gets closer to zero. In the WAEMU, although the immediate response of DEVINDEX to a shock to CAPLIB is positive, it has similar trend to the one observed in Nigeria and Kenya as the response remains positive and approaching zero by the 20th quarter. In that market, the positive response of the development index is also considerably small, being less than 0.25 percent.

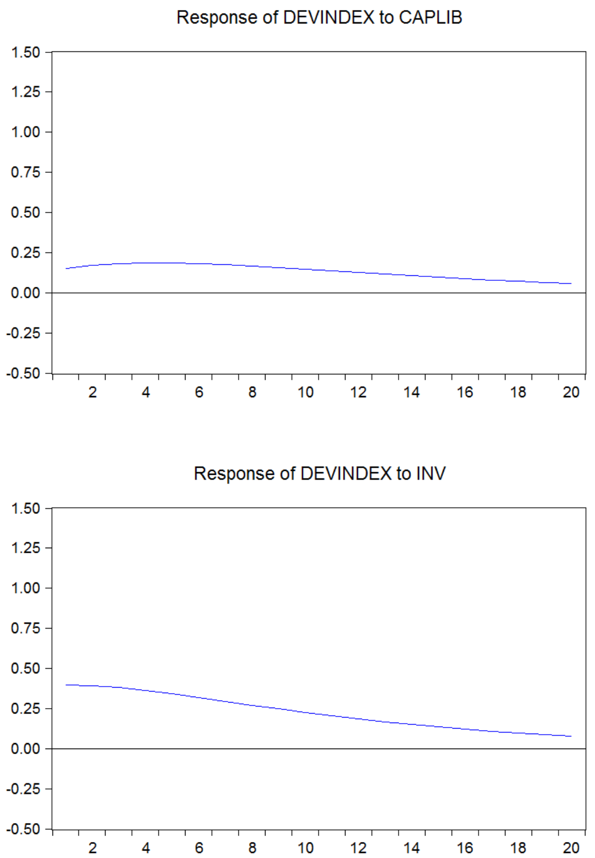
Conversely, DEVINDEX in South Africa has an opposite response to a one-unit increase in CAPLIB. The response in the first quarter is considerably small (less than one percent) and negative. It remains constant and negative even after the 20th quarter. In all four markets, the response of DEVINDEX to a unit shock to INF is considerably small, hence insignificant. Interestingly, a unit shock to investment in Nigeria produces an initial negative response of the stock market development index, which progressively becomes more negative until the ninth quarter, and subsequently approaches zero. While in the other three markets, the initial response of DEVINDEX to a unit shock to INV is positive, it subsequently decreases, reaching a negative value in South Africa by the 20th quarter; reaching the value of zero in Kenya by the 15th quarter; and closely approaching zero in the WAEMU by the 20th quarter.

Variance decomposition

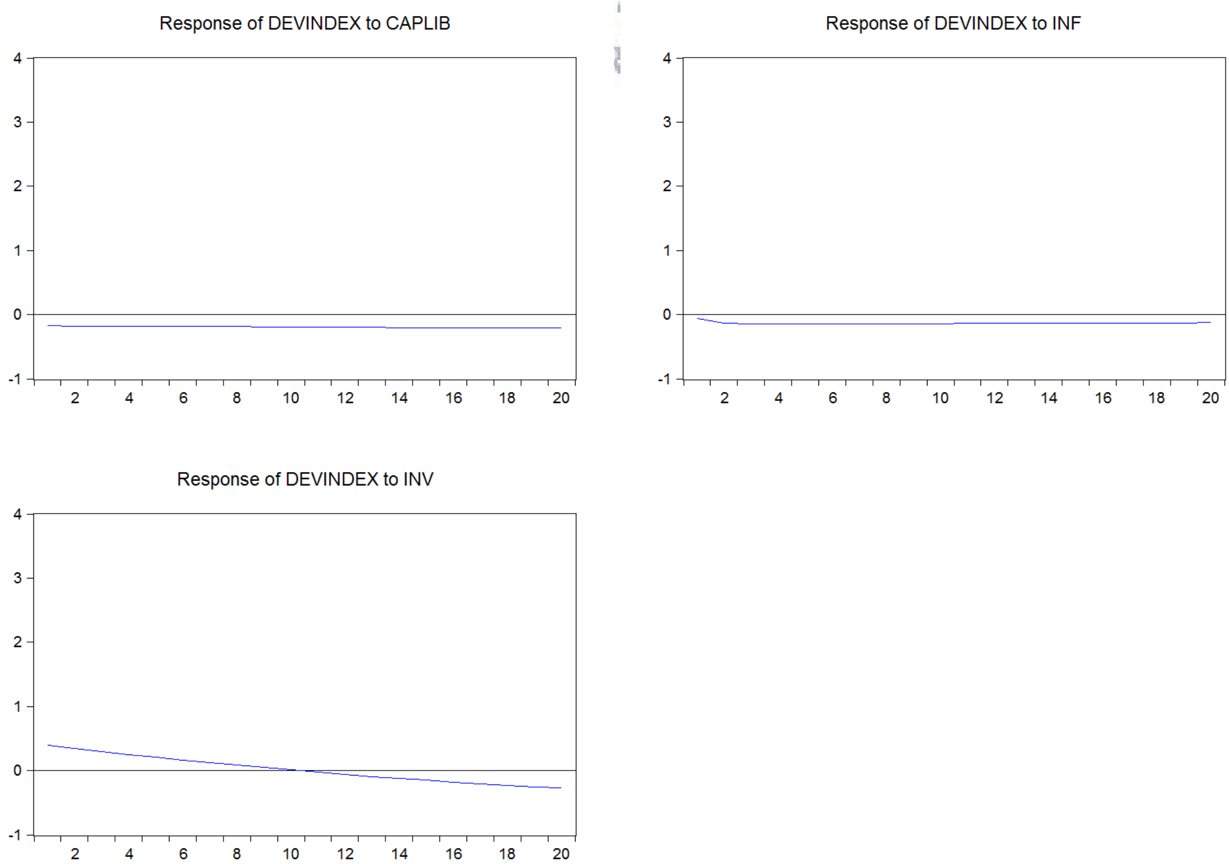
The variance decomposition was estimated from Model one for each of the markets to get more insight about the actual value of each policy variable in explaining stock market development. Table 3.5 summarizes the results. There is some evidence that innovations in INV are relatively important in explaining the variations in the DEVINDEX in the WAEMU, as it represents 7.3 percent of the variance decomposition of DEVINDEX in the first quarter, 13.6 percent in the 10th quarter and 14.9 percent in the 20th quarter. However, innovations in INF are relatively insignificant in explaining the variations in DEVINDEX at less than 0.5 percent between the first and 20th quarter; while innovations to CAPLIB have a small, yet increasing, part in

Figure 3.1: Impulse-response functions for Model one

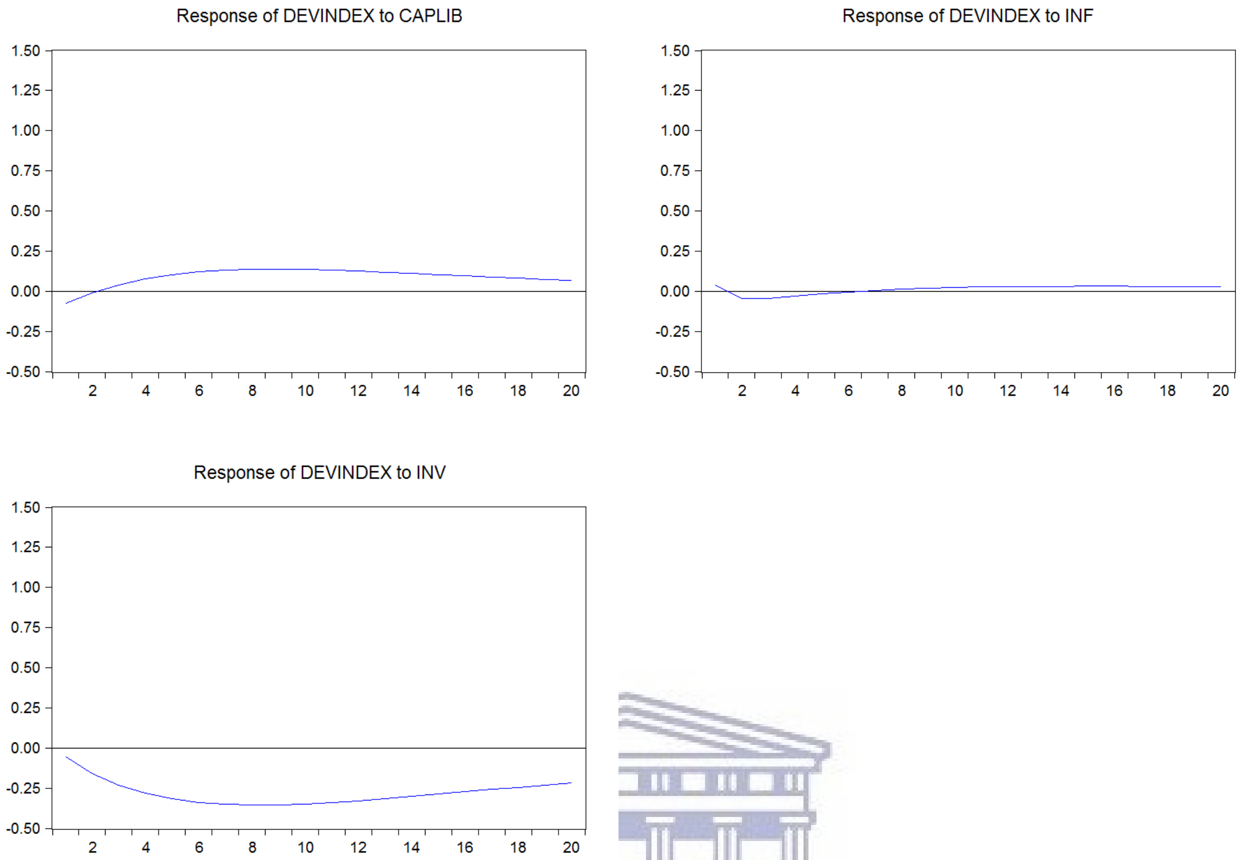
A- WAEMU



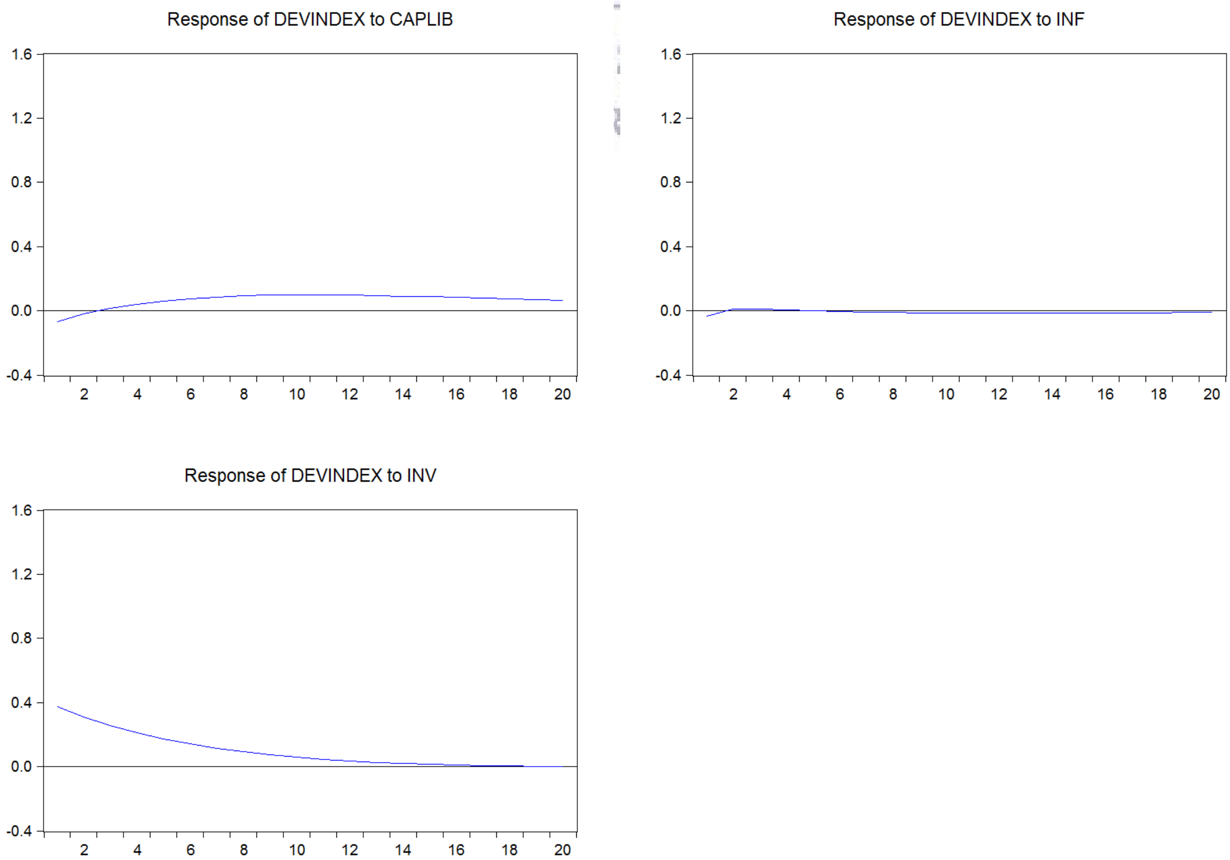
B- SOUTH AFRICA



C- NIGERIA



D- KENYA



Source: Author's estimations

explaining variations in DEVINDEX, with 1.07 percent in the first quarter and 4.5 percent in the 20th quarter.

Similarly, the evidence shows that in Nigeria, innovations in INV are relatively important in explaining the variations in DEVINDEX over time. Although, innovations in INV represent 0.16 percent of the variance decomposition of DEVINDEX in the first quarter, it increases to 17.73 percent of the variance decomposition of DEVINDEX in the 20th quarter. In the case of Kenya, the proportion of the variance decomposition on DEVINDEX that is explained by INV follows a decreasing trend with 7.66 percent in the first quarter, 6.29 percent in the 10th quarter and 5.94 percent in the 20th quarter. For all four markets, innovations in INF are relatively insignificant in explaining the variations in DEVINDEX, at less than 0.5 percent from the first to the 20th quarter. The proportion of innovations to CAPLIB in the variance decomposition of DEVINDEX, although increasing from the first to 20th quarter, is relatively small in the Nigeria, and Kenya and relatively insignificant in South Africa.

3.5.4 Stock Market liberalization and stock market development

This section focuses on the effect of stock market liberalization on stock market development, still using the Bayesian VAR method. As previously the optimal lag length is selected and the BVAR model is estimated. In this case, the model is referred to as Model two and will also include DEVINDEX, INF, INV, as in Model one, and the liberalization index considered here which is STOCKLIB for each market. Finally, the impulse functions and variance decompositions are estimated.

Optimal lag length selection

Table 3.6 presents the optimal lag order selection criteria for Model two for the four countries. The results focus on only three criteria, namely the Akaike Information Criterion (AIC), Schwartz Information Criterion (SC) and the Hannan-Quinn Information Criterion (HQ).

As can be observed from Table 3.6, for three of the markets, i.e. WAEMU, South Africa and

Table 3.5: Variance Decomposition for Model one

Panel A: WAEMU

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	CAPLIB
1	1.470	91.207	0.399	7.329	1.070
10	2.818	82.543	0.210	13.580	3.667
20	2.919	80.333	0.201	14.941	4.525

Panel B: SOUTH AFRICA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	CAPLIB
1	3.504	98.420	0.025	1.300	0.255
10	10.384	99.019	0.173	0.491	0.317
20	13.765	98.960	0.192	0.446	0.401

Panel C: NIGERIA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	CAPLIB
1	1.440	99.523	0.064	0.158	0.262
10	2.845	87.715	0.099	10.821	1.365
20	3.076	79.839	0.176	17.731	2.254

Panel D: KENYA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	CAPLIB
1	1.343	92.030	0.063	7.660	0.247
10	2.608	92.932	0.027	6.289	0.752
20	2.698	92.322	0.048	5.944	1.686

Source: Author's estimations

Table 3.6: Lag order criteria for Model two

Panel A: WAEMU

Lag	AIC	SC	HQ
0	19.69651	19.80335	19.73970
1	**12.70734***	**13.24158***	**12.92329***
2	12.88737	13.84900	13.27607
3	12.95414	14.34316	13.51560
4	13.13122	14.94763	13.86544
5	13.22782	15.47162	14.13480
6	13.09030	15.76150	14.17004
7	13.27394	16.37252	14.52644
8	13.13091	16.65689	14.55617

Panel B: SOUTH AFRICA

Lag	AIC	SC	HQ
0	20.95845	21.03802	20.99078
1	**11.34676***	**11.74464***	**11.50840***
2	11.48446	12.20064	11.77540
3	11.53218	12.56667	11.95242
4	11.62337	12.97615	12.17291
5	11.66054	13.33163	12.33940
6	11.72436	13.71376	12.53252
7	11.87878	14.18648	12.81625
8	11.92695	14.55295	12.99372

Panel C: NIGERIA

Lag	AIC	SC	HQ
0	21.83757	21.94442	21.88076
1	**13.80948***	**14.34372***	**14.02543***
2	13.85121	14.81284	14.23992
3	13.94016	15.32919	14.50163
4	14.05220	15.86862	14.78643
5	13.94101	16.18481	14.84799
6	14.17466	16.84585	15.25440
7	14.37435	17.47293	15.62685
8	14.39802	17.92400	15.82328

Panel D: KENYA

Lag	AIC	SC	HQ
0	18.42038	18.53613	18.46691
1	12.44044	**13.01921***	12.67310
2	12.03534	13.07712	**12.45413***
3	**11.86937***	13.37416	12.47428
4	12.05581	14.02362	12.84685
5	12.32797	14.75878	13.30514
6	12.06719	14.96101	13.23048
7	12.05485	15.41169	13.40427
8	12.14010	15.95996	13.67565

Note: * indicates the lag order selected by the criterion
Source: Author's estimations

Nigeria, the optimal lag order was found to be 1. In the case of Kenya, the AIC, SC and HQ chose different lag orders. However, because the SC is known to be more parsimonious when estimating the coefficients, one lag order selected by the SC will be used for Kenya. Thus, in all four cases, BVAR(1) models are estimated next as Model two. A Minnesota/Litterman prior is specified in all cases with univariate AR as the initial residual covariance matrix, degrees of freedom correction, and hyper-parameters $\mu = 0$, $\lambda_1 = 0.1$, $\lambda_2 = 0.99$ and $\lambda_3 = 1$. The results are presented in Table B.4 in the Appendix B.

Impulse response functions

Since the objective of Model two is to identify the effect of stock market liberalization on stock market development, only the functions of the response of DEVINDEX to a shock to each of the other three variables (i.e. STOCKLIB, INF and INV) will be presented. Moreover, the impulse definition in this model also included a Cholesky decomposition with the ordering set as $\begin{bmatrix} STOCKLIB \\ INF \\ INV \\ DEVINDEX \end{bmatrix}$.This Cholesky ordering assumes that STOCKLIB has a contemporaneous effect on INF, INV, and DEVINDEX but the reverse does not apply. Similarly, INF has a contemporaneous effect on INV and DEVINDEX but the reverse does not apply; and INV has a contemporaneous effect on DEVINDEX but the reverse does not apply.

Figure 3.2 depicts the impulse response functions for Model two for the four markets considered in the study. From the figure, it is interesting to see that the response of DEVINDEX to a unit shock to STOCKLIB generally follows the same trend in all four stock markets. The initial response is negative, although it immediately increases and stays positive and high (i.e. around one percent) in the case of South Africa, even after the 20th quarter where it is still persistent. In the case of the WAEMU, Nigeria and Kenya, the response is not as persistent and approaches zero by the 20th quarter. Noticeably, the response of DEVINDEX to a unit shock to STOCKLIB in the WAEMU is considerably higher than the response of the development index to CAPLIB in Model one.

Similar to Model one, the response of DEVINDEX to a unit shock to INF is insignificant, for all markets; while there is an initial negative response of DEVINDEX to a unit shock to investment

Table 3.7: Variance Decomposition for Model two

Panel A: WAEMU

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	STOCKLIB
1	1.474	90.084	0.000	9.860	0.055
10	2.612	71.533	0.198	22.105	6.164
20	2.823	64.549	0.178	24.527	10.747

Panel B: SOUTH AFRICA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	STOCKLIB
1	3.543	98.894	0.009	1.021	0.076
10	9.254	94.471	0.106	1.164	4.259
20	11.777	89.866	0.180	0.791	9.163

Panel C: NIGERIA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	STOCKLIB
1	1.438	99.717	0.049	0.198	0.036
10	2.834	88.883	0.153	9.759	1.204
20	3.047	80.804	0.231	16.564	2.401

Panel D: KENYA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	STOCKLIB
1	1.354	92.987	0.086	6.527	0.400
10	2.573	91.893	0.047	6.320	1.740
20	2.681	90.268	0.066	5.871	3.794

Source: Author's estimations

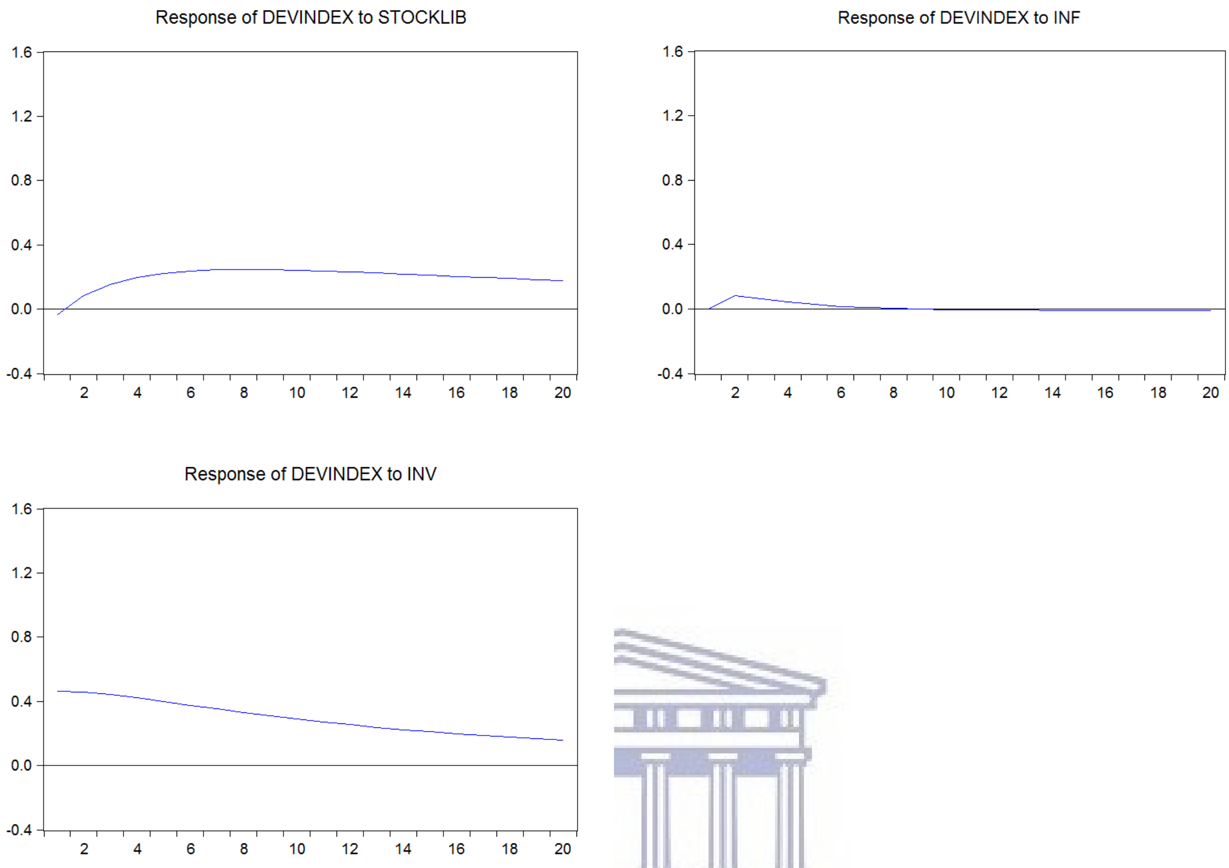
in Nigeria. The progressively becomes more negative until the ninth quarter, and subsequently approaches zero. In Kenya, the WAEMU and South Africa, the initial response of DEVINDEX to a unit shock to INV is positive but subsequently decreases. It reaches a negative value in South Africa by the 20th quarter; the value of zero in Kenya by the 15th quarter; and closely approaches zero in the WAEMU by the 20th quarter.

Variance decomposition

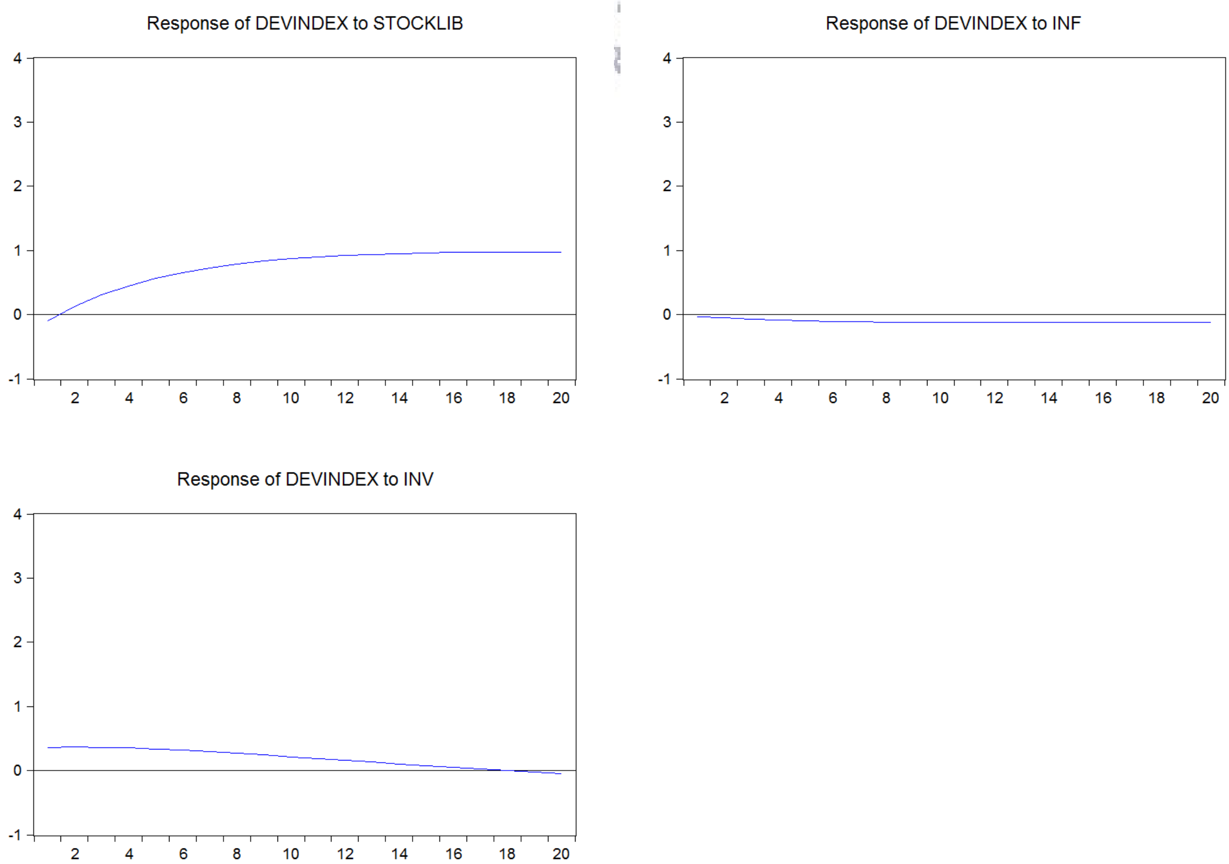
In this model, innovations to INF are still insignificant in explaining the variations in DEVINDEX, for all four markets. In all four cases, however, innovations to STOCKLIB get relatively more important in the variance decomposition of DEVINDEX over time. Although in all cases, it is less than 0.5 percent in the first quarter, it increases over time reaching 10.7 percent, 9.2

Figure 3.2: Impulse-response functions for Model two

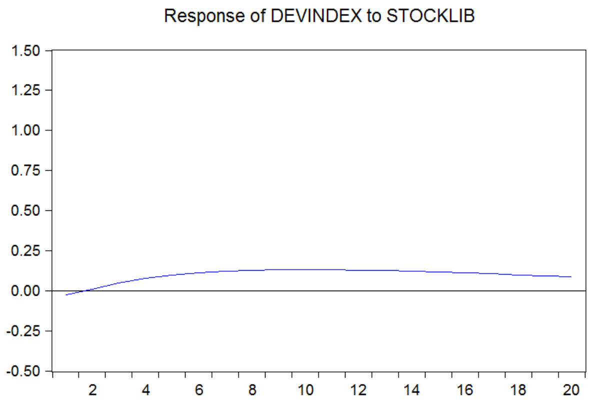
A- WAEMU

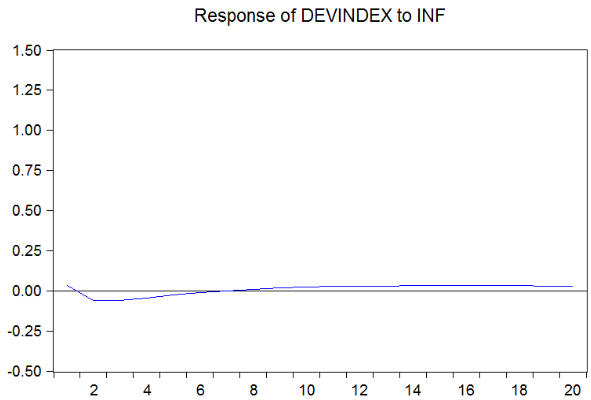


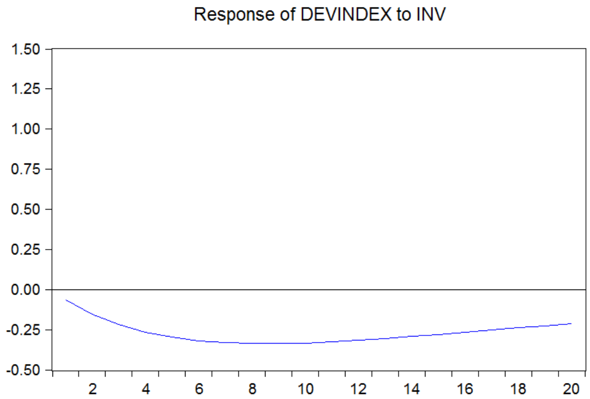
B- SOUTH AFRICA



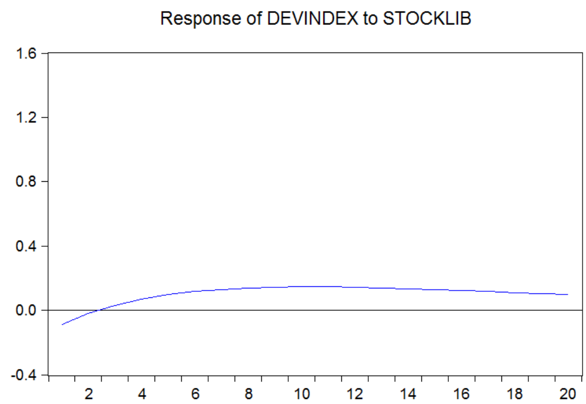
C- NIGERIA

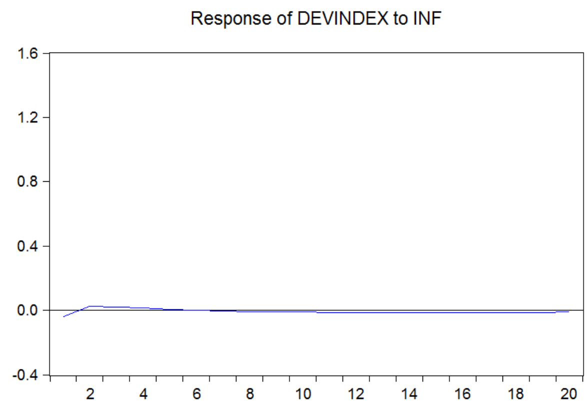


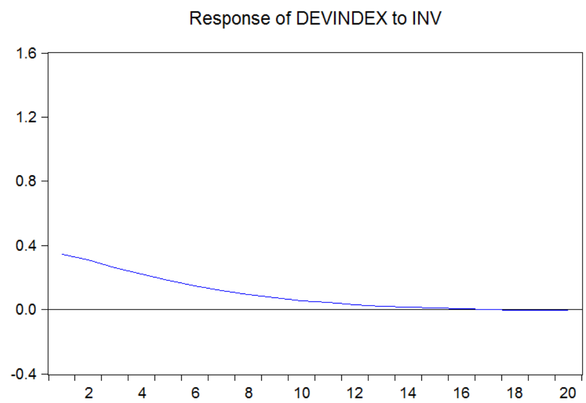




D- KENYA







Source: Author's estimations

percent, 3.8 percent and 2.4 percent in WAEMU, South Africa, Kenya and Nigeria, respectively, in the 20th quarter. Interestingly, in this model, innovations to INV are more significant in the variance decomposition of DEVINDEX in the WAEMU, at 24.5 percent in the 20th quarter.

3.5.5 Financial sector liberalization and stock market development

This section will present the analysis of the effect of financial liberalization on stock market development using the Bayesian VAR method. Similar to the previous two sections, the optimal lag length is selected and the BVAR model is estimated for each of the four stock markets considered. This model is referred to as Model three and will include four variables, that are the same three included in the Model one and two (i.e. DEVINDEX, INF, INV) and the liberalization index FINLIB, for each market. Finally, the impulse functions are estimated.

Optimal lag length selection

Table 3.8 presents the optimal lag order selection criteria for Model three for the four countries. Again, the results focus on only the same three criteria, which are the Akaike Information Criterion (AIC), Schwartz Information Criterion (SC) and the Hannan-Quinn Information Criterion (HQ).

From Table 3.8, it can be observed that all three criteria selected one as the optimal lag order for South Africa and Nigeria. For Kenya, both the SC and the HQ also selected lag order one, while the AIC selected lag order two. In the case of the WAEMU, the AIC, SC and HQ chose different lag orders. However, because the SC is known to be more parsimonious when estimating the coefficients, lag order one selected by the SC will be used for the WAEMU. Thus, in all four cases, BVAR(1) models are estimated next as Model three. Model three also specifies a Minnesota/Litterman prior, with univariate AR as the initial residual covariance matrix, degrees of freedom correction, and hyper-parameters $\mu = 0$, $\lambda_1 = 0.1$, $\lambda_2 = 0.99$ and $\lambda_3 = 1$. The results are summarized in Table B.5 in the Appendix B.

Table 3.8: Lag order criteria for Model three

Panel A: WAEMU

Lag	AIC	SC	HQ
0	17.07537	17.18222	17.11856
1	10.28504	**10.81928***	10.50099
2	10.35864	11.32027	10.74735
3	10.14896	11.53798	10.71043
4	9.592129	11.40854	**10.32635***
5	**9.469202***	11.71301	10.37618
6	9.639386	12.31058	10.71913
7	9.746500	12.84509	10.99900
8	9.813600	13.33958	11.23886

Panel B: SOUTH AFRICA

Lag	AIC	SC	HQ
0	21.57206	21.65163	21.60438
1	**11.46604***	**11.86391***	**11.62767***
2	11.56646	12.28264	11.85740
3	11.66914	12.70363	12.08939
4	11.73562	13.08841	12.28517
5	11.67314	13.34423	12.35200
6	11.72741	13.71681	12.53557
7	11.89798	14.20568	12.83545
8	11.96249	14.58849	13.02926

Panel C: NIGERIA

Lag	AIC	SC	HQ
0	21.54242	21.64927	21.58561
1	**13.37553***	**13.90977***	**13.59148***
2	13.41516	14.37679	13.80387
3	13.51841	14.90743	14.07987
4	13.54337	15.35978	14.27759
5	13.53756	15.78136	14.44454
6	13.62104	16.29224	14.70078
7	13.72186	16.82044	14.97436
8	13.81297	17.33895	15.23823

Panel D: KENYA

Lag	AIC	SC	HQ
0	19.41527	19.52788	19.46064
1	12.34702	**12.91005***	**12.57385***
2	**12.34094***	13.35440	12.74924
3	12.35680	13.82069	12.94657
4	12.47098	14.38528	13.24220
5	12.55286	14.91759	13.50555
6	12.63127	15.44643	13.76543
7	12.57448	15.84006	13.89010
8	12.61323	16.32923	14.11031

Note: * indicates the lag order selected by the criterion
Source: Author's estimations

Impulse response functions

The focus of Model three is to identify the effect of financial sector liberalization on stock market development. Thus, only the functions of the response of DEVINDEX to a shock to each of the other three variables, being the control variables INF and INV and the liberalization variable FINLIB, are observed. Similar to the first two models, the impulse definition in this model also included a Cholesky decomposition with the ordering set as $\begin{bmatrix} FINLIB \\ INF \\ INV \\ DEVINDEX \end{bmatrix}$. The assumption of this Cholesky ordering is that FINLIB has a contemporaneous effect on INF, INV, and DEVINDEX but the reverse does not apply; INF has a contemporaneous effect on INV and DEVINDEX but the reverse does not apply; and INV has a contemporaneous effect on DEVINDEX but the reverse does not apply.

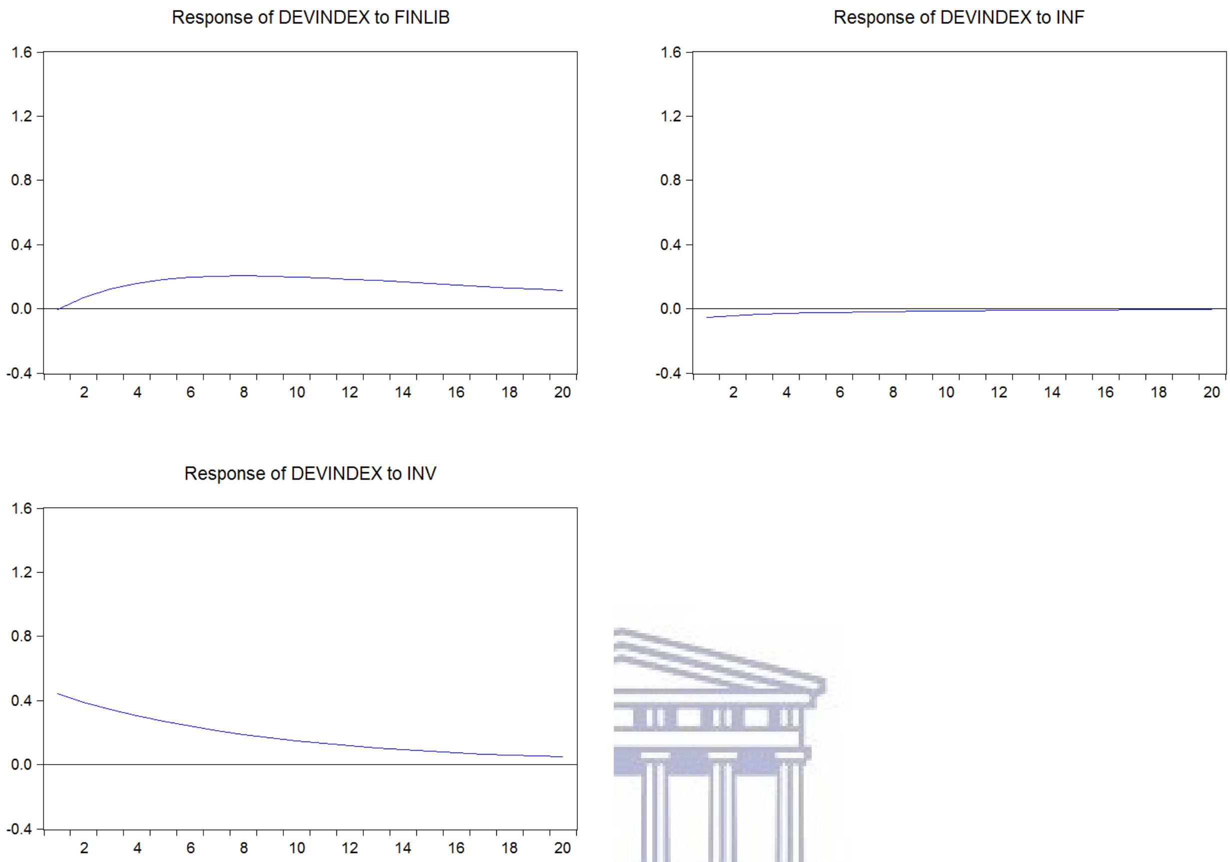
The impulse response functions for Model three for the four markets considered in the study are depicted in Figure 3.3. From the figure, it can be seen that while in both South Africa and Kenya, the initial response of DEVINDEX to a one unit increase in FINLIB is negative; the initial response of DEVNDEX was null in the WAEMU and positive in Nigeria. In subsequent periods, the response in all markets increased and stayed positive after the 20th period. Noticeably, the response of DEVINDEX to FINLIB in Kenya only becomes positive after the fourth quarter and stays constant even after the 20th quarter. The same persistence is also seen in South Africa; while in the WAEMU and Nigeria, the response gets closer to zero by the 20th quarter. The response of DEVINDEX to INF and INV is similar to Model two, for all four markets.

Variance decomposition

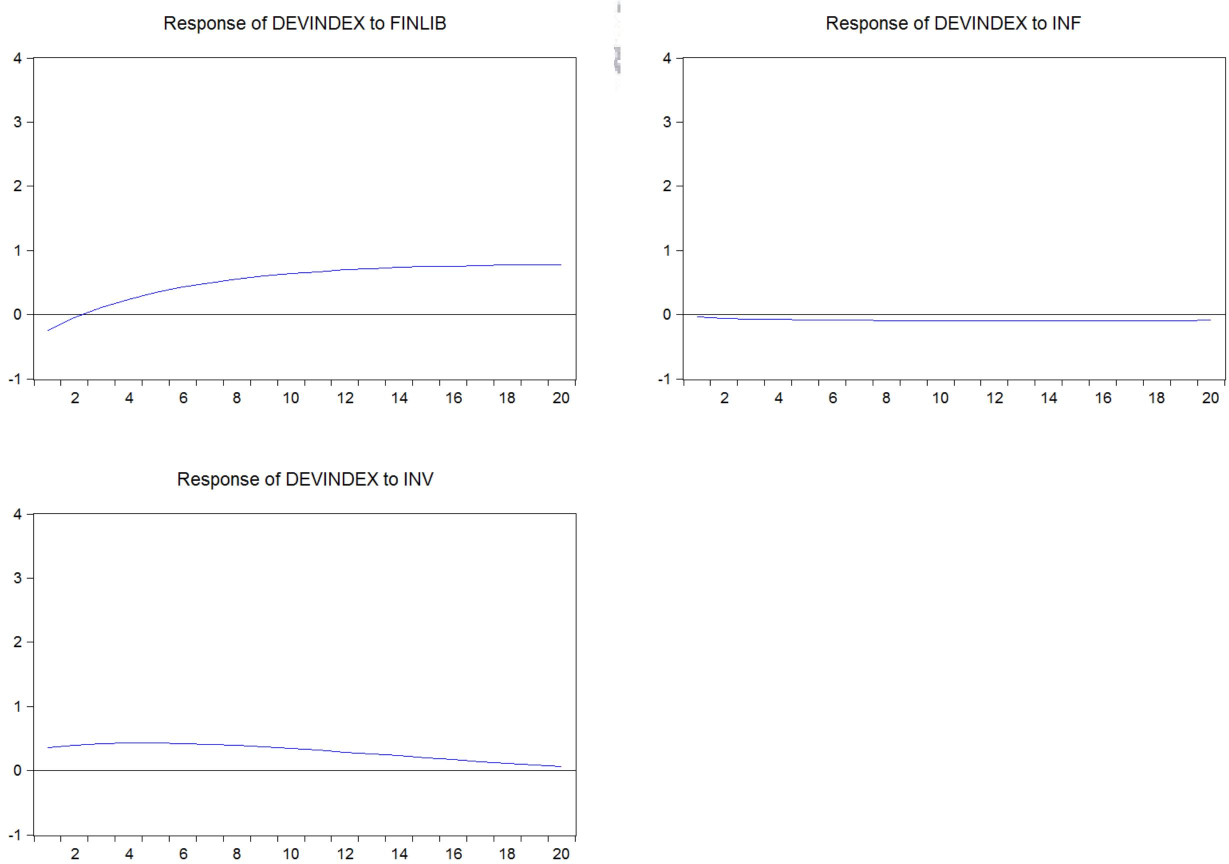
This model also confirms the insignificance of innovations in INF in explaining variations in DEVINDEX for all four markets. Innovations in FINLIB are more significant than innovations in CAPLIB in explaining variations in DEVINDEX for all the stock markets considered. As in Model two, the proportion of FINLIB in the variance decomposition of DEVINDEX increases over time, but it is still lower than the proportion of STOCKLIB in Model two. Innovations in INV are, in this case, still the most important of the three variables in explaining variations

Figure 3.3: Impulse-response functions for Model three

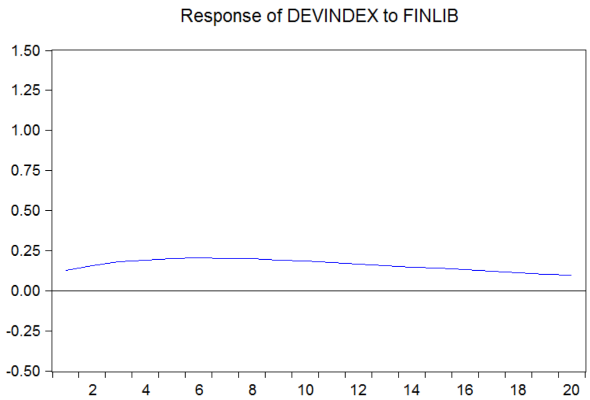
A- WAEMU

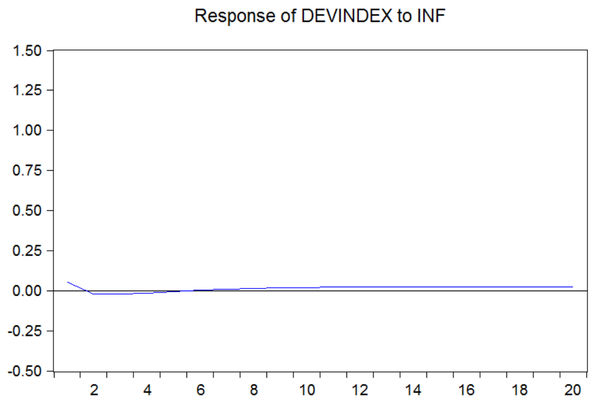


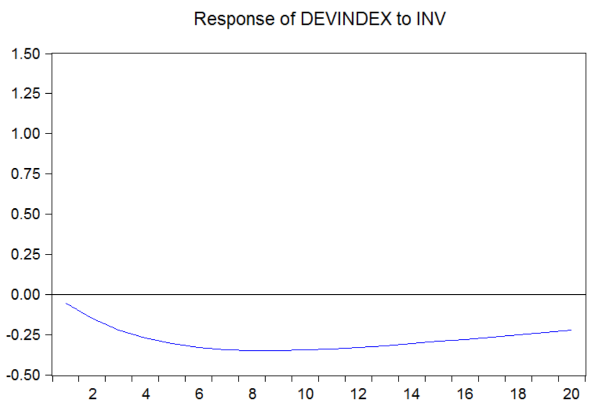
B- SOUTH AFRICA



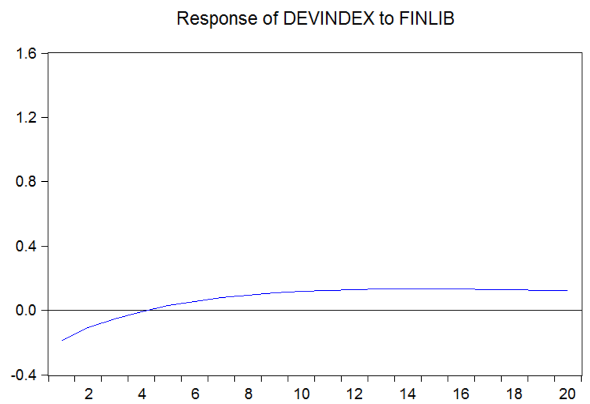
C- NIGERIA

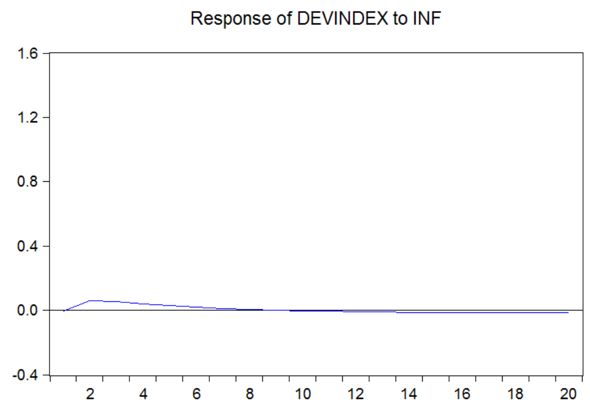


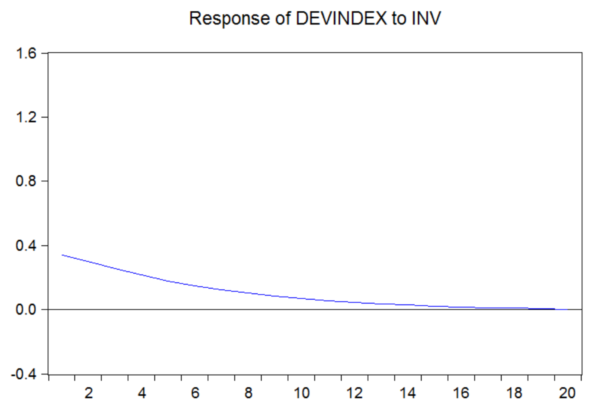




D- KENYA







Source: Author's estimations

Table 3.9: Variance Decomposition for Model three

Panel A: WAEMU

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	FINLIB
1	1.472	90.866	0.137	8.995	0.001
10	2.511	82.388	0.144	13.008	4.460
20	2.589	78.717	0.146	13.358	7.778

Panel B: SOUTH AFRICA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	FINLIB
1	3.542	98.512	0.013	0.995	0.479
10	9.211	95.990	0.074	1.860	2.076
20	11.593	92.998	0.112	1.485	5.405

Panel C: NIGERIA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	FINLIB
1	1.444	98.934	0.126	0.146	0.795
10	2.782	84.684	0.061	10.817	4.437
20	3.002	75.517	0.118	18.449	5.916

Panel D: KENYA

Variance Decomposition of DEVINDEX:					
Period	S.E.	DEVINDEX	INF	INV	FINLIB
1	1.352	91.829	0.002	6.291	1.877
10	2.484	91.732	0.162	6.589	1.516
20	2.572	89.622	0.179	6.266	3.933

Source: Author's estimations

in DEVINDEX, in all markets, except South Africa where the proportion of FINLIB exceeds INV in the 20th quarter.

3.5.6 Discussion of the results and Conclusion

This section presented the empirical analysis conducted to study the effect of three different forms of liberalization on the development of four selected Sub-Saharan African stock markets. The Augmented Dickey Fuller (ADF) test used to investigate stationarity in each of the variables included in the model showed that almost all the variables are $I(1)$ at the one percent level of significance, for all four markets. Only FINLIB for the WAEMU, as well as INF in the WAEMU, South Africa and Kenya, were found to be $I(0)$ at the one percent level of significance. Based on the arguments by Sims (1980) and Sims, Stock and Watson (1990), the study made use of the variables in levels as the analysis aimed to capture the dynamic responses of non-policy variables as a result of unexpected shocks in the policy variables.

When analysing the effect of capital account liberalization on stock market development, the results of the impulse response functions showed that a unit shock to CAPLIB leads to an initial considerably small yet negative response of DEVINDEX in both Nigeria and Kenya. The response becomes positive by the third quarter and stays positive but gets closer to zero by the 20th quarter. Besides a positive yet considerably smaller initial response of DEVINDEX to a shock to CAPLIB in the WAEMU, the subsequent trend is similar to Nigeria and Kenya. An opposite response is observed in South Africa, with a small negative initial response which remains constant and negative even after the 20th quarter.

In the examination of the effect of stock market liberalization on stock market development, it was found that stock market development initially responded negatively to a shock to stock market liberalization. Although in all cases it immediately increased and remained positive, in the South African case it was relatively high and persistent. In the case of the WAEMU, Nigeria and Kenya, the response was not as persistent, and approaches zero by the 20th quarter. In the WAEMU particularly, DEVINDEX responded more strongly to a shock to STOCKLIB than it did to a shock to CAPLIB.

Furthermore, the investigation of the effect of financial sector liberalization on stock market development found that both South Africa and Kenya have an initially negative response of DEVINDEX to a shock to FINLIB as the initial response of DEVNDEX was null in the WAEMU and positive in Nigeria. Although, in Kenya the response only becomes positive after the fourth quarter, it shows persistence even after the 20th quarter. The response of the development index in South Africa which recovers earlier than in Kenya, also has the same persistence. In the WAEMU and Nigeria, although the response increased, it was not persistent and approached zero by the 20th quarter.

Finally, for all four markets, the response of DEVINDEX to a unit shock to INF and its response to a unit shock to INV is generally the same in the three models. The response of the development index to a shock to inflation is considerably small, hence insignificant. In all markets except Nigeria, the initial response of DEVINDEX to a unit shock to INV is positive; it subsequently decreases, reaching a negative value in South Africa by the 20th quarter; reaching the value of zero in Kenya by the 15th quarter; and closely approaching zero in the WAEMU by the 20th quarter. In Nigeria, a shock to investment produces an initially negative response of the stock market development index, which progressively becomes more negative until the ninth quarter, and subsequently approaches zero. Interestingly, in Models two and three the response of the development index to a shock to investment reaches the negative value at a much later stage than it does in Model one.

The initial response of the stock market to capital account liberalization is found to be small and negative in Nigeria and Kenya. This could be explained by the initial adverse reaction from domestic investors in these countries who may be encouraged to move their domestic investments to other markets perceived as more profitable. In effect, the integration of segmented markets through liberalization and the elimination of differential risk across markets would immediately entice local investors to redirect their interest to other markets, as can be observed in South Africa where a shock to capital account liberalization lead to a constant and negative response of stock market development . However, due to the low participation rate of domestic investors in these markets, the adverse effects of the initial capital outflow from these stock markets will be offset in the long-run by the stronger participation from foreign investors who would create capital inflow in the market. This could be the case in the BRVM from the initial shock as the market may be mainly dominated by foreign investors.

Stock market liberalization has a more direct impact on stock markets by opening them to foreign participation. In all of the markets under consideration the liberalization of the stock market improved their market capitalization and turnover ratios, hence their positive response to stock market liberalization. The persistence of the positive response of the markets, especially in South Africa speaks to the potential long lasting effect of stock market liberalization policies. With the continuous interest of global investors in Sub-Saharan African equities for both their high returns and their portfolio risk diversification opportunities, increased stock market liberalization should lead to a continuously greater stock market development.

Lastly, financial sector liberalization has an indirect effect on stock market development by improving the mobilization of savings, the channeling of capital into the most appropriate sectors of the economy and the amount of investment. By removing direct credit controls, liberalizing interest rate, denationalizing banks, and strengthening prudential regulations, investors are encouraged by the availability of cheaper credit into investing more on the stock markets. This seems to be the case in to happen in the long run in all four markets as their response to a shock to financial liberalization becomes and stays persistently positive in the long run. However, similarly to the case of a shock to capital account liberalization, there is a varying trend in the initial response of the markets. In both South Africa and Kenya, the initial response of stock market development to a shock to financial sector liberalization is negative. This is a puzzling result especially in the case of South Africa whose financial sector is considered as more developed and sophisticated by international standards, compared to the other three markets. However, coupled with the high level of integration between the market and more developed ones, a shock to financial sector liberalization, such as relaxation of credit controls and interest rate deregulation that increase the real rate of interest, may have an adverse initial impact on stock market development due to an increase in the pre-disposition to save and a loss of risk adverse investors' confidence in the domestic banking sector and financial stability of the country. In the WAEMU, the delayed response of stock market development to a shock to financial liberalization may be attributed to its relatively small size and relative isolation from other more developed markets. It may take global investors, who have the higher rate of participation in this market, a little delay to redirect their funds to the market.

3.6 CONCLUSION AND RECOMMENDATIONS

3.6.1 Summary of findings

The growing importance of equity as means of financing for Sub-Saharan African economies, accentuates the relevance to examine the effect of changes to the financial regulatory environment on the stock markets in the region. Hence, an analysis of the impact of liberalization in the financial sector on the stock markets could contribute to form policy makers' understanding of the right instruments to employ in order to promote the development of security exchanges. The main objective of this study was to investigate the relationship between liberalization in the financial sector and the development of stock markets in Sub-Saharan Africa. This study focused on four stock markets, which together constitute more than 80 percent of the total market capitalization in the Sub-Saharan African region. These are the Nigerian stock exchange, the Nairobi stock market, the Johannesburg stock exchange and the West African stock market (i.e. the Bourse Regionale des Valeurs Mobilieres). Moreover, the study looked at three separate dimensions of financial liberalization: capital account liberalization, stock market liberalization and financial sector liberalization. Due to unavailability of data, different sample periods were used for each of the stock markets considered.

The scrutiny of the evolution of liberalization in the Sub-Saharan African region showed that financial liberalization was not a uniform process across the Sub-Saharan African region. Most economies joined the movement in the 1980s, and while some undertook many reforms in the same year, others adopted a gradual method to liberalization by implementing only a couple of measures per year. Although most countries have taken considerable steps towards liberalization since 1980, a great number of them are still found with a low liberalization index in 2014. There was also some reversal of the reforms initially adopted due to their adverse effects on economic growth and development, or in the face of tough economic conditions experienced.

The financial liberalization theory advanced by McKinnon (1973) and Shaw (1973) encourages the removal of interest rate and credit controls, the free mobility of capital in and out of the economy and the opening of domestic capital markets to foreign investors. The argument maintains that this will lead to a rise in savings and investment, and ultimately boost economic growth and financial development. However, the arguments against liberalization stress the importance of policy complementarity suggesting that liberalization cannot induce development as long as it is not coupled with other macroeconomic policies. Empirically, a number of studies have been conducted to analyse the effect of financial liberalization on economic growth and financial development. Although some of the studies uncovered a positive relationship between liberalization and growth, others proved that liberalization measures on their own do not have significant effect on growth and development. In fact, only when these reforms are associated with other macroeconomic variables such as governance and institutional quality, were they found to positively affect growth.

For this study, the data sample consisted of quarterly values of the variables included in the model for different time periods specific to each country considered. The variables used in the models were the stock market development index (DEVINDEX), the capital account liberalization index (CAPLIB), stock market liberalization index (STOCKLIB), financial liberalization index (FINLIB), as well as two control variables (i.e. Inflation and Investment). A preliminary analysis of correlation among the variables showed that stock market development is negatively related to inflation and positively related to STOCKLIB and FINLIB in all four markets. While in the WAEMU and Kenya, DEVINDEX is also positively related to investment, it is the opposite in South Africa and Nigeria where it is negatively related. In almost all the markets, inflation is negatively related to all three forms of liberalization, except in the WAEMU, where there is a significantly positive correlation between inflation and CAPLIB. Investment is also negatively related to all three forms of liberalization in all markets except in the WAEMU where there is a significant positive relationship between investment and CAPLIB.

To conduct the formal empirical analysis, The Bayesian VAR model was employed with Minnesota prior. The unit root test disclosed that almost all the variables are $I(1)$ at the one percent level of significance, for all four markets. Only FINLIB for the WAEMU, as well as INF in the WAEMU, South Africa and Kenya, were found to be $I(0)$ at the one percent level of significance. Based on the arguments by Sims (1980) and Sims, Stock and Watson (1990), the study made use of the variables in levels as the analysis aimed to capture the dynamic responses of non-policy variables as a result of unexpected shocks in the policy variables.

The results of the impulse response functions found that in both Nigeria and Kenya, stock market development initially responded negatively to an increase in capital account liberalization. Although the response quickly becomes and stays positive, it starts dying out by the fifth year. Besides a positive yet considerably small initial response of stock market development to capital account liberalization in the WAEMU, the subsequent trend is similar to Nigeria and Kenya. An opposite response was observed in South Africa, with a small negative initial response of stock market development, which remains constant and negative even after the fifth year.

The effect of stock market liberalization on stock market development was then examined in Model two. It was found that stock market development initially responded negatively to a shock to stock market liberalization, in all four stock markets. Although in all cases, it immediately increased and remained positive, in the South African case it was relatively high and persistent. In the case of the WAEMU, Nigeria and Kenya, the response was not as persistent, and started dying out by the fifth year. In the WAEMU particularly, stock market development responded more strongly to stock market liberalization than it did to capital liberalization.

Furthermore, the investigation of the effect of financial sector liberalization on stock market development found that stock market development in both South Africa and Kenya initially responded negatively to financial liberalization. In the WAEMU, there was no initial response of stock market development; and in Nigeria, stock market development initially responded positively. Although in Kenya the response only becomes positive after the first year, it shows persistence even after the fifth year. The response of the development index in South Africa, which recovers earlier than in Kenya, also has the same persistence. In the WAEMU and Nigeria, although the response of stock market development increased, it was not persistent and started dying out by the fifth year.

Finally, for all four markets, the response of stock market development to inflation and its response to investment are generally the same in the three models. The response of stock market development to inflation is considerably small, hence insignificant. In all markets except Nigeria, the initial response of stock market development to investment is positive, and subsequently decreases, reaching a negative value in South Africa by the fifth year; almost dying out in the WAEMU by the fifth year; and dying out in Kenya by the fourth year. In Nigeria, investment leads to an initially negative response of stock market development, which progressively becomes more negative until the ninth quarter, and subsequently starts dying out. Interestingly, in Models two and three for South Africa, the response of stock market development to investment reaches the negative value at a much later stage than it does in Model one.

3.6.2 Implications and policy recommendations

The results of this study have important implications for regulators and policy makers. Firstly, the existence of negative correlation between stock market development inflation in all four markets suggests that policy makers in these countries should pay special attention to inflation targeting policies in order to positively contribute to enhancing the markets. Secondly, the positive correlation found between stock market development and the liberalization of stock markets and the financial sector in all four countries also advocate for the opening of financial markets to international investors, as well as the deepening of the sector. Additionally, this is confirmed by the positive long-run response of stock market development to all three forms of liberalization in all the markets considered. More emphasis should therefore be put on improving financial openness process and removing of the restrictions in the financial sectors of the respective economies, as this will contribute to boosting the effectiveness of the deliverance of credit to the private sector, efficient credit evaluation and public sector surveillance, which is provided through the stock market.

3.6.3 Limitations of the study and areas of further research

Due to the unavailability of high frequency data for most of the variables selected and in most of the countries considered, annual values of the data had to be used with Newton's method of interpolation to create a dataset in quarterly frequencies. This could have affected the robustness of the results, and has increased the risk of data mining. Thus, the results of these analyses should be interpreted with caution. Since three dimensions of financial liberalization were examined in this study, it could be of interest to investigate the effect of current account liberalization on the performance of stock markets in the region.

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Appendix B

Table B.1: Stock Markets indicators

Panel A: WAEMU(1989 - 2014)

Year	Market size (%)	Liquidity (%)	Volatility
1989	4.8	1.1	–
1990	5.4	3.1	–
1991	5.1	1.3	–
1992	4.8	0.7	–
1993	3.0	1.6	–
1994	1.4	9.9	–
1995	0.4	32.9	–
1996	0.5	30.6	–
1997	8.9	2.3	–
1998	14.7	1.0	–
1999	12.5	4.9	0.08
2000	7.4	4.2	0.07
2001	6.3	1.2	0.10
2002	9.5	1.5	0.13
2003	10.7	1.5	0.09
2004	11.8	2.6	0.09
2005	13.0	1.6	0.14
2006	18.4	3.3	0.30
2007	31.9	2.5	0.21
2008	34.0	3.5	0.21
2009	26.4	3.8	0.18
2010	25.9	3.5	0.09
2011	27.5	1.7	0.09
2012	25.0	2.4	0.14
2013	37.8	3.1	0.20
2014	34.4	3.4	0.13

Panel B: SOUTH AFRICA (1975 – 2014)

Year	Market size (%)	Liquidity (%)	Volatility
1975	62.4	3.9	0.24
1976	57.3	3.7	0.25
1977	55.8	3.8	0.17
1978	60.8	4.0	0.20
1979	68.3	5.5	0.20
1980	64.0	10.1	0.24
1981	72.3	4.1	0.26
1982	86.8	3.7	0.38
1983	91.4	4.3	0.28
1984	73.7	2.9	0.19
1985	68.3	5.3	0.16
1986	99.1	6.6	0.20
1987	122.8	7.8	0.32
1988	111.2	3.5	0.23
1989	104.5	5.7	0.19
1990	111.7	6.6	0.19
1991	129.2	5.2	0.17
1992	133.4	4.2	0.18
1993	134.9	4.4	0.21
1994	164.7	5.8	0.11
1995	172.6	5.9	0.17
1996	161.7	11.2	0.14
1997	151.0	18.3	0.14
1998	131.9	29.9	0.41
1999	150.7	35.4	0.21
2000	160.6	32.2	0.17
2001	129.7	22.4	0.27
2002	131.5	31.4	0.17
2003	148.4	18.9	0.24
2004	164.3	22.3	0.13
2005	194.6	22.2	0.17
2006	226.2	28.3	0.13
2007	252.4	34.1	0.11
2008	213.9	33.0	0.26
2009	215.4	34.1	0.22
2010	247.8	29.8	0.17
2011	208.8	26.0	0.12
2012	202.5	28.2	0.09
2013	235.3	26.9	0.1
2014	256.5	27.4	0.1

Panel C: NIGERIA (1989 – 2014)

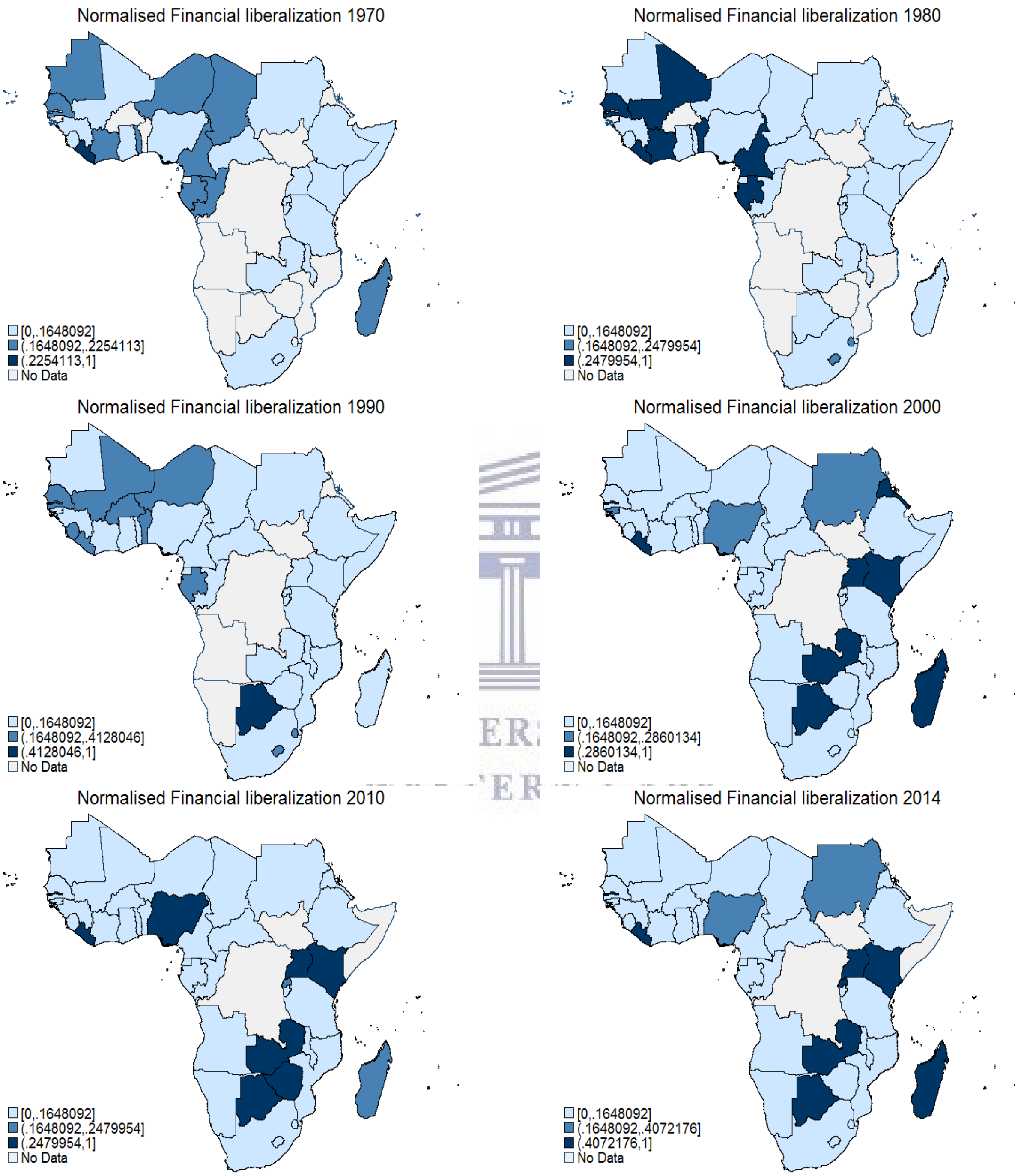
Year	Market size (%)	Liquidity (%)	Volatility
1989	3.8	0.4	–
1990	3.9	0.9	–
1991	5.3	0.6	–
1992	4.5	1.1	–
1993	11.7	1.6	–
1994	13.3	1.9	–
1995	17.0	1.7	–
1996	29.0	3.1	–
1997	35.8	3.9	–
1998	34.8	5.5	–
1999	18.2	1.7	–
2000	7.5	7.6	–
2001	10.9	10.3	–
2002	3.9	8.6	–
2003	10.7	11.8	–
2004	17.0	11.3	–
2005	17.8	9.8	0.27
2006	19.6	12.7	0.17
2007	35.5	29.4	0.21
2008	34.6	23.2	0.17
2009	20.9	12.7	0.27
2010	11.1	12.4	0.57
2011	10.8	8.7	0.20
2012	10.3	8.6	0.18
2013	13.2	9.1	0.14
2014	12.7	7.1	0.19

Panel D: KENYA (1989 – 2012)

Year	Market size (%)	Liquidity (%)	Volatility
1989	5.5	–	–
1990	5.3	2.2	–
1991	5.1	2.6	–
1992	6.3	2.3	–
1993	15.8	1.3	–
1994	30.4	3.2	–
1995	30.1	2.2	–
1996	15.2	3.9	–
1997	13.8	5.4	–
1998	14.0	3.8	–
1999	12.6	4.6	–
2000	9.5	3.1	–
2001	8.8	3.4	–
2002	9.4	3.0	–
2003	19.2	7.0	–
2004	25.3	7.0	–
2005	28.0	9.6	–
2006	35.7	14.8	–
2007	40.0	8.8	–
2008	35.8	5.8	–
2009	28.0	1.9	0.3
2010	31.1	6.4	0.3
2011	28.4	7.7	0.1
2012	25.4	7.9	0.2

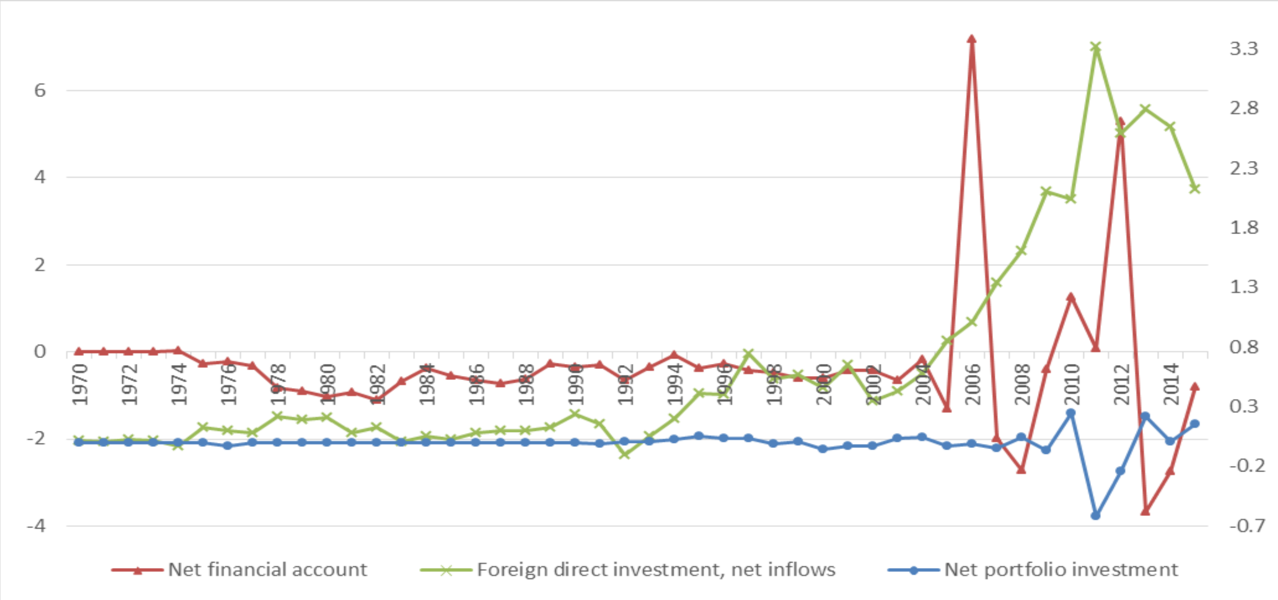
Source: Federal Reserve Bank of St Louis (2017) and author's own estimations.

Figure B.1: Financial liberalization in Sub-Saharan Africa 1970-2014



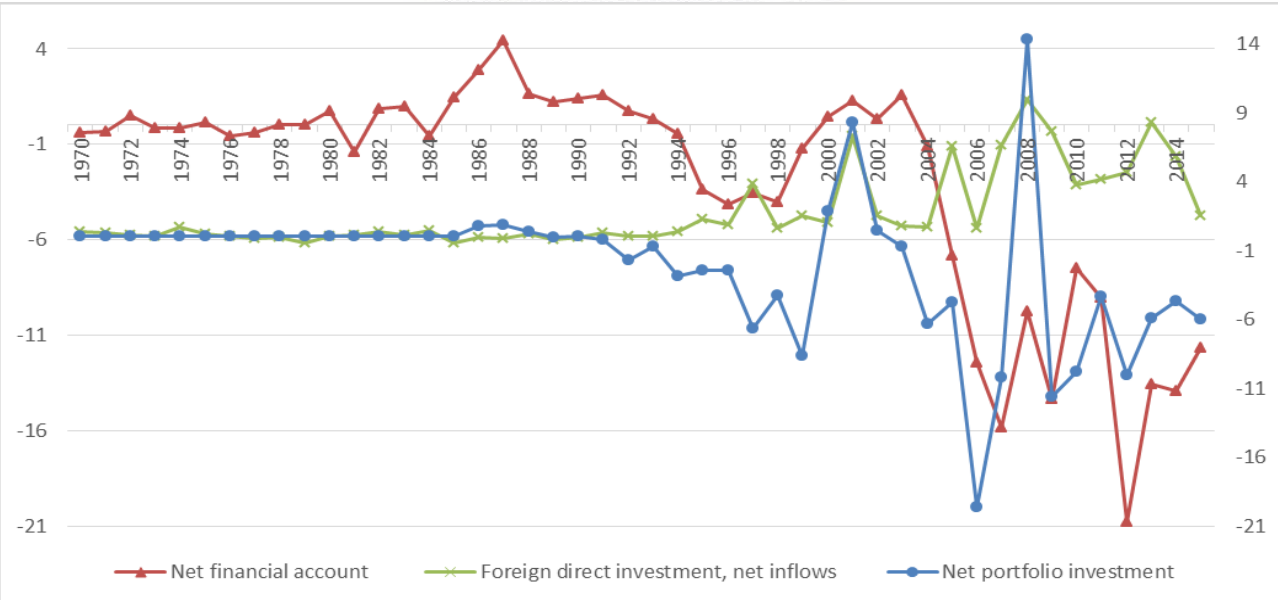
Note: Financial liberalization index was normalized to range between zero and one.
Source: Data extracted from Chinn-Ito (2014)

Figure B.2: Capital account balances in the WAEMU in current US$ billion (1970 – 2015)



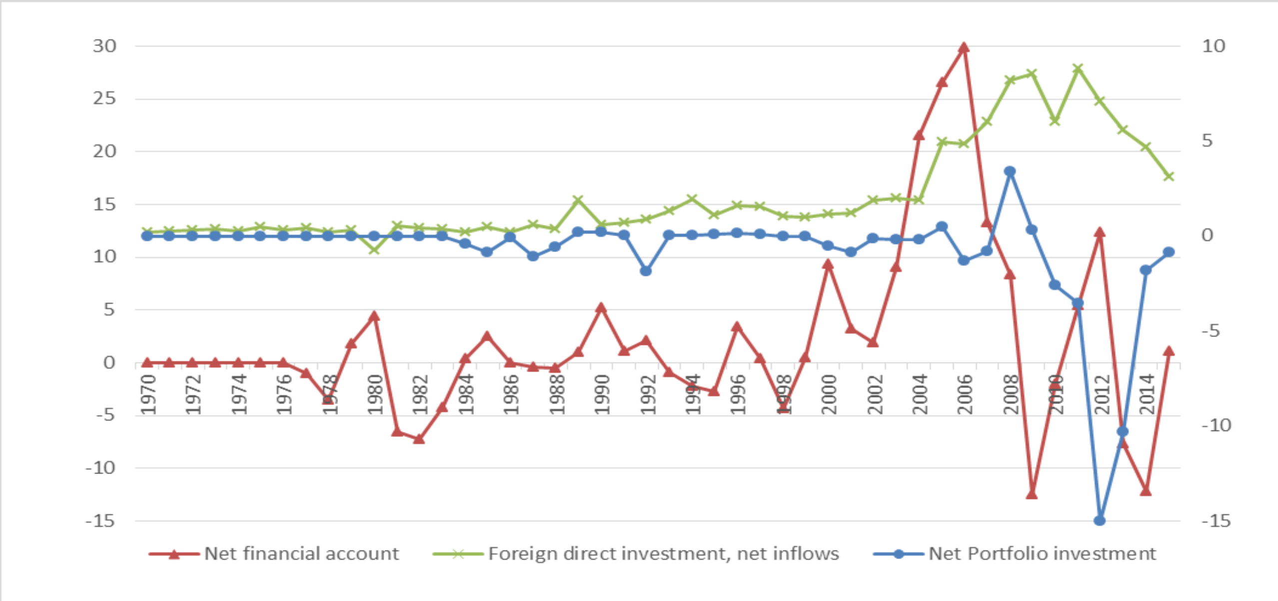
Source: IMF data (2017)
Note: Foreign direct investment and net portfolio investment are measured on the secondary axis

Figure B.3: Capital account balances in South Africa in current US$ billion (1970 – 2015)



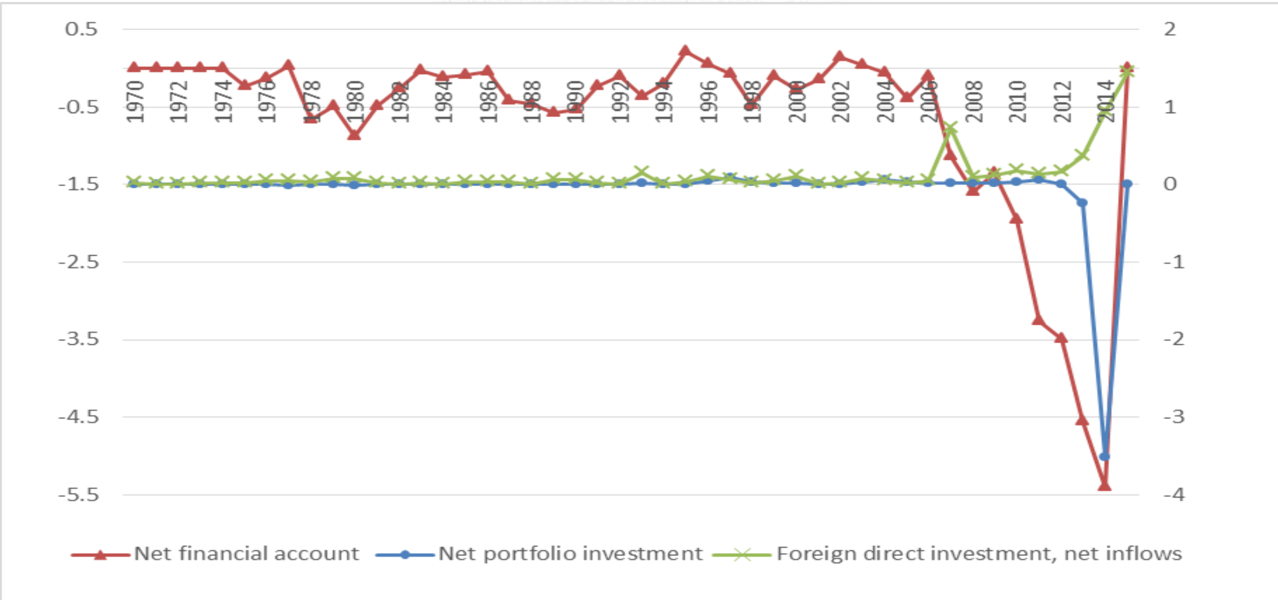
Source: IMF data (2017)
Note: Foreign direct investment and net portfolio investment are measured on the secondary axis

Figure B.4: Capital account balances in Nigeria in current US$ billion (1970 – 2015)



Source: IMF data (2017)
Note: Foreign direct investment and net portfolio investment are measured on the secondary axis

Figure B.5: Capital account balances in Kenya in current US$ billion (1970 – 2015)



Source: IMF data (2017)
Note: Foreign direct investment and net portfolio investment are measured on the secondary axis

Table B.2: Financial Sector Indicators

Panel A: WAEMU(1970 - 2015)

Year	Deposit interest rate (%)	Lending interest rate (%)	Real interest rate (%)	Domestic credit provided by financial sector (% of GDP)	Domestic credit to private sector (% of GDP)	Domestic credit to private sector by banks (% of GDP)	Commercial banks and other lending (current US$ million)
1970	..	..	..	12.11	11.16	10.82	13.832
1971	..	..	..	12.86	11.83	11.50	53
1972	..	..	..	14.08	12.83	12.53	18.279
1973	..	..	..	16.31	15.14	14.84	196.888
1974	..	..	..	18.49	17.59	17.40	113.212
1975	..	..	..	22.55	21.50	21.28	282.832
1976	..	..	..	22.81	21.52	21.24	293.552
1977	..	..	..	23.20	22.21	21.82	689.35
1978	..	..	..	26.93	25.05	24.63	1011.854
1979	..	..	..	27.42	26.41	26.05	781.163
1980	..	..	..	28.64	26.75	26.41	1065.284
1981	..	..	..	29.44	25.82	25.57	825.965
1982	..	..	..	31.62	26.34	26.04	762.349
1983	..	..	..	32.54	26.18	25.96	243.51
1984	..	..	..	27.59	22.65	22.45	46.305
1985	..	..	..	26.70	22.57	22.37	-58.763
1986	..	..	..	29.28	22.59	22.82	-169.414
1987	..	..	..	27.28	22.42	23.15	-245.875
1988	..	..	..	26.49	22.27	22.95	-18.641
1989	..	..	..	24.34	20.89	21.18	90.504
1990	..	..	..	29.84	20.92	20.38	3.431
1991	..	..	..	20.42	18.72	18.50	-89.529
1992	..	..	..	19.67	17.53	16.99	-37.099
1993	..	..	..	18.99	17.40	16.71	-58.007
1994	..	..	..	15.64	12.40	11.70	-48.351
1995	..	..	..	14.30	11.30	10.93	-10.964
1996	..	..	..	13.88	11.25	10.92	97.602
1997	..	..	..	14.81	11.34	10.95	8.499
1998	..	..	..	15.14	11.90	11.56	-237.218
1999	..	..	..	14.93	11.19	11.11	-237.656
2000	..	..	..	15.19	11.87	11.83	3.27
2001	..	..	..	13.38	9.28	9.28	-64.266
2002	..	..	..	12.17	8.98	8.80	-114.062
2003	..	..	..	13.12	10.23	10.23	-114.574
2004	..	..	..	13.20	10.94	10.80	-38.656
2005	4.42	10.15	5.00	13.46	10.81	10.69	-88.46
2006	4.92	9.57	8.34	12.94	11.81	11.67	-95.227
2007	4.27	9.52	6.03	14.04	14.25	14.11	-201.765
2008	4.70	9.81	0.80	14.99	14.46	14.34	40.903
2009	4.91	9.81	7.65	17.60	15.82	15.69	313.045
2010	5.05	9.14	6.14	19.42	16.90	16.78	131.062
2011	5.22	8.96	2.19	21.31	18.83	18.67	191.148
2012	5.01	9.10	4.59	22.82	19.67	19.52	1725.487
2013	5.40	7.91	8.54	24.81	22.16	21.99	801.91
2014	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Panel B: SOUTH AFRICA (1970 – 2015)

Year	Deposit interest rate (%)	Lending interest rate (%)	Real interest rate (%)	Domestic credit provided by financial sector (% of GDP)	Domestic credit to private sector (% of GDP)	Domestic credit to private sector by banks (% of GDP)	Commercial banks and other lending (current US$ million)
1970	..	8.17	3.72	88.60	68.30	50.29	..
1971	..	8.83	2.69	91.02	68.85	50.27	..
1972	..	8.79	-2.00	90.31	67.58	49.95	..
1973	..	8.00	-8.73	88.09	67.76	51.52	..
1974	..	10.17	-4.95	82.80	63.73	49.02	..
1975	..	11.79	1.01	87.55	65.83	51.31	..
1976	..	12.25	1.66	87.14	63.49	49.50	..
1977	8.00	12.50	1.20	87.77	61.98	48.03	..
1978	7.67	12.13	0.40	86.15	60.81	47.07	..
1979	6.00	10.00	-4.46	84.80	58.68	45.28	..
1980	5.54	9.50	-12.34	76.35	55.60	42.76	..
1981	8.19	14.00	3.70	82.21	60.66	47.35	..
1982	13.00	19.33	4.74	83.68	62.55	48.74	..
1983	13.71	16.67	0.08	88.13	66.84	50.90	..
1984	18.29	22.33	9.70	90.38	69.93	54.09	..
1985	17.02	21.50	4.02	96.81	73.40	54.17	..
1986	10.97	14.33	-2.33	94.92	72.77	50.49	..
1987	8.70	12.50	-1.74	93.50	73.41	49.67	..
1988	13.54	15.33	0.13	94.43	75.28	52.76	..
1989	18.13	19.83	2.20	93.58	77.85	52.58	..
1990	18.86	21.00	4.74	97.80	80.95	52.41	..
1991	17.30	20.31	3.96	..	..	..	..
1992	13.78	18.91	3.78	119.79	102.45	56.92	..
1993	11.50	16.16	-0.27	125.28	105.02	53.67	..
1994	11.11	15.58	5.50	131.67	111.01	56.04	20.4
1995	13.54	17.90	6.97	135.65	116.00	57.48	747.5
1996	14.91	19.52	10.76	135.94	116.72	59.96	-844.7
1997	15.38	20.00	11.12	134.54	113.36	61.85	-1120.0
1998	16.50	21.79	12.99	135.61	115.17	66.45	-699.1
1999	12.24	18.00	10.25	149.45	131.05	66.27	-1401.9
2000	9.20	14.50	5.24	148.57	130.31	67.34	-282.0
2001	9.37	13.77	5.69	179.48	138.79	74.43	-1511.3
2002	10.77	15.75	3.16	155.25	110.72	56.03	-2102.8
2003	9.76	14.96	8.66	159.92	115.86	60.77	-2165.8
2004	6.55	11.29	4.47	168.16	126.93	62.50	-668.2
2005	6.04	10.63	4.91	178.16	138.16	65.90	866.9
2006	7.14	11.17	4.60	192.50	156.98	73.62	-552.6
2007	9.15	13.17	3.97	192.66	160.12	78.29	255.1
2008	11.61	15.13	5.78	167.94	140.35	76.69	-596.8
2009	8.54	11.71	3.91	181.45	145.94	74.60	-478.8
2010	6.47	9.83	3.27	185.47	148.98	70.35	356.7
2011	5.67	9.00	2.32	171.54	139.60	67.59	-437.8
2012	5.44	8.75	3.29	181.18	146.47	68.63	-1089.3
2013	5.15	8.50	1.79	181.44	148.85	67.10	252.5
2014	5.80	9.13	3.24	184.90	150.87	66.93	3457.1
2015	6.15	9.42	5.25	178.11	148.74	68.86	9967.6

Panel C: NIGERIA (1970 – 2016)

Year	Deposit interest rate (%)	Lending interest rate (%)	Real interest rate (%)	Domestic credit provided by financial sector (% of GDP)	Domestic credit to private sector (% of GDP)	Domestic credit to private sector by banks (% of GDP)	Commercial banks and other lending (current US$ million)
1970	3.00	7.00	-29.27	12.74	4.92	3.86	-16.126
1971	3.00	7.00	5.58	10.86	5.39	4.80	-13.44
1972	3.04	7.00	3.99	11.54	6.14	5.45	-9.459
1973	3.00	7.00	1.57	10.29	6.05	5.96	-137.497
1974	3.00	7.00	-25.67	-1.60	4.70	4.62	-103.527
1975	3.00	6.25	-13.97	4.44	6.81	6.43	-154.384
1976	2.67	6.50	-6.87	10.28	7.62	7.21	-278.445
1977	2.83	6.00	-4.26	17.71	9.24	8.74	23.069
1978	4.15	6.75	-6.29	21.58	10.99	10.71	1592.552
1979	4.47	7.79	-3.32	20.26	10.39	10.16	1233.733
1980	5.27	8.43	-3.55	21.35	12.23	12.03	1450.386
1981	5.72	8.92	-8.06	30.51	15.62	15.42	1725.592
1982	7.60	9.54	4.49	40.12	17.92	17.71	2414.671
1983	7.41	9.98	-3.33	47.80	17.00	16.85	1012.679
1984	8.25	10.24	-2.67	47.37	16.16	16.01	-411.211
1985	9.12	9.43	3.69	43.40	15.43	15.30	-953.167
1986	9.24	9.96	-1.50	48.67	20.03	19.91	-545.269
1987	13.09	13.96	-31.92	36.02	14.44	14.35	425.446
1988	12.95	16.62	-5.13	34.31	12.94	12.82	149.999
1989	14.68	20.44	-16.96	20.14	9.24	9.16	520.605
1990	19.78	25.30	14.65	21.90	8.71	8.69	-121.012
1991	14.92	20.04	2.07	21.46	9.40	8.95	-119.397
1992	18.04	24.76	-25.77	30.80	13.43	13.33	..
1993	23.24	31.65	4.37	39.24	12.32	12.20	..
1994	13.09	20.48	-8.03	46.44	15.03	14.95	..
1995	13.53	20.23	-43.57	23.62	10.05	10.02	..
1996	13.06	19.84	-9.71	13.26	9.01	8.98	..
1997	7.17	17.80	16.61	12.59	10.69	10.66	..
1998	10.11	18.18	25.28	18.20	13.00	12.98	..
1999	12.81	20.29	2.77	19.08	13.52	13.49	..
2000	11.69	21.27	-10.32	10.01	12.35	12.30	..
2001	15.26	23.44	23.84	19.30	16.57	16.51	..
2002	16.67	24.77	-10.81	19.55	13.04	13.02	..
2003	14.22	20.71	8.61	21.20	13.82	13.80	465.301
2004	13.70	19.18	19.37	11.70	13.14	13.12	539.796
2005	10.53	17.95	-3.34	8.60	13.24	13.22	1925.041
2006	9.74	16.90	-0.37	4.91	13.18	13.17	174.135
2007	10.29	16.94	11.61	19.20	25.25	24.57	2152.273
2008	11.97	15.48	4.19	26.55	33.75	33.65	719.309
2009	13.30	18.36	23.71	37.11	38.39	38.35	83.356
2010	6.52	17.59	-42.31	18.80	15.42	15.39	..
2011	5.70	16.02	5.94	22.15	12.48	12.46	..
2012	8.41	16.79	6.88	20.80	11.80	11.79	..
2013	7.95	16.72	10.25	21.85	12.59	12.59	..
2014	9.34	16.55	11.36	21.80	14.54	14.49	..
2015	9.15	16.85	13.60	23.07	14.22	14.19	..
2016	7.50	16.87	..	..	..	..	..

Panel D: KENYA (1970 – 2016)

Year	Deposit interest rate (%)	Lending interest rate (%)	Real interest rate (%)	Domestic credit provided by financial sector (% of GDP)	Domestic credit to private sector (% of GDP)	Domestic credit to private sector by banks (% of GDP)	Commercial banks and other lending (current US$ million)
1970	3.50	..	..	16.40	15.12	15.12	29.497
1971	3.50	9	20.07	19.90	17.43	17.43	3.101
1972	3.50	9	7.70	20.06	16.49	16.49	38.211
1973	3.50	9	-1.09	21.98	17.89	17.89	108.272
1974	4.32	9.5	-5.64	23.41	17.98	17.98	146.957
1975	5.13	10	-1.64	26.79	17.33	17.33	35.452
1976	5.13	10	-7.49	25.72	16.83	16.83	69.844
1977	5.13	10	-5.90	24.88	17.51	17.51	-28.79
1978	5.13	10	6.71	30.67	21.71	21.71	311.704
1979	5.13	10	4.13	30.79	20.97	20.97	205.362
1980	5.75	10.58	0.94	30.11	21.81	21.81	221.87
1981	8.85	12.42	1.41	32.68	21.00	21.00	-31.587
1982	12.20	14.5	2.61	37.10	20.44	20.44	-39.606
1983	13.27	15.83	3.57	32.60	19.32	19.32	58.742
1984	11.77	14.42	3.84	32.08	18.99	18.99	-123.544
1985	11.25	14	5.26	31.91	19.33	19.33	8.248
1986	11.25	14	4.86	34.93	19.31	19.31	29.533
1987	10.31	14	8.16	37.47	18.42	18.42	153.202
1988	10.33	15	8.03	35.42	18.93	18.93	164.182
1989	12.00	17.25	6.82	32.72	19.22	19.22	160.773
1990	13.67	18.75	7.33	35.82	18.66	18.66	64.666
1991	..	19.00	5.75	37.38	19.96	19.96	273.529
1992	..	21.07	1.83	37.26	22.15	22.15	19.398
1993	..	29.99	3.41	29.06	18.50	18.50	-39.961
1994	..	36.24	16.43	36.23	19.83	19.83	-281.613
1995	13.60	28.80	15.80	42.75	25.81	25.63	-163.459
1996	17.59	33.79	-5.78	34.31	21.68	21.51	-194.531
1997	16.72	30.25	16.88	37.10	24.36	24.22	-121.502
1998	18.40	29.49	21.10	36.63	23.96	23.81	-1.578
1999	9.55	22.38	17.45	37.65	26.57	26.42	-67.541
2000	8.10	22.34	15.33	35.75	25.76	25.62	-80.572
2001	6.64	19.67	17.81	36.41	25.22	25.07	-143.907
2002	5.49	18.45	17.36	38.98	25.85	25.70	-66.516
2003	4.13	16.57	9.77	38.97	25.16	24.99	122.188
2004	2.43	12.53	5.05	39.38	27.29	27.13	-64.188
2005	5.08	12.88	7.61	37.36	26.28	26.13	-55.502
2006	5.14	13.64	-8.01	32.00	22.89	22.77	-60.923
2007	5.16	13.34	4.82	31.09	23.04	22.93	-10.914
2008	5.30	14.02	-0.98	33.90	25.38	25.28	-8.124
2009	5.97	14.80	2.84	35.58	25.02	24.93	24.47
2010	4.56	14.37	12.03	41.08	27.23	27.13	7.969
2011	5.63	15.05	3.84	41.68	30.57	30.42	16.671
2012	11.57	19.72	9.45	42.24	29.54	29.48	667.517
2013	8.64	17.31	11.34	42.94	31.71	31.63	-3.752
2014	8.37	16.51	7.89	44.25	34.16	34.10	-612.677
2015	9.19	16.09	6.36	45.20	34.89	34.82	734.318
2016	8.69	16.56	..	..	..	..	..

Source: IMF database (2017)

Note: ".." represents unavailable value

Table B.3: Bayesian VAR estimates for Model one

Panel A: WAEMU

	DEVINDEX	INF	INV	CAPLIB
DEVINDEX(-1)	0.836282 (0.03534) [23.6611]	-0.028479 (0.05155) [-0.55243]	0.068458 (0.02323) [2.94741]	-0.006198 (0.00365) [-1.69929]
INF(-1)	0.015388 (0.04862) [0.31652]	0.103673 (0.07137) [1.45271]	-0.008329 (0.03198) [-0.26046]	0.006956 (0.00502)8 [1.38453]
INV(-1)	0.064364 (0.05483) [1.17389]	-0.009380 (0.08005) [-0.11717]	0.828112 (0.03610) [22.9368]	0.001941 (0.00566) [0.34265]
CAPLIB(-1)	0.185077 (0.39737) [0.46575]	1.854972 (0.58052) [3.19536]	0.424292 (0.26139) [1.62321]	0.746792 (0.04113) [18.1573]
C	0.820557 (0.76344) [1.07481]	3.159969 (1.11521) [2.83352]	1.984909 (0.50255) [3.94966]	-0.250750 (0.07895) [-3.17626]
R-squared	0.882904	0.178850	0.889490	0.807367
Adj. R-squared	0.878125	0.145334	0.884980	0.799504
Sum sq. resids	218.2183	393.1064	92.58387	2.305161
S.E. equation	1.492219	2.002821	0.971974	0.153369
F-statistic	184.7308	5.336201	197.1996	102.6846
Mean dependent	7.804323	0.957542	11.48968	-1.064981
S.D. dependent	4.274401	2.166425	2.865939	0.342519

Panel B: SOUTH AFRICA

	DEVINDEX	INF	INV	CAPLIB
DEVINDEX(-1)	0.984705 (0.01466) [67.1584]	-0.017977 (0.00427) [-4.21366]	0.000533 (0.00263) [0.20273]	0.000581 (0.00076) [0.76788]
INF(-1)	-0.081365 (0.21744) [-0.37420]	0.207249 (0.06351) [3.26311]	0.003373 (0.03900) [0.08648]	-0.010921 (0.01121) [-0.97379]
INV(-1)	-0.070301 (0.06754) [-1.04087]	0.038443 (0.01965) [1.95642]	0.969151 (0.01212) [79.9943]	-0.003806 (0.00348) [-1.09267]
CAPLIB(-1)	-0.060788 (0.58147) [-0.10454]	-0.548497 (0.16921) [-3.24152]	0.072723 (0.10429) [0.69732]	0.817308 (0.03002) [27.2294]
C	2.960049 (2.09647) [1.41192]	1.235230 (0.60987) [2.02538]	0.644052 (0.37601) [1.71286]	-0.166755 (0.10812) [-1.54230]
R-squared	0.978514	0.477128	0.982766	0.856630
Adj. R-squared	0.977956	0.463547	0.982318	0.852906
Sum sq. resids	1927.722	134.9425	61.30791	5.139286
S.E. equation	3.538032	0.936082	0.630954	0.182680
F-statistic	1753.361	35.13183	2195.445	230.0360
Mean dependent	51.44522	2.328841	21.06810	-1.301506
S.D. dependent	23.82953	1.278051	4.744993	0.476314

Panel C: NIGERIA

	DEVINDEX	INF	INV	CAPLIB
DEVINDEX(-1)	0.839804 (0.03288) [25.5435]	-0.020169 (0.10056) [-0.20057]	-0.009697 (0.02078) [-0.46672]	0.005841 (0.00223) [2.61650]
INF(-1)	-0.023530 (0.02158) [-1.09020]	0.249447 (0.06638) [3.75784]	-0.000407 (0.01365) [-0.02979]	-0.003096 (0.00147) [-2.11012]
INV(-1)	-0.123732 (0.04423) [-2.79725]	0.006497 (0.13542) [0.04797]	0.895979 (0.02800) [31.9994]	0.000298 (0.00301) [0.09904]
CAPLIB(-1)	0.390937 (0.30659) [1.27512]	-2.824105 (0.93874) [-3.00841]	0.251894 (0.19388) [1.29922]	0.910113 (0.02084) [43.6721]
C	3.477158 (0.85181) [4.08206]	0.307504 (2.60638) [0.11798]	1.483654 (0.53871) [2.75411]	-0.133021 (0.05787) [-2.29879]
R-squared	0.926539	0.341110	0.921806	0.973735
Adj. R-squared	0.923540	0.314217	0.918614	0.972663
Sum sq. resids	209.5591	1867.069	84.89621	0.896749
S.E. equation	1.462313	4.364828	0.930746	0.095658
F-statistic	309.0081	12.68378	288.8217	908.3143
Mean dependent	9.975058	4.429098	10.53084	-1.086309
S.D. dependent	5.288388	5.270766	3.262543	0.578562

Panel D: KENYA

	DEVINDEX	INF	INV	CAPLIB
DEVINDEX(-1)	0.865318 (0.03379) [25.6053]	0.077818 (0.08933) [0.87113]	0.062504 (0.02132) [2.93153]	0.014488 (0.00817) [1.77297]
INF(-1)	0.011748 (0.02671) [0.43980]	0.158037 (0.07105) [2.22431]	0.007328 (0.01687) [0.43451]	-0.009338 (0.00647) [-1.44418]
INV(-1)	-0.011603 (0.07331) [-0.15828]	-0.203716 (0.19395) [-1.05034]	0.690568 (0.04637) [14.8911]	-0.034109 (0.01774) [-1.92266]
CAPLIB(-1)	0.127749 (0.11525) [1.10843]	-0.877138 (0.30503) [-2.87555]	-0.046812 (0.07277) [-0.64332]	0.871950 (0.02791) [31.2366]
C	1.359856 (1.24998) [1.08790]	5.913848 (3.30787) [1.78781]	5.056692 (0.79078) [6.39455]	0.580888 (0.30255) [1.91998]
R-squared	0.907531	0.190017	0.787669	0.935130
Adj. R-squared	0.903421	0.154018	0.778233	0.932247
Sum sq. resids	167.6603	1047.924	68.75954	9.338449
S.E. equation	1.364878	3.412271	0.874068	0.322119
F-statistic	220.8243	5.278369	83.46687	324.3462
Mean dependent	9.019620	3.152758	18.16875	0.324228
S.D. dependent	4.391902	3.709907	1.856079	1.237515

Note: Standard errors are in parenthesis and t-statistics are in square brackets.
Source: Author's estimations.

Table B.4: Bayesian VAR estimates for Model two

Panel A: WAEMU

	DEVINDEX	INF	INV	STOCKLIB
DEVINDEX(-1)	0.748124 (0.04274) [17.5035]	0.005129 (0.06230) [0.08232]	0.092244 (0.02807) [3.28594]	0.017272 (0.01920) [0.89961]
INF(-1)	0.039322 (0.04712) [0.83449]	0.153458 (0.06915) [2.21926]	-0.000407 (0.03100) [-0.01312]	-0.022316 (0.02120) [-1.05247]
INV(-1)	0.114603 (0.05548) [2.06578]	0.007597 (0.08098) [0.09382]	0.823454 (0.03652) [22.5452]	0.019551 (0.02495) [0.78355]
STOCKLIB(-1)	0.164223 (0.04666) [3.51952]	-0.104369 (0.06811) [-1.53246]	-0.054674 (0.03068) [-1.78227]	0.935948 (0.02099) [44.5843]
C	-0.097458 (0.59727) [-0.16317]	1.195603 (0.87222) [1.37075]	1.663130 (0.39325) [4.22918]	0.056724 (0.26875) [0.21107]
R-squared	0.882267	0.105341	0.889829	0.969181
Adj. R-squared	0.877461	0.068824	0.885332	0.967923
Sum sq. resids	219.4071	428.2971	92.30036	41.14099
S.E. equation	1.496278	2.090545	0.970485	0.647924
F-statistic	183.5971	2.884734	197.8806	770.4580
Mean dependent	7.804323	0.957542	11.48968	4.970874
S.D. dependent	4.274401	2.166425	2.865939	3.617648

Panel B: SOUTH AFRICA

	DEVINDEX	INF	INV	STOCKLIB
DEVINDEX(-1)	0.934733 (0.02550) [36.6580]	-0.013881 (0.00741) [-1.87239]	0.006328 (0.00457) [1.38455]	0.011765 (0.00321) [3.66955]
INF(-1)	-0.020368 (0.21003) [-0.09698]	0.259398 (0.06133) [4.22932]	-0.010449 (0.03767) [-0.27739]	-0.031985 (0.02641) [-1.21092]
INV(-1)	0.048455 (0.08390) [0.57751]	0.023408 (0.02441) [0.95906]	0.955993 (0.01505) [63.5156]	-0.031203 (0.01055) [-2.95658]
STOCKLIB(-1)	0.494994 (0.20733) [2.38750]	-0.050114 (0.06029) [-0.83122]	-0.056288 (0.03717) [-1.51426]	0.869942 (0.02608) [33.3565]
C	0.128897 (2.31237) [0.05574]	2.216134 (0.67292) [3.29333]	0.883881 (0.41482) [2.13078]	0.927953 (0.29086) [3.19037]
R-squared	0.978031	0.443325	0.982715	0.984040
Adj. R-squared	0.977460	0.428866	0.982266	0.983626
Sum sq. resids	1971.055	143.6663	61.48743	29.91999
S.E. equation	3.577577	0.965867	0.631877	0.440778
F-statistic	1713.968	30.66068	2188.922	2373.788
Mean dependent	51.44522	2.328841	21.06810	5.710692
S.D. dependent	23.82953	1.278051	4.744993	3.444581

Panel C: NIGERIA

	DEVINDEX	INF	INV	STOCKLIB
DEVINDEX(-1)	0.845369 (0.03242) [26.0769]	-0.060854 (0.09916) [-0.61372]	0.004645 (0.02049) [0.22673]	0.031381 (0.01415) [2.21718]
INF(-1)	-0.025499 (0.02147) [-1.18747]	0.263990 (0.06604) [3.99748]	-0.005152 (0.01358) [-0.37928]	-0.024049 (0.00938) [-2.56262]
INV(-1)	-0.111201 (0.04385) [-2.53583]	-0.083847 (0.13427) [-0.62447]	0.901739 (0.02776) [32.4833]	-0.018565 (0.01916) [-0.96878]
STOCKLIB(-1)	0.047907 (0.04718) [1.01531]	-0.344473 (0.14447) [-2.38435]	0.001407 (0.02984) [0.04716]	0.898722 (0.02062) [43.5787]
C	2.470537 (0.70165) [3.52104]	7.567358 (2.14958) [3.52039]	1.014050 (0.44403) [2.28372]	0.925592 (0.30662) [3.01870]
R-squared	0.926741	0.323109	0.921302	0.974427
Adj. R-squared	0.923751	0.295481	0.918089	0.973383
Sum sq. resids	208.9811	1918.079	85.44340	36.23836
S.E. equation	1.460294	4.424051	0.933741	0.608095
F-statistic	309.9306	11.69490	286.8151	933.5370
Mean dependent	9.975058	4.429098	10.53084	8.417476
S.D. dependent	5.288388	5.270766	3.262543	3.727282

Panel D: KENYA

	DEVINDEX	INF	INV	STOCKLIB
DEVINDEX(-1)	0.842755 (0.03764) [22.3887]	0.169361 (0.09948) [1.70250]	0.075857 (0.02375) [3.19439]	0.035253 (0.01251) [2.81719]
INF(-1)	0.017500 (0.02696) [0.64906]	0.140315 (0.07172) [1.95637]	0.003449 (0.01702) [0.20259]	-0.013407 (0.00897) [-1.49392]
INV(-1)	0.020696 (0.07705) [0.26860]	-0.334586 (0.20384) [-1.64138]	0.671355 (0.04875) [13.7716]	-0.061102 (0.02564) [-2.38315]
STOCKLIB(-1)	0.148175 (0.08449) [1.75368]	-0.759350 (0.22359) [-3.39622]	-0.075119 (0.05334) [-1.40820]	0.858264 (0.02813) [30.5080]
C	-0.060767 (1.56504) [-0.03883]	12.67781 (4.14139) [3.06124]	5.819625 (0.98994) [5.87876]	1.888086 (0.52090) [3.62465]
R-squared	0.905933	0.224106	0.786589	0.948885
Adj. R-squared	0.901753	0.189622	0.777105	0.946613
Sum sq. resids	170.5565	1003.821	69.10930	17.27487
S.E. equation	1.376616	3.339696	0.876288	0.438113
F-statistic	216.6924	6.498805	82.93058	417.6800
Mean dependent	9.019620	3.152758	18.16875	7.178947
S.D. dependent	4.391902	3.709907	1.856079	1.896127

Note: Standard errors are in parenthesis and t-statistics are in square brackets.
Source: Author's estimations.

Table B.5: Bayesian VAR estimates for Model three

Panel A: WAEMU

	DEVINDEX	INF	INV	FINLIB
DEVINDEX(-1)	0.784935	-0.075511	0.054616	0.000597
	(0.03905)	(0.05694)	(0.02565)	(0.00711)
	[20.1024]	[-1.32614]	[2.12938]	[0.08405]
INF(-1)	0.000729	0.153845	0.001742	-0.003483
	(0.04740)	(0.06956)	(0.03118)	(0.00864)
	[0.01538]	[2.21163]	[0.05587]	[-0.40311]
INV(-1)	0.045798	0.024178	0.834355	0.003410
	(0.05454)	(0.07964)	(0.03592)	(0.00994)
	[0.83969]	[0.30360]	[23.2300]	[0.34310]
FINLIB(-1)	0.279571	0.148431	0.051442	0.912126
	(0.09762)	(0.14254)	(0.06420)	(0.01779)
	[2.86383]	[1.04133]	[0.80132]	[51.2608]
C	-2.463701	-0.852677	0.876503	1.185943
	(1.20425)	(1.75835)	(0.79203)	(0.21950)
	[-2.04584]	[-0.48493]	[1.10666]	[5.40293]
R-squared	0.882633	0.096097	0.887613	0.974105
Adj. R-squared	0.877842	0.059203	0.883026	0.973048
Sum sq. resids	218.7248	432.7224	94.15669	6.815717
S.E. equation	1.493950	2.101317	0.980195	0.263720
F-statistic	184.2463	2.604679	193.4963	921.6213
Mean dependent	7.804323	0.957542	11.48968	13.32282
S.D. dependent	4.274401	2.166425	2.865939	1.606372

Panel B: SOUTH AFRICA

	DEVINDEX	INF	INV	FINLIB
DEVINDEX(-1)	0.937520	-0.013655	0.007965	0.013697
	(0.02502)	(0.00727)	(0.00448)	(0.00368)
	[37.4715]	[-1.87719]	[1.77587]	[3.72243]
INF(-1)	-0.018682	0.258613	-0.012982	-0.024617
	(0.21019)	(0.06138)	(0.03770)	(0.03092)
	[-0.08888]	[4.21334]	[-0.34435]	[-0.79610]
INV(-1)	0.100501	0.016292	0.942964	-0.056541
	(0.09998)	(0.02908)	(0.01794)	(0.01471)
	[1.00521]	[0.56021]	[52.5738]	[-3.84342]
FINLIB(-1)	0.349605	-0.039167	-0.054270	0.889257
	(0.15074)	(0.04383)	(0.02703)	(0.02218)
	[2.31932]	[-0.89352]	[-2.00782]	[40.0967]
C	-3.110847	2.610493	1.507663	2.162225
	(3.29980)	(0.96011)	(0.59196)	(0.48557)
	[-0.94274]	[2.71896]	[2.54691]	[4.45293]
R-squared	0.978045	0.443486	0.982649	0.990766
Adj. R-squared	0.977474	0.429032	0.982199	0.990526
Sum sq. resids	1969.837	143.6247	61.72259	40.08207
S.E. equation	3.576472	0.965727	0.633085	0.510170
F-statistic	1715.051	30.68070	2180.436	4130.817
Mean dependent	51.44522	2.328841	21.06810	13.79717
S.D. dependent	23.82953	1.278051	4.744993	5.241416

Panel C: NIGERIA

	DEVINDEX	INF	INV	FINLIB
DEVINDEX(-1)	0.827830 (0.03350) [24.7142]	-0.021525 (0.10244) [-0.21012]	-0.005778 (0.02117) [-0.27299]	0.011468 (0.01172) [0.97846]
INF(-1)	-0.019663 (0.02167) [-0.90722]	0.250292 (0.06666) [3.75473]	-0.001727 (0.01371) [-0.12599]	-0.021145 (0.00759) [-2.78538]
INV(-1)	-0.117814 (0.04372) [-2.69455]	-0.043398 (0.13387) [-0.32419]	0.900743 (0.02768) [32.5442]	-0.021764 (0.01531) [-1.42128]
FINLIB(-1)	0.103834 (0.05688) [1.82543]	-0.489905 (0.17416) [-2.81288]	0.032438 (0.03597) [0.90183]	0.920150 (0.01992) [46.1847]
C	1.559099 (0.91871) [1.69706]	11.15109 (2.81522) [3.96101]	0.646812 (0.58130) [1.11270]	1.467104 (0.32184) [4.55848]
R-squared	0.926224	0.333343	0.921754	0.977785
Adj. R-squared	0.923213	0.306133	0.918561	0.976878
Sum sq. resids	210.4551	1889.078	84.95186	23.16711
S.E. equation	1.465435	4.390479	0.931051	0.486209
F-statistic	307.5883	12.25055	288.6164	1078.344
Mean dependent	9.975058	4.429098	10.53084	14.78883
S.D. dependent	5.288388	5.270766	3.262543	3.197494

Panel D: KENYA

	DEVINDEX	INF	INV	FINLIB
DEVINDEX(-1)	0.836542 (0.03726) [22.4489]	0.167744 (0.09848) [1.70330]	0.072368 (0.02351) [3.07864]	0.019680 (0.01237) [1.59037]
INF(-1)	0.019663 (0.02690) [0.73098]	0.140865 (0.07155) [1.96867]	0.004659 (0.01698) [0.27435]	-0.015696 (0.00894) [-1.75485]
INV(-1)	0.016916 (0.07464) [0.22663]	-0.277167 (0.19747) [-1.40358]	0.680854 (0.04722) [14.4190]	-0.029067 (0.02481) [-1.17151]
FINLIB	0.111543 (0.05248) [2.12543]	-0.483794 (0.13887) [-3.48371]	-0.039122 (0.03313) [-1.18092]	0.932068 (0.01745) [53.4191]
C	-0.286830 (1.52532) [-0.18805]	12.30659 (4.03628) [3.04899]	5.630124 (0.96464) [5.83648]	1.335278 (0.50709) [2.63319]
R-squared	0.906251	0.222759	0.787550	0.980349
Adj. R-squared	0.902084	0.188215	0.778108	0.979476
Sum sq. resids	169.9813	1005.564	68.79831	16.95292
S.E. equation	1.374293	3.342593	0.874314	0.434011
F-statistic	217.5019	6.448552	83.40716	1122.476
Mean dependent	9.019620	3.152758	18.16875	12.64474
S.D. dependent	4.391902	3.709907	1.856079	3.029461

Note: Standard errors are in parenthesis and t-statistics are in square brackets.
Source: Author's estimations.

Chapter 4

THE DETERMINANTS OF STOCK MARKET LIQUIDITY: A MARKOV SWITCHING VECTOR AUTOREGRESSIVE APPROACH

4.1 INTRODUCTION

4.1.1 Background and problem statement

Stock market liquidity, also referred to as the transactional liquidity of equity markets, is defined as the ability to purchase or sell large volume of equities with minimum impact on the price (Kumar and Misra, 2015: 36). According to Brandao-Marques (2016: 6), equity market liquidity has crucial significances for a country's financial stability and real economic activity for a number of reasons. Firstly, a higher cost of equity may result from low market liquidity. In effect, when higher liquidity risks are incorporated in the price, investors will demand the returns to be higher, and subsequently investment could be negatively affected by the higher cost of equity. However, there is also another potential outcome. That is, in a general equilibrium framework a response of firms to the higher returns on equity could be to use more debt as a source of funding, which will lead to the weighted cost of capital remaining unchanged.

A second reason for the importance of stock market liquidity is that high leverage may be induced through low stock market liquidity as equity becomes more expensive. Moreover, equity issuance is discouraged since information asymmetries and agency problems between firm insiders and outside investors may be evident in markets that are less liquid (Brandao-Marques, 2016: 6).

Thirdly, when stock markets' liquidity is low, initial public offerings become more difficult and costly and private equity activity may be discouraged. The effect of this is disproportionate for the most common users of these types of finance which are the younger firms, thus limiting firm creation and innovation. Besides, when liquidity is high the management of young firms, as well as old ones, may improve through the enhancement of corporate governance and the rise in effectiveness of equity-based managerial compensation. Lastly, low liquidity in stock markets represents a hindrance for price discovery through the reduction in market efficiency as well as a higher risk of misalignment of equity valuations with its fundamentals exposing it to large corrections (Brandao-Marques, 2016: 6).

These aforementioned reasons advocating for higher liquidity in stock markets are in line with the "bright" view on liquidity. However, a "dark" view on liquidity also exists and some economists point to the dangers of liquidity. Keynes (1936: 155) in his paper on the General Theory of Employment, Interest and Money, explained that instead of being beneficial for the financial system, liquidity may rather be a source of destabilization in the financial markets. He argues that in liquid markets the fixation is only on the short run and fundamentals are no longer considered in the investors' decision-making process. Thus, this creates instability which can impact other markets, leading to a system-wide instability.

In addition, Coffee (1991) links liquidity to issues in corporate governance. He reasons that as liquidity allows investors to quickly convert their assets into money and reduce the cost of diversification, it also impairs corporate governance since diffuse stockholding is encouraged while active investing is discouraged. Practical examples used to justify these arguments are the Enron and Parmalat scandals of 2002 and 2003, respectively. These events appeared to be a result of liquid markets in which instead of focusing their investment on the underlying economic process, investors only focused on trading in stocks.

In an attempt to diversify their investment portfolios and in their search for unexplored investment opportunities, global investors are turning their attention to the developing markets, the popularities of which are growing with globalization and economic integration. However, contrary to the more developed stock markets, developing markets are generally characterized by a high degree of illiquidity which is arguably emerging from the fact that trading, which is infrequent, is often limited to only a few stocks. Also, turnover ratios remain low compared to international standards.

Despite the contradicting views on the impact of liquidity on the performance of markets, it is still of considerable importance to understand the sources of variations of liquidity in the individual stock markets, especially given the effects of liquidity (either positive or negative) on many aspects of financial variables. Therefore, the relevant research question addressed in this study is: What are the major influential factors of market liquidity in Sub-Saharan Africa?

4.1.2 Objectives of the study

The objective of this study is to investigate the concept of liquidity in Sub-Saharan African Stock Markets.

However, the specific objectives are to:

i. Examine the patterns of aggregate market liquidity in the chosen Sub-Saharan African stock markets over time.

ii. Investigate the relevance of the mainstream determinants of market liquidity in the chosen Sub-Saharan African stock markets.

4.1.3 Relevance

Despite the considerable body of existing literature on the understanding of market liquidity advocating for higher liquidity levels in economic systems, information on liquidity in developing markets in general, and on sub-Saharan African markets in particular, remains limited. Past available studies on market liquidity focused mostly on developed and emerging financial markets in Europe, America and Asia. However, the size, complexity and level of maturity of these markets make the results of their investigations usually inapplicable to the Sub-Saharan African markets. Moreover, with the recent surge in the growth rate in African economies and their potential capacity to provide a wide range of profitable investment opportunities for global investors, the improvement of market efficiency and the development of the regions capital markets have become imperative. Thus, this study could contribute to reaching these objectives by offering more insight on market liquidity in the region, which will assist market participants, academics, regulators and policy makers in devising and implementing the appropriate policies and regulations. Additionally, this study will focus on illustrating the patterns in market liquidity in recent years with the sample period 2 January 2009 – 31 December 2016.

4.1.4 Structure of the chapter

The rest of the chapter is organized as follows. Section 4.2 gives an overview of the markets' microstructure and evolution of market liquidity over time. Section 4.3 provides a theoretical and empirical literature review on liquidity and the choice of the methodology is justified by reviewing the different tools used in the existing literature. Section 4.4 discusses the methodology used in this analysis and provides a detailed description of the data. Section 4.5 presents the empirical analysis and discusses the findings; while Section 4.6 provides a conclusion to the study and recommendations for future research.

4.2 MARKET STRUCTURE AND STOCK MARKET LIQUIDITY IN SUB-SAHARAN AFRICA

4.2.1 Introduction

African stock markets have certainly attracted considerable interest from international investors. However, their reputation for being relatively low in liquidity compared to international norms has been deterring these investors. According to the JSE (2014), there are a number of factors contributing to this high illiquidity. These are, for example, high transaction costs in the range of 2.5 and five percent slowing the velocity of trade; a lack of documentation and product standardisation, the lack of participation of retail investors on the markets, existence of limits restricting short-selling, lack of counters listed on the markets mostly dominated by breweries, telecom and banks listings; and long term and large holdings of pension funds.

It is argued that liquidity is crucial to stock markets and represents their lifeblood. Highly illiquid stock markets have shown evidence of disparities in price to book value, impeded foreign trade and limitation for investors to achieve optimal portfolio requirements. Thus, in the absence of liquidity in the market, price setting is pointless (JSE, 2014). Therefore, markets could benefit from the improvement of liquidity through enhanced price discovery, increased quantity of stocks available for required portfolio allocation, increased investment choices and improved investors' confidence in the market.

The following sections will look more closely at liquidity in the four Sub-Saharan African markets under consideration in the study.

4.2.2 Bourse Régionale des Valeurs Mobilières (BRVM)

The original Bourse des Valeurs d'Abidjan (BVA) was opened in 1976 as an attempt by the Ivorian government to encourage share trading by foreign companies to the Ivorian public. However, as part of a much broader economic integration package, a treaty had been signed in November 1973, establishing the West African Monetary Union and making provision for the creation of financial markets organized into sub-regions (Ahoussou, 2007). Despite the idea being evoked as part of the treaty, no concrete steps were taken to materialize it until the early 1990s. On 17th December 1993, a final statement issued from the special session of WAEMU ministry council held at Dakar, Senegal, informed of the decision to create a regional stock exchange. With the regional exchange, the other states of the WAEMU replicated the idea of using it as a mean to diffuse ownership and retain a role for the West African citizens., The main difference therefore lies in the agreement of the other states to give up the creation of domestic exchanges and privatize their industries on the regional market, while reserving the right to prioritize their own citizens when offering shares in IPOs (Lavelle, 2001: 732).

This exchange was aimed at increasing the savings rate in the region as well as strengthening companies' financial structure (Ouattara, 2016: 2). Moreover, with the creation of the exchange, the banks were able to return to their first role of providing short and medium-term financing; while the stock market had the function of providing long-term financing for the economic operators. Furthermore, the regional stock exchange by building a bridge between demand and supply of capital would significantly cut the costs of financial intermediation, while offering higher returns to savers.

Hence, after some preliminary activities were conducted, the West African Regional exchange market (BRVM) and a clearing house, the Central Depository/Settlement Bank (DC/BR), on the 16th September 1998, had its regional nature confirmed by the listing on the 2nd October 1998 by the previously government-owned Senegalese telecommunications firms Sonatel (Lavelle, 2001: 734). Funding and technical assistance were provided by the Canadian International Development Agency and procedures were established by each state to locally promote the regional market, guarantee information dissemination and centralize orders' transmission.

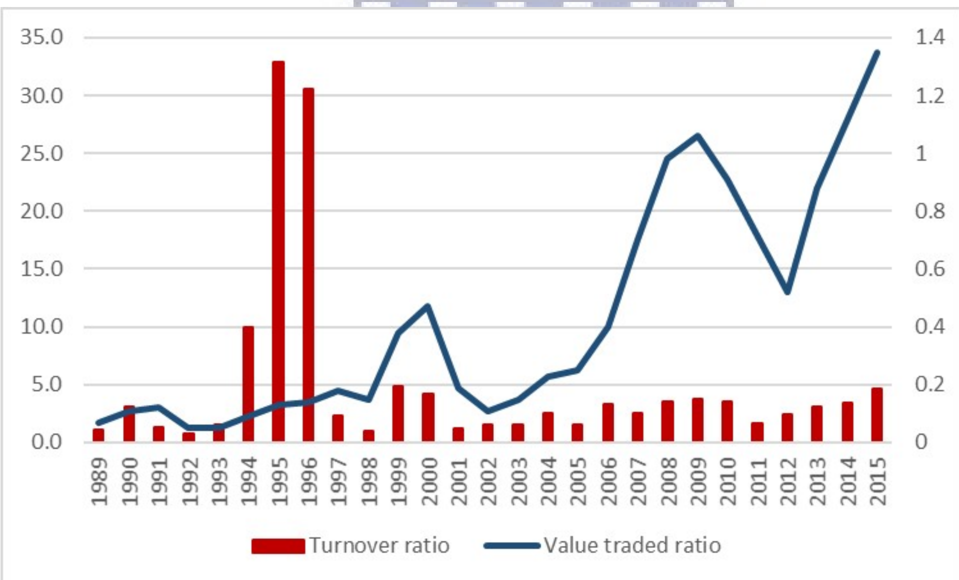
The Regional Council for Public Saving and Financial Markets (CREPMF), an oversight mechanism from the public sector, was also established to represent the general interest and thwart malpractice and fraud in the market (Lavelle, 2001: 734).

The bourse started by trading only on Mondays, Wednesdays and Fridays between 9:30 am and 10:30 am, with two sessions of fixing stock prices that decrease or increase by more than 7.5 percent in a session. The respective ministries of finance in each of the member states had the right to put limits on purchases which favoured local ownership during IPOs, even though there were no official investment limits with respect to foreign ownership (Lavelle, 2001: 734). Trading later migrated to daily sessions with the pre-opening call auction and continuous auction between 10:00 am and 10:30 am (Hearn and Piesse, 2010: 1013). The decentralized electronic quote system was launched in March 1999 with an electronic trading and competitive settlement system, as well as removed terminals set up in each of the licensed brokers (SGI). Of the 27 SGIs authorized to act on the market, 12 are based in Cote d'Ivoire, five in Senegal where the BCEAO is located, four in Benin, two in Burkina Faso, and one in each of the other WAEMU countries. In each country, a separate institution, Antenne Nationale de Bourse (ANB), is charged with handling the technical issues regarding the exchange activities and marketing (Hearn and Piesse, 2010: 1013).

In line with a new strategic plan drawn up with the principal objective to position the BRVM at the third place on the continent by 2021, trading was moved from daily fixing of quotation to continuous trading on the 16th September 2013. This move was made with the goal of increasing the number of trades and modernizing the market. In addition to all the possible benefits that could be associated with the improvement in trading conditions it was also envisioned that it would boost market liquidity, as well as indirectly impact the determinants of market liquidity (Ouattara, 2016: 2).

Settlement was tightened in July 2007, from a T+5 system (i.e. five days) to a T+3 system (i.e. three days). It is partially G30 compliant, and only a few well-capitalized international banks operate on the market. More specifically, this settlement occurs as receipt versus payment or delivery versus payment in same day funds, and is effected on T+3. It also entails the following elements: trades matching by brokers on T+1 (i.e. the day after deal date); confirming trade on T+2; net basis settlement of cash and stock; a central depository; international securities numbering system; and no securities lending. Hearn and Piesse (2010: 1013) highlight that the exchange does not offer institutional investors a great variety of opportunities for diversification, despite the intrinsic nature of its microstructure designed to maximize order flow in a region which is among the poorest in the world. Figure 1 below provides information in support of this argument. In effect, the average annual turnover ratio and the average annual value traded ratio in the BRVM between 1989 and 2015 show that the market remained highly illiquid over the years, despite the improvement done to the market's structure and functioning.

Figure 4.1: Annual liquidity in the BRVM (1989 – 2015)



Source: Data from Federal Reserve Bank of St Louis (2017)

Apart from the years 1994, 1995 and 1996 where the turnover ratio reached its values of 9.9, 32.9 and 30.6 percent respectively, the ratio has generally remained below the five percent mark, with the lowest value of 0.05 percent recorded in 1992. This substantial increase in liquidity in

1994 may be attributed to the return of flight capital as a result of the 50-percent devaluation of the CFA franc by the central bank in 1994 (Lavelle, 2001: 730). In 2015, the turnover ratio rose by more than 40 percent from 3.4 percent to 4.7 percent. In contrast, the value traded ratio, which is relatively small, followed an increasing general trend between 1989 and 2015, reaching its highest value of the period in 2015 at 1.35 percent.

4.2.3 Johannesburg Stock Exchange (JSE)

In 1887 several financial and mining houses were established after gold was discovered on the Witwatersrand. From this, the Johannesburg Stock Exchange (JSE) was born. The mission of the exchange was to assist the new mines and their financiers in raising capital to develop the mining industry and subsequently form investment companies (Samkange, 2010). Samkange (2010) argued that even though mostly non-mining companies are currently listed on the exchange, the riches of the gold mining industry are still reflected on the JSE, such as in the late 1800s, as the highest-ranking companies in terms of market capitalization are mainly mining companies. Between 1932 and 2014, the number of listed companies on the exchange grew from 151 mining, financial and industrial companies to 402 companies. From the mushrooming of listed companies worldwide, as well as on the JSE in the 1980s, two new categories of stocks were created. These are the Venture Capital Market (VCM) which is a listing of companies that undertake greenfield venture; and the Development Capital Market (DCM) catering for small companies with fewer requirements in terms of profits and company size (Moolman and Du Toit, 2005).

A restructuring program implemented in 1995 included the deregulation of the JSE effectively eliminating the restriction of membership to only South African citizens. This move opened the market to all types of investors, including legal persona, which led to an increase in trade volume as well as market liquidity. This can be observed in Figure 2, with a jump in turnover ratio from 5.9 percent in 1995 to 11.2 percent in 1996; as well as an increase in value traded ratio from 9.41 percent to 13.44 percent between 1995 and 1996. The exchange acquired the

South African Futures Exchange (SAFEX) in 2001; and 2003 saw the launch of an alternative exchange (AltX) incorporating small and medium sized listings that are not necessarily meeting the requirements of the main board (JSE, 2014). Following the launch of the AltX, an exchange for interest rate and currency instruments, called YieldX, was also launched, and the Bond Exchange of South Africa was acquired in 2009 (JSE, 2014). The JSE was demutualized and listed as a company on its own market in 2005. As a privately owned and funded entity, the JSE is administered by a Board of Directors, and acts under the licensing and regulation of two acts of parliament, namely the Stock Exchanges' Control Act, 1 of 1985 (SECA) which governs the equities markets, and the Financial Markets Control Act, 55 of 1989 (FMCA) regulating the derivatives' markets.

Five financial markets are currently offered by the JSE. These are the financial, equities, bonds, commodities and interest rate derivatives markets. The exchanges entered into a partnership with the FTSE Group and its equities trading model was aligned with the European model. Hence, its instruments were reclassified in line with the FTSE Global Classification system, renaming its index series the FTSE/JSE Africa Index Series, and its two benchmark indices the FTSE/JSE Top 40 Index and the FTSE/JSE All Share Index.

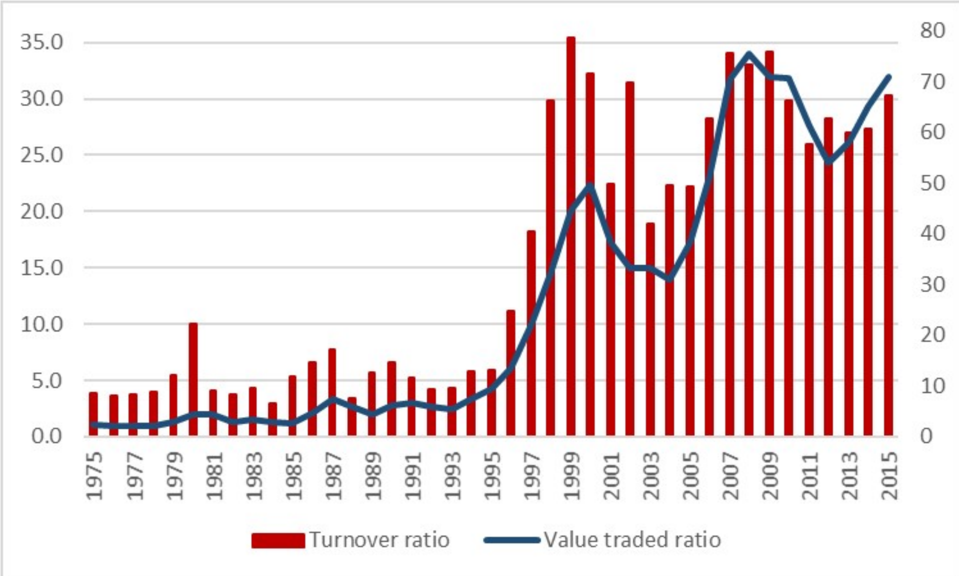
Following the international trend, open outcry floor trading ended on the JSE in 1996 making way for an upgrade to electronic trading on the JSE Equities Trading System (JET). Through this order-driven centralised and automated trading system, instructions are given for specific actions after publicly verifiable information, such as changes in price have been received. The orders are placed or executed against displayed orders by market participants who send electronic messages to the automated trading system. The price of the stock is then adjusted by an auctioneer until total order to buy and total orders to sell are equated (Samkange, 2010). As a central trading platform, multiple trading services are supported on the JET system, which represents a single method to capture both orders and quotes, while simplifying the swift execution and reporting of transactions.

In 2002, the JSE moved from the JET system to a system used on the London Stock Exchange (LSE), called Stock Exchange Trading Systems (SETS). The matching and trading engine of the exchange were thus housed at the LSE. However, a major change in the market structure of the JSE occurred in 2012 when the matching and trading engine was migrated away from the LSE and back to the JSE through the implementation of a more technologically advanced equity trading platform named Millennium Exchange (Hattingh, 2014: 1). This move effectively eliminated the considerable importance to the JSE and its market participants of the UK-SA connectivity links; and increased the speed of execution for market participants in the JSE central order book which became almost 400 times faster than the previous platform. Moreover, market participants gained a low latency advantage while the market attracted high frequency trading activity and operational stability (Hattingh, 2014: 1). The enhancement in trading volumes can be noticed in the jump in the value traded ratio from 54 percent in 2012 to 70.9 percent in 2015 (cf. Figure 4.2).

The exchange went further in its attempt to align itself to the standards of developed stock markets by introducing a colocation centre in 2014, aimed at providing faster access to all JSE markets and lowest latency connectivity for the reception of real-time data and trading (JSE, 2014). This arguably brought down the cost of equity for the listed companies as liquidity and information transparency improved (Zito, 2014: 4).

In terms of settlement, the manual settlement of script on the exchange was replaced by its central securities depository (CSD), the Share Transactions Totally Electronic (STRATE) system, an electronic settlement system aimed at mitigating risk, bringing efficiencies to financial markets as well as improving the country's profile as an investment destination (Samkange, 2010). The methodology, which is largely G30 compliant, introduced a rolling settlement on a T+5 basis until recently. In 2013, the JSE started a three-phase process to shorten its settlement cycle to T+3. The project completed its third and last phase in July 2016 with the official move to the T+3 settlement cycle (JSE, 2017). The instantaneous update of electronic records at the point of settlement guarantees the settlement of transactions on the specified settlement date. Hence, the risks of delayed settlement and loss of earning are effectively minimised as the relevant securities and cash accounts are credited or debited on the said settlement date (Samkange, 2010).

Figure 4.2: Annual liquidity in the JSE (1975 – 2015)



Source: Data from Federal Reserve Bank of St Louis (2017)

Even though the liquidity on the JSE is much higher than in other African markets, the JSE remains relatively illiquid in comparison to international exchanges such as the Shanghai Stock Exchange, Deutsche Boerse and the London Stock Exchange which can reach levels of liquidity as high as 155 percent (Hattingh, 2014: 2). It can be argued that the distinctive difference in liquidity levels between the South African exchange and its African counterparts may be attributed to the JSE's elaborate information dissemination system. In effect, the Stock Exchange News Service (SENS), launched in 1997, is the main platform operating on a real-time basis to disseminate listed companies' corporate news, or any price-sensitive information. The platform can be accessed directly from the JSE's website or through a subscription to a recommended data vendor.

However, the JSE's low level of liquidity compared to developed markets standards may be due to the greater participation by foreign investors on the JSE, the tendency of the largest South African companies to pursue primary listings on overseas exchanges such as the LSE and NYSE, the concentration of the number of South African institutional money managers, and the market concentration of the JSE (Gobodo, 2007: 2).

4.2.4 Nairobi Stock Exchange (NSE)

The Nairobi Stock Exchange (NSE) is the oldest and the most developed in East and Central Africa. It started trading in shares in the 1920's, while Kenya was still a British colony. At the time, trading was taking place on a gentleman's agreement with no physical trading floor. The Nairobi Stock Exchange was then formally founded in 1954, and was registered under the Societies Act (1954) as a voluntary association of stockbrokers charged with the responsibility of developing the Kenyan capital market and regulating trading activities. At the time, transactions were made by telephone and prices determined through negotiation (NSE, 2015). Between 1963 and 1970, the Kenyan government implemented a new policy with the primary goal of transferring economic and social control to citizens. Thus, by 1968 the number of listed public sector securities was 66 of which 45 percent belonged to the Kenyan government, 23 percent to the Tanzanian government and 11 percent to the Ugandan government. During this period, the NSE operated as a regional market in East Africa where a number of the listed industrial shares and public sector securities included issues by the Governments of Tanzania and Uganda (the East African Community) (NSE, 2015).

However, with the changing political regimes among East African Community members, various decisions taken affected the free movement of capital which ultimately led to the delisting of Ugandan and Tanzanian companies from the Nairobi Stock Exchange. In 1988, the NSE completed its first privatization with the successful sale of 20 percent of the stakes of the government of Kenya in the Kenya Commercial Bank; privatization which left the government of

Kenya and its affiliated institutions with 80 percent ownership of the bank (NSE, 2015).The Capital Markets Authority (CMA), a body in charge of promoting and facilitating the development of an orderly and efficient capital market in the country, was constituted in January 1990 through the Capital Markets Authority Act (Cap 495A) and inaugurated in March 1990. Consequently, the NSE was registered as a private company limited by shares and the trading of shares went from being conducted over a cup of tea, to the floor based open outcry system located in Nairobi (NSE, 2015). The Investor Compensation Fund was also established in 1995 with the purpose of indemnifying investors for financial losses arising from the failure of a licensed broker or dealer to meet their contractual obligations. The Association of Kenya Stockbrokers (AKS) was also formed by the members of the NSE, aiming at developing a code of conduct, upholding professionalism, establishing examinable courses for its members and facilitating communication with the CMA and the exchange (NSE, 2015).

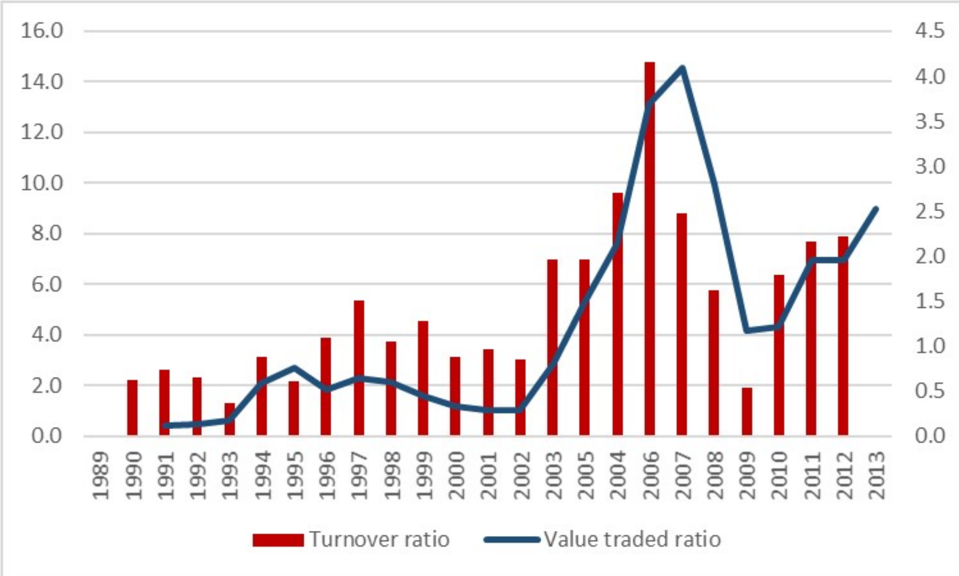
Moving from the call over trading system to the floor-based open outcry system in 1991 occurred at the recommendation of a joint study by the International Finance Corporation and the Central Bank of Kenya which argued that the conduct of brokerage business behind closed doors prevented the exchange from generating suitable public awareness and confidence in securities trading (Ngugi, 2003: 29). Thus, the call over trading system arguably was unable to guarantee that the best prices were obtained by buyers and sellers, as all trading interests were not exposed to one another. The new system gave brokers similar opportunities when bidding for stocks which boosted transparency and improved the way in which the rising trading activity was handled (Ngugi, 2003: 29). The NSE adopted live trading with an automated electronic trading system in September 2006. With this system, investors are allowed to make on-line trades of debts securities fully integrated with the settlement framework of the Central Bank of Kenya (CBK) for treasury bonds (NSE, 2015).

Flexible, scalable and efficient, the automated trading system was provided by the South African financial software development company Securities Trading and Technology Pty (STT) and is the same used by the Johannesburg Stock Exchange. Thus, in an attempt to make foreign-denominated bonds available on the exchange, the system offers the multicurrency trading functionality. Moreover, a 2-way-quote trading model depicting a market making ability is also supported by the system. This allows an integration of the system with the regulator's surveillance systems, as well as the reporting of transactions that are concluded over-the-counter for purpose of settlement (Minney, 2014).

The exchange initially employed a manual system of clearing and settlement. However, the NSE argued that the financial transaction period is lengthened by this system as transfers usually come into effect a week or two after the transactions occurred, except in the case of any unforeseen holdups (Ngugi, 2003: 31). The length of settlement period could have an adverse effect on the market's efficiency and liquidity, as a lot of time is wasted between the confirmation of trade and the actual sale. In the absence of a central depository system, stock market liquidity was therefore inhibited. This argument gave rise to the idea of establishing a Central Depositing system that took effect in the early 2000s. With the CDS, electronic transfer of ownership was expected to be facilitated by eliminating physical movement of certificates which would thus minimize the settlement period as well as systemic risk, and eventually raise trading volume (Ngugi, 2003: 31). The exchange also made the move from a manual to an electronic and centralized settlement clearing.

Clearing, delivery and settlement services for securities traded are provided by the Central Depository and Settlement Corporation Limited (CDSC) which supervises the conduct of Central Depository Agents, including stockbrokers and investments banks which are associated with the NSE and Custodians. A settlement cycle of T+3 (with T being the trade date) was adopted by the exchange in July 2011. This means that the settlement takes place three business days after the trade was made. Trades take place from Monday to Friday, with pre-opening time from 09:00 to 09:30 (GMT+3), followed by auctions at 09:30 and official opening of the market at 09:31. The exchange stops trading and closes at 15:00. Thus, settlement can also happen from Monday to Friday with the ownership right to securities being transferred to the holder on the settlement date (NSE, 2015).

Figure 4.3: Annual liquidity in the NSE (1989 – 2013)



Source: Data from Federal Reserve Bank of St Louis (2017)

Despite the series of technological improvements in the exchange coupled with regulatory reforms, the Kenyan exchange remains relatively illiquid compared to international standards, and even compared to some of its African counterparts, such as the JSE. From Figure 4.3, it can be seen that although annual liquidity in the NSE, in terms of the turnover ratio and the value traded ratio, generally followed an upward trend between 1990 and 2007, its highest level was reached at 14.8 percent for the turnover ratio in 2006 and 4.1 percent for the value traded ratio in 2007. One could be tempted to attribute the steep increase in liquidity between 2002 and 2007 to the launch of the CDS in the early 2000s, and the peak in liquidity in 2006 and 2007 to the adoption of the live trading with an automated electronic trading system in September 2006. However, there was a sharp drop in liquidity in subsequent years until 2010 when the increasing trend resumed. Moreover, despite the shortening of the settlement period to T+3 in 2011, there was no substantial increase in liquidity during subsequent years.

According to Ngugi (2003: 37), the low level of liquidity in the secondary market as well as the low supply of stocks for trading could be explained by the level of foreign participation in the domestic market over the years. In effect, the level of foreign inflow in the domestic market, which was performing remarkably well in the year following the opening of the market, saw a considerable decline in 1997 and even recorded a net outflow of 42 percent in 1998. The distribution of share ownership appears to be skewed with the majority of shares owned by local investors. Ngugi (2003: 37) also highlighted that in an analysis of 57 percent of listed companies on the NSE, 50 percent of the shares are held by the top 20 shareholders which represents six percent of the total share ownership. However, examining trading volumes showed that minority shareholders dominated activities on the secondary market. Thus, the top 20 shareholders seem to show more interest in dividend income to capital gains, and are not active in the secondary market.

In addition to measures such as the automation of the trading and settlement system, the introduction of the CDS and the shortening of the settlement cycle aimed at making the process of price discovery more efficient, and improving market liquidity, it is also believed that by establishing an East African Regional Capital Market, a greater pool of financing can be made available to companies, facilitating the cross-border listing of shares, improving risk diversification and raising liquidity (Ngugi, 2003: 37).

4.2.5 Nigeria Stock Exchange (NGSE)

Established in 1960 as the Lagos Stock Exchange, it began operations in June 1961 with 19 listed securities of which 10 were industrial loans, six were federal government bonds and three were equities (Ozaze, 2011). In an attempt to give contributors some protection in case of temporary unemployment, invalidity or old age, the National Provident Fund, a compulsory contributory savings scheme, was founded in 1961. A requirement from the Fund's Act was the investment of surplus funds solely in Nigerian securities approved by the Trustee Investment Acts of 1957 and 1962. Investment was also restricted to shares issued or created by or on behalf of the federal government (Ozaze, 2011). The mushrooming of the Nigerian capital market highlighted the need for a high institution to monitor activities and informed the installation of the Capital Issues Committee simultaneously to the enactment of the Trustee Investment Act and the Exchange Control Act. The Capital Issue Committee was also given the power to employ sale or subscription offers in determining the timing and price of new securities' issues (Ozaze, 2011).

The exchange was rebranded as the Nigerian Stock Exchange in 1977 and the establishment of branch exchanges was recommended. Hence, the period from 1978 to 2002 saw the establishment of six new trading floors across the country. In 1978, the Capital Issues Commission was replaced by the Securities and Exchange Commission with the scope of activities also being expanded to establishing multiple exchanges in the country as well as approving securities allotments (Ozaze, 2011). In 1985, the requirements of small and medium size companies were accounted for through the establishment of the Second-tier Securities Market (SSM) on the Nigerian Stock Exchange. This move was made in a bid to expand the market by diluting the requirements for listings and encouraging small and medium sized companies to list on the exchange.

The Nigerian Enterprises Promotion decree 34 was passed in 1987 to allow the issuance by public companies listed on the NGSE of non-voting paid-up equities open to subscription from Nigerian citizens and non-citizen, as well as residents and non-residents (Ozaze, 2011). The following year, the process of increasing the number of companies listed on the NGSE was engaged through the passing of the Privatisation and Commercialization decree 25, making provision for the privatisation of some partially government-owned companies as well as the sale of some fully government-owned companies. Legal issues such as insider trading, acquisitions and mergers, reconstructions, unit trusts, securities registration and allotment, prospectus, and invitation of the public to offers, are dealt with by the Companies and Allied Matters Act (CAMA) of 1990 (Ozaze, 2011).

Following the 1991 recommendation by the Inter-ministerial Committee on the Nigerian Capital Market, an official central clearing and depository of the exchange, the Central Securities Clearing System (CSCS) was incorporated in 1992. Its mandate included the implementation of a computerized stock exchange management system which focuses on immobilizing share certificates in a Central Depository (Ozaze, 2011). With the official deregulation of the Nigerian capital market in 1993, the official timing, pricing and allotment of stock issues were terminated and the issuing house were put in charge of performing these functions. The mission to examine stockbrokers, licence stockbrokers and dealers, and monitor stockbrokers' conduct was entrusted to the Chartered Institute of Stockbrokers, also established in 1992 (Ozaze, 2011).

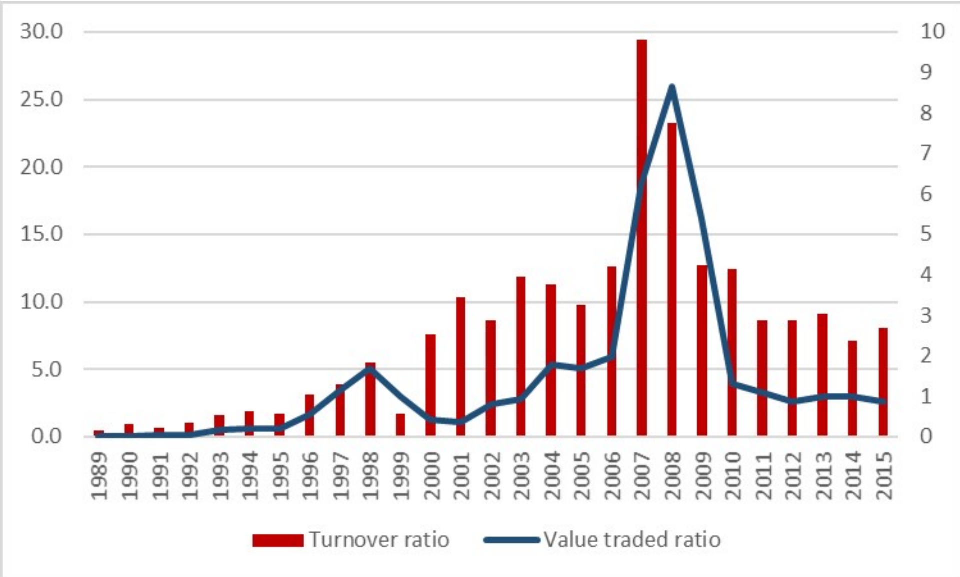
To ensure transparency and the resolution of disputes among market participants in a flexible, speedy and effective manner, the Nigerian Minister of Finance installed the Nigerian Investment and Securities Tribunal in 2002 (Ozaze, 2011). Moreover, the SEC introduced the Code of Corporate Government in 2003 as a persuasive tool for listed companies to enforce international best-practice codes in financial reporting, such as investor protection, accountability, transparency, accuracy, and appropriate disclosure. Additionally, a Memorandum of Understanding was signed between the Nigerian SEC and its Ghanaian counterpart to facilitate information dissemination between authorities in charge of enforcing security laws and regulations (Ozaze, 2011).

In 1999, the open outcry trading system was replaced by the Automated Trading System (ATS). This new system represents an arrangement by which participants trade through an on-line network of computers automatically and in real-time. Trading is executed daily on an electronic continuous auction system between 10:00 and 14:30. The ATS platform has a central order book allowing for dealers' participation on equal footing, with competition on the hierarchical basis of price, cross and time priority (NGSE, 2017). The exchange operates a hybrid market, where licensed dealers are allowed to submit orders, and market makers (i.e. a number of broker-dealers selected by the NGSE) can submit continuous two-way quotes (i.e. bid and ask) for the securities that they are in charge of. The NGSE (2017) argues that this process, which is called Market Making, provides some benefits to both the market and its participants, such as improvement in the price discovery process by anchoring intra-day, opening and closing auctions; competition for customer order flow through the provision a two-way quotes that is sometimes better than the bid or offer; deepening of the market; reduction in regulatory and transaction fees; less impact of price fluctuation on the market; and improved market liquidity, which facilitates entry and exit.

By automating its trading system, the NGSE also effectively improved settlement efficiency by shortening the settlement cycle from T+2 weeks to T+3 days. With the creation of the CDS in 1992 and the employment of international custodian banks, the NGSE settlement system is partially G30 compliant.

Although the NGSE is the largest exchange in West Africa, with 234 listed companies as of 2010, it still presents some complexities arising from globalization trends as well as the rising variety of new instruments traded (Ogunrinola and Motilewa, 2015: 2). It could be tempting to claim that the full spectrum of the Nigerian capital market has been insufficiently active considering the age of the market, the country's existing institutions as well as the country's considerable financial resources. However, the capital market has recorded poor performance over the years, which has been exacerbated by the poor state of the Nigerian economy in recent years and the global financial crisis (Ogunrinola and Motilewa, 2015: 2). Investors and market participants have been concerned mostly with low market liquidity. In effect, compared to international standards, and also compared to other Sub-Saharan African markets such as the JSE, market liquidity in terms of both the turnover ratio and the value-added ratio, has been relatively low between 1989 and 2015. Figure 4.4 shows a general upward trend in turnover ratio from 1989 to 2007, and in value-traded ratio from 1989 to 2008. After reaching their highest values in 2007 and 2008 respectively, both ratios have shown a generally downward trend until 2015.

Figure 4.4: Annual liquidity in the NGSE (1989 – 2015



Source: Data from Federal Reserve Bank of St Louis (2017)

According to Ogunrinola and Motilewa (2015: 11), the macroeconomic environment in which the stock market operates should enable it to reach its full potential. That is why productivity in the public sector as well as the private sector should be stimulated through sustained efforts, as the services of stock markets have a derived demand. Hence, demand for the market's services will increase, and higher liquidity will be encouraged. Moreover, the government should put in place a regulatory framework that is dependable enough to actively surveil the market. It is believed that this framework would boost investors' confidence in the market (Ogunrinola and Motilewa, 2015: 11). Government should also draw up policies that enhance participation in stock market activities and discourage buy-and-hold strategies. Additionally, Ogunrinola and Motilewa (2015: 11) recommend the enhancement of the propensity to trade in securities by keeping the cost of transactions on trading floors as low as possible and improving confidence in the NGSE. These measures could contribute considerably to increasing market liquidity.

4.2.6 Conclusion

From the above discussion, it can be seen that considerable efforts have been made by African markets to position themselves at the same rank as their developed counterparts. These efforts include restructuring the market structure through the establishment of central depository systems as well as supervisory and monitoring institutions. Technological innovations have also been embraced through the adoption of automated electronic trading and settlement systems and the switch to a shorter settlement cycle. However, despite all these improvements coupled with the implementation of regulatory reforms aimed at protecting investors and improving information dissemination, the markets in Sub-Saharan Africa remain small and highly illiquid. With the exception of the JSE, which is the biggest in the region in terms of market capitalization and the most liquid in terms of turnover ratio and value traded ratio, the three other Sub-Saharan African markets in consideration in this study remain small and relatively illiquid with both the turnover ratio and the value traded ratio at less than 10 percent as of 2015.

In addition to the measures already taken, it is believed that increasing market liquidity in Sub-Saharan African markets could be achieved by promoting and encouraging a wider range of product in market segments through improved regulations (JSE, 2014). Moreover, the products and documentations on the markets should be standardized in order to follow international benchmarks and to conform to international norms. Furthermore, there should be a reduction of transaction costs and agencies/brokers fees in order to encourage investors as well as companies to list on the exchange. Finally, in the case of the smaller exchanges, it is believed that the establishment of regional markets would contribute to the creation of a greater pool of financing for companies, the facilitation of cross-border listing of shares, the enhancement of risk diversification and the increase in market liquidity.

4.3 LITERATURE REVIEW

4.3.1 Introduction

The study aims to investigate the determinants of stock markets' liquidity in Sub-Saharan Africa. This section will thus review the theory underlying the notion of market liquidity and its determinants; as well as the empirical studies already existing on the topic. The structure is as follows. Section 4.3.2 presents the theoretical literature on the liquidity concept. Section 4.3.3 gives a review of the empirical literature. Finally, Section 4.3.4 provides a conclusion to the chapter identifying the gaps in the reviewed literature and the measures taken in this study to counter the identify weaknesses.

4.3.2 Theoretical literature

Wuyts (2007) defined liquidity as the ease with which traders are able to buy or sell large numbers of stocks without considerably affecting the price. The author argued that four interacting dimensions are involved in this notion, namely spread, depth, resiliency and immediacy (Wuyts, 2007). In addition, some other design elements pertaining to the trading system were also considered, namely transparency, anonymity and the presence of a trading floor. In effect, the concept of market liquidity differs from the idea of funding liquidity[1] of market makers or cash flow liquidity[2] in a bank. The literature identifies a number of factors determining the behaviour of liquidity across equity markets, as well as individual stocks. These factors are based on market and macroeconomic indicators, trading systems and regulations (Muktiyanto, 2015: 45). The effects of these drivers could be transmitted through various channels which are grouped into three hypotheses: market microstructure, structure conduct performance and seasonal regularities. Generally, the similarity of these theories lies in their extension of classic

[1]Funding liquidity refers to the ease with which market traders can secure funding (Brunnermeier and Pedersen, 2008:1)

[2]Cash flow liquidity refers to the bank's ability to repay its debts from generated cash funds.

finance theory assuming that markets are perfect and frictionless[3]. However, their principal characteristics rest on the corresponding agreement that the market structure impacts the interactions among the various market elements, and that the market is frictionless. Thus, each structure has an impact on equilibrium results like market performance or efficiency, and asset price (Muktiyanto, 2015: 46). The following sections will present the three hypotheses.

Market Microstructure Theory

According to the modern theory of market microstructure, trading is an interaction between liquidity suppliers and liquidity demanders. The former states either an offer price at which they would sell a particular security or a bid price at which they would buy it; while the latter accepts the offer price to buy the security or the bid price to sell it. On the liquidity supplier's side, liquidity is crucial as it characterizes the quantity, profit and time of a trade. On the liquidity demander's side, it represents the quantity, cost and time of a trade (Holden, Jacobsen and Subrahmanyam, 2014: 266).

O'Hara (1995: 1) defines market microstructure as the study of the effect of specific trading mechanisms on the price determination process. Contrary to the traditional Walrasian theory, which assumes that there is no friction in the market and that participants are free to enter, the market microstructure theory addresses the frictions that are involved in the transformation process of demands into prices. The idea governing the microstructure theory, initially introduced by Garman (1976), is that the trading process is at every step influenced by different frictions, such as individual behaviour, market structure, market conventions and trading rules. The market microstructure theory contributes substantially to the description of the effect of various rules on market structure, which in turn impacts price formation, as well as market quality and liquidity.

[3]In a frictionless market, sellers and buyers are able to trade an infinite number of assets without impacting the price. Moreover, there are cost-free transactions and no restrictions on the trade of assets.

Essentially, the market structure which is seen as "the black box" of the market aims to organize, process and transform the orders into transactions, based on the rules and regulations of the market. Thus, the cost of transaction is significantly impacted by the selection of the market structure (Muktiyanto, 2015: 47). That is why trading strategies that efficiently handle the cost of transactions have to be conducted by investors. Consequently, factors such as liquidity, execution time and order type are incorporated into modern trading systems through the use of complex algorithms. This is in an attempt to minimise costs in lieu of taking advantage of profitable trading (Muktiyanto, 2015: 47). The market microstructure encompasses two fundamental paradigms which illustrate the influence of market frictions on liquidity. These paradigms are the inventory model and the information-based model.

Inventory model

The focus of this model is the stochastic nature of demand and supply. It is based on the central assumption that the provision of liquidity to public investors is principally governed by the role of dealers (O'Hara, 1995: 13). In situations where buyers' and sellers' needs do not converge, dealers are introduced into the market as intermediaries, selling securities that were previously bought from the sellers to the buyers. On the other hand, the dealers' own inventory may be sold and re-acquired at a later stage. Dealers thus have a mission to bridge the time gap between transactions, a function that can effectively be performed by maintaining a certain level of inventory which causes opportunity costs (Muktiyanto, 2015: 48). According to Demsetz (1968), similar to retailers and wholesalers, a sufficient level of margins has to be set by dealers in order to cover the costs of sustaining inventory, to hedge against unwanted inventory and to create profit. The margins are set based on the spread between selling and buying price. Hence, trades cannot be settled by a single market price; and in serving the immediate supply, the bid and ask prices will be dynamically adjusted by dealers. To obtain a positive margin, dealers should set an asking price that is higher than the bid price. In such cases, bid-ask spread will be adjusted in service of the markets and for the swift completion of transactions (Demsetz, 1968).

From Smidt's (1971) arguments, the variations in inventory level create a need for dealers to actively adjust the stock price. In cases of high inventory level, the higher risk created by holding the extra inventory makes dealers disinclined to accumulate additional inventories. In a bid to entice more buyers and liquidate the position, dealers have to set lower ask prices. By doing so, they effectively reduce their unwanted position and return to the optimum level (Smidt, 1971). However, if inventory level held by dealers is lower than the optimum level, higher bid prices will be posted, attracting more sellers and reverting positions back to the optimum point. Therefore, setting the right price gives dealers the ability to circumvent the accumulation of unwanted positions as well as increase the inventory turnover (Smidt, 1971).

Garman (1976) built on Smidt's (1971) idea by developing a model examining the relationship between inventory level and the quoted price. By including the capital limitation as an independent factor affecting how dealers can act as sellers or buyers, the temporary imbalances created by stochastic order arrivals and the market clearance of stochastic flows are addressed. According to this model, a large trading will lead to a deviation of the price from the current price, the equilibrium will be recovered at a later stage; and transitory price variations will be reduced by the resulting rise in capital (Garman, 1976).

Another model developed by Stoll (1978), in which the bid-ask spread is adjusted by dealers after inventory levels deviate from optimum, assumes that an optimal level of inventory is set by dealers according to their risk return preferences. Thus, the model includes optimisation problems and the risk return preferences therefore depend on the central traits of the stocks. According to each dealer and each stock, there is a variation in the estimated optimum inventory level from where the variations in bid-ask spread across stocks quoted by various dealers (Stoll, 1978). There could be a deviation of optimal level of inventory to a sub-optimum level after a transaction. As a result, quotations subjected to the adjusted bid-ask spread are posted by the dealer who attempts to revert its position to optimum. To summarize, as the fluctuations in inventory exacerbate the risks of holding inventory, market liquidity will be affected through the adjustment of the bid-ask price by dealers.

Information-based model

Initially mentioned by Bagehot (1971), the model posits that informed traders, assumed to hold private information about the fundamental value of the asset, generate losses for market makers, while uninformed traders, assumed to have other motives for trades such as liquidity needs, make profits for market makers. Thus, ask prices that are higher than bid prices have to be set by market makers in their attempt to avoid a consistent loss of money. Since distinguishing between informed and uninformed traders is virtually impossible, all traders take advantage of the spread. Therefore, the bid-ask spread is a result of information asymmetry, while it would exist without explicit transaction costs, even in competitive markets (Bagehot, 1971).

When assuming that there can be three categories of traders, namely uninformed traders, informed traders and market specialists, another model was presented by Glosten and Milgrom (1985) explaining price formation depending on information asymmetry. The bid-ask spread is determined by the dealers' (also considered uninformed traders) reliance on the observation of past trading activities as their trading strategies. Since they are unable to differentiate informed traders from uninformed ones, the bid and ask quotes are set to sufficiently cover any loss incurred from informed traders' transactions (Glosten and Milgrom, 1985). As new information becomes available from trade to trade, the quotes are constantly updated and the increased information in prices leads to a drop in the bid-ask spread over time. When the probability of trading with informed traders is high, higher bid-ask spread will be set.

An identified flaw in Bagehot's (1971) and Glosten and Milgrom's (1985) models is the assumption that traders enter only one transaction and no subsequent trade is made, preventing the price impact that creates large volume transactions. Kyle (1985) addressed the issue by introducing a frequent participation of traders in the model, as efficient and effective trading strategies are required. The model includes the assumption that informed traders possess detailed knowledge of stocks' volatility; while orders by uninformed traders are posted regardless of the stocks' true value. While trading with both informed and uninformed traders, market makers set market clearing prices as a linear function of net order flow, especially when anticipating aggressive trading from informed traders. Order accumulation of uninformed and informed traders is also combined. As a result, the optimal quantity to trade must be chosen by the market makers depending on the rational conjectures about market liquidity variables (Kyle, 1985).

If new information becomes available, informed traders will base their transactions on information signal, while uninformed traders may decide not to trade regardless of the new information. A decision from the latter to refrain from trading will slow down the trading process. As a result, informative events are comprised in the time between trades (Easley and O'Hara, 1992). To summarize, conversely to the inventory model which argues that the effect of changes in inventory level on price is only temporary, the information-based model posits that the impact of information on prices is permanent. According to this model, the bid-ask spread is dependent on the information quality of insiders, the supply and demand elasticity and the information on order arrival.

Structure-Conduct-Performance (SCP) Paradigm

Mason (1939) and Bain (1951) were the main instigators of public policy on industry structure and companies' behaviour, which include the SCP paradigm. This model constitutes a theoretical basis in the practical implementation of the economic theory of market models. The model's argument is that the structure of the industry (i.e. the firms' industry concentration) has a considerable influence on the firms' price policy and market control. Generally, the SCP model posits that the structure of the market and the way in which it behaves have a degree of influence on the firm's performance and market efficiency (Caves, 1987). Contrary to the traditional view of industrial organization, real world frictions, namely trading cost, barrier to entry and limited information are considered in the SCP paradigm. The notion of industry concentration creating higher economic profitability is supported by two channels. The first argument is the one by the market concentration hypothesis which stipulates that, irrespective of the firm's efficiency greater market concentration will produce better market performance and increase market power. Secondly, a firm's performance is based on its efficiency, as asserted by the efficient structure hypothesis. In other words, since a leading firm has higher efficiency and greater competitiveness, it is in a position to dominate the market and earn higher profit. Consequently, the firm's collusive conduct leading to market concentration is not the cause of its performance. Instead, the performance is attained through its cost advantage which allows the sale of the firm's products at a lower price, as well as the acquisition of a bigger share of the market (Muktiyanto, 2015: 51).

Generally, the focus of the studies on the SCP paradigm has been on the effects of market structure on the profit levels of firms or a society's welfare. However, recently interest has grown toward the economic relationship between financial economic attributes and industrial organisation theory. In theory, the markets' stock prices will be impacted by the level of competitiveness of firms. On the basis of the firms' competitiveness, the decision to set a price or to invest in advertisement cost will be determined, which in turn will impact the firms' future cash flow (Muktiyanto, 2015: 52). In other words, the stronger the firms' market power, the more stable the future cash flow generated by the firms. Thus, the return on stocks tends to be lower, as the volatility of stock prices would be lower. With a lower volatility in return and a more stable cash flow, there is less impact on the market which is also more liquid. The integration of private information into stock prices is accelerated by the greater trading volume of stocks belonging to firms which have market monopoly. This also leads to the improvement of these stocks' liquidity (Muktiyanto, 2015: 52).

To sum up, the SCP paradigm argues that leading firms are permitted to improve their future cash flow through industry concentration. Since higher market power is derived from monopoly, higher stock trading volume will be registered by the firms, while private information on stock prices is swiftly incorporated and market liquidity increases (Muktiyanto, 2015: 52).

Seasonal Regularities

The existing body of empirical studies contains a considerable amount of evidence of the existence of seasonal regularities in stock returns in cross sectional, as well as time series observations. Because these findings are generally in contradiction of existing central hypothesis and paradigms, they are often classified as anomalies to the traditional theories. It is the case of seasonal regularities such as the January effect or the holiday effect that are not consistent with classical finance theories such as the efficient market hypothesis.

Schwert (2003: 940) argues that anomalies can fundamentally only be characterized relatively to a model of "normal" return behaviour. That is, they are considered empirical results showing market shortfalls (or profit opportunities) in the underlying asset-pricing models. Fama and Malkiel (1970) had an early argument on this point positing that by testing market efficiency, a joint test of the maintained hypothesis of equilibrium expected asset returns. Therefore, a conclusion of market inefficiency may usually present evidence of the inadequacy of the underlying asset-pricing model.

Michaud (1999: 5) explains that while there is a wide acknowledgment of the existence of considerable links between stock factor and ex post risk-adjusted return, there is a high controversy regarding the interpretation of their economic significance. For investment management, the crucial questions are concerned with the economic significance and persistence of the factors. Similarly, controversy arises from the effectiveness of style analysis. That is, in cases where capitalization or book-to-price ratio is found to be economically insignificant, or if stronger economic significance is found in other factors, there may be limited value in using traditional two-factor style analysis (Michaud, 1999: 5).

The underlying rationales for the anomalous factor-return relationships are the basis for the perception of these relationships' economic significance and persistence. According to Michaud (1999: 6), there are at least nine underlying rationales explaining the factor-return relationships, two of which are consistent with economic significance and market inefficiency. These rationales are the irrational investor behaviour hypothesis and the ephemeral inefficiencies.

The irrational behavioural hypothesis is seen as an optimistic rationale for the economic significance of anomalous factors (Michaud, 1999: 6). This hypothesis is based on the view that irrational or naïve investor behaviour may be the cause of market anomalies. A naïve investor is identified by their overreaction to price variations and information, their extrapolation of past growth too far ahead, their lack of consideration for firm fundamentals when riding stock price trends, or their lack of regard for prices when focusing on firm fashionableness and attractiveness. If such behaviour is prevalent enough, more sophisticated and rational investors using disciplined and contrarian strategies may be provided with risk-adjusted profit opportunities. Moreover, there may be persistence as a result of the inherent unfashionableness of many anomalies, as well as the fact that a small number of sufficiently rational investors exist that keep using contrarian strategy despite the widespread market sentiment (Michaud, 1999: 6).

For several investment practitioners and some early researchers, the favoured interpretation of a market's anomalous return factors is based on the idea of ephemeral inefficiencies. That is, anomalies may be an indication of episodes of informational inefficiency in capital markets. Because of the lack of fundamental rationale, reliable persistence of anomalies over time is improbable. Additionally, it is argued that after the identification of an anomaly, it may become widely used, hence losing its effectiveness (Michaud, 1999: 6). However, there is still evidence of a relatively long-lasting persistence of some market anomalous factors.

4.3.3 Empirical literature

Over the past decades, various studies have provided a general understanding of market liquidity. However, very few have turned their focused on investigating the drivers of equity market liquidity in developing countries.

Chordia, Sarkar and Subrahmanyam (2001) previously studied the common determinants of U.S. bond and stock market liquidity, as well as the impact of financial crises monetary policy and mutual fund flows on the liquidity of the markets. The study was conducted over the period 1991-1998. They found that returns, bid-ask spreads and volume in one market affect the bid-ask spread and volume in the other market, leading to the conclusion that liquidities in both stock and bond markets are codetermined (Chordia *et al.*, 2001). Moreover, during normal periods, stock market liquidity changes, measured by changes in stock bid-ask spreads, are positively affected by the lagged money flows into stock mutual funds. This is, however, not the case during periods of crises (Chordia *et al.*, 2001).

Later, Chordia *et al.* (2004) extended their earlier analysis of the determinants of U.S. stock and bond liquidity measures to specific drivers, namely returns, return volatility as well as trading activity, during the period 17 June 1991 – 31 December 1998. In this model, liquidity was measured by the daily average quoted spread and the daily average bid and ask depths in shares. Trading activity was measured by the daily order imbalance in lieu of volume as it is argued that it bears a stronger link to trading costs, representing aggregate pressure on market makers' inventories (Chordia *et al.*, 2004: 4). The results of the VAR analysis showed evidence of similar weekly regularities in both stock and bond market liquidity, with the highest liquidity recorded on Tuesdays and the lowest liquidity recorded on Fridays in both markets. Higher liquidity was also recorded between July and September, while lower liquidity was recorded in October, in both markets. Chordia *et al.* (2004: 28) also found volatility to be an essential driver of bond and stock market liquidity as there is a persistent effect of shocks to volatility on spreads in the markets. In addition, liquidity and volatility shocks were found to be generally systemic in nature, since there is a positive and significant correlation between volatility and unexpected liquidity shocks across markets.

Interestingly, Bortolotti, De Jong, Nicodano and Schindele (2004) investigated the spillover impact of privatization on market turnover and liquidity in 19 OECD economies over the period 1985 – 2000. To measure privatization on public equity markets, daily stock prices, value of trades and market capitalization were collected for each of the 228 privatized companies included in the sample, as well as for the market as a whole. This information was used in the construction of monthly series at country level of six privatization measures. Liquidity was measured using the turnover ratio to capture trading intensity, and Amihud's (2002) illiquidity ratio to capture the price impact. The model also includes some control variables, namely market size as measured by the log of the total number of listed firms; country risk; capital market integration as captured by a dummy variable equal to one from 1992 onwards (i.e. the year the Maastricht treaty was concluded) for the European Union countries; openness of trade as measure by the ratio of the sum of exports and imports to GDP; launch of the Euro as measured by a dummy variable equal to one from 1999 onwards; and insider trading as measured by the indicator for the enforcement of insider trading regulations as posited by Bhattacharya and Daouk (2002) (Bortolotti *et al.*, 2004: 18). After conducting a two-stage least square (2SLS) analysis, Bortolotti et al. (2004: 25) found that the liquidity of individual private firm's stocks, as well as stock market liquidity as a whole are enhanced by privatization, since a positive spillover effect is created by privatization on the price impact of non-privatized shares. Moreover, Bortolotti *et al.* (2004: 26) argued that improvements in market liquidity that are linked to privatization are also driven by the positive externalities imposed by share issue privatization on the domestic market in addition to the boost in privatized stocks' liquidity. Additionally, since the adverse selection component of the price impact is reduced by retail investors who raise uninformed trading, their participation in privatization was also found to be a crucial element in improving market liquidity (Bortolotti *et al.*, 2004: 26).

Choi and Cook (2005) examined the relationship between financial market liquidity and the macroeconomy in Japan between 1990 and 2001. Using Pastor and Stambaugh's (2003) measure of U.S. equity markets' liquidity to measure the Japanese aggregate stock market liquidity, the authors used a VAR methodology including variables such as real activity, measured by an economic activity/production index; the uncollateralized overnight call money rate; real money demand, measured by the logarithm of the ratio of M2 plus cash deposits divided by the core CPI; and financial wealth, measured by the log of the Topix stock market index. Choi and Cook (2005: 23) found that firms' equity returns were impacted by liquidity shocks during the crash that resulted from the bursting of the Japan's bubble in the late 1980's. Moreover, the results identified higher exposure to liquidity shocks in the case of firms with illiquid markets for their equity and illiquid balance sheets. This was interpreted as a correlation between liquidity shocks to the stock market and liquidity shocks in broader financial markets which include credit markets. The results of the analysis also showed that simultaneously to the international financial shocks such as the September 1998 and September 2001 ones, there were great drops in market liquidity. A series of bankruptcies of financial intermediaries, such as financial firms, were found to occur simultaneously with the large initial drops in liquidity (Choi and Cook, 2005: 24). Finally, stock market liquidity is reduced by exogenous negative business cycle shocks. This implies that monetary authorities may revert to reducing interest rates in order to stabilize aggregate demand in situations of liquidity shocks (Choi and Cook, 2005: 24).

Kim, Jain and Rezaee (2006) investigated the determinants of market liquidity in the period before and after the Securities and Exchange Commission in the U.S enacted the Sarbanes-Oxley Act (SOX) of 2002. The act, passed as a response to the series of financial scandals that occurred at the turn of the 21st century, was aimed at improving the trustworthiness of public financial information, strengthening corporate governance, audit functions and financial reporting in order to prevent further financial scandals, as well as raising criminal penalties for corporate misconduct (Kim *et al.*, 2006: 1). For the sample period 1 January 2001 – 31 December 2004, the authors estimated a regression which included the percentage quoted spread as the liquidity measure and the dependent variable. The exogenous variables included a dummy indicator variable for financial scandals, a dummy indicator variable for the SOX; and a set of firm-specific and microstructure events control variables such as a dummy variable differentiating the period before and after the opening of the NYSE limit order book to the public, the inverse of the stock's last trade price at the time of the quote, the daily trading volume and the firm size (Kim *et al.*, 2006: 15).

The results of the analysis found that market liquidity deteriorated significantly following reported financial scandals, which implies a loss of market participants' confidence in the process of financial reporting. Moreover, there was a rise in depth and a fall in the adverse selection component of spreads following a decline in SOX spreads (Kim *et al.*, 2006: 17). According to Kim *et al.* (2006: 17), this implies that the passing of the SOX and implementation of the SEC rules successfully improved market liquidity by re-establishing long run normalcy in the financial markets and enhancing investors' confidence in financial information.

In their study of how the raising of capital and trading by firms on international markets can affect stock market liquidity, Levine and Schmukler (2006) built a daily and annual panel database of around 2 900 firms from 45 emerging markets, for the period 1989 – 2000. The yearly turnover (i.e. value of a firm's transactions divided by the firm's market capitalization), commonly used as a proxy for liquidity, was interpreted as a general index of trading activity. Two indicators of liquidity were also built using daily data. These are Amihud's (2002) illiquidity index (i.e. the ratio of a stock's absolute returns to its value traded) and the zero-return index (i.e. the proportion of days in a year when there are no changes in the price of the stock). After estimating regressions including country and year effects and using Newey-West standard errors, Levine and Schmukler (2006: 26) found that domestic market liquidity is negatively impacted by internationalization. This conclusion which is largely in line with the two-part migration-spillover view of internationalization, suggests that the cross-listing or issuance of depositary receipts of a firm's stock in an international market leads to a migration of the trading of the firm's stocks from the domestic market to the international market.

Similar to Chordia *et al.* (2000), Goyenko and Ukhov's (2009) study aimed at establishing a linkage between U.S Treasury bond and stock markets using a VAR analysis framework. The study, covering the period July 1962 – 2003, considers and analyses bond illiquidity of different maturities (i.e. short, medium and long term) separately. The measure of bond illiquidity used in this study is the relative quoted spread, while Amihud's (2002) illiquidity measure is used to measure stock market illiquidity (Goyenko and Ukhov, 2009: 195). Market return and return volatility are also included in the models. Goyenko and Ukhov (2009: 195) also investigated the impact of monetary policy on the bond and stock illiquidity by including macroeconomic variables such as the federal funds rate, orthogonalized nonborrowed reserves, inflation and industrial production. The results of the analysis showed evidence of a bidirectional Granger causality and a lead-lag relationship between illiquidity in the two markets. That is, illiquidity conditions in one market are affected by changes in illiquidity of the other market (Goyenko and Ukhov, 2009: 210). Moreover, the effect of monetary policy variables is slowly captured in stock illiquidity, while quickly captured by bond illiquidity. This confirms the hypothesis that monetary policy shocks reach the stock market through the effects of bond illiquidity on stock illiquidity. In general, contractionary monetary policy leads to a fall in liquidity (Goyenko and Ukhov, 2009: 210). Finally, Goyenko and Ukhov (2009: 210) found that stock market illiquidity is more affected by illiquidity of short-term bonds than illiquidity of medium-term and long-term bonds.

As discussions of the 2008 financial crisis have commonly highlighted that there is a decline in stock market liquidity preceding crisis in the real economy, Næs, Skjeltorp and Ødegaard (2011) set out to prove that stock market liquidity is an appropriate leading indicator of the real economy in the US and Norway. Focusing on the period 1947 – 2008, the authors chose a number of liquidity measures based on their need for reasonably long time series. Hence, they used the relative spread (i.e. the quoted spread as a fraction of the midpoint price), the Roll (1984) implicit spread estimator or effective bid-ask spread (i.e. the square root of the serial covariance of successive price movements), the Lesmond, Ogden and Trzcinka (1999) measure (i.e. an estimate of the implicit cost required for a stock's price to remain unchanged when the entire market moves), and the Amihud (2002) illiquidity ratio. To measure the state of the real economy, the proxies used were real investment, real consumption, unemployment rate and real GDP. Moreover, a number of financial variables, thought to hold important information about economic growth, were also included in the model. These were: the credit spread (i.e. the difference between the yield on a 30-year government bond benchmark and the yield on the Moody's Baa credit benchmark); the term spread (i.e. the difference between the yield on the 3-month treasury bill and the yield on a 10-year Treasury bond benchmark); market volatility (i.e. the cross-sectional average volatility of the sample stocks); and excess market return (i.e. the value weighted return on the S&P500 index in excess of the 3-month treasury bill rate) (Næs *et al.*, 2011: 8).

After employing a VAR methodology, Næs *et al.* (2011: 30) were able to find robust evidence of the causal relationship between stock market liquidity and the real economy. In other words, it was found that there is useful information contained in stock market liquidity when evaluating the current and future state of the economy. Additionally, it was found that there is a relationship between time variation in market liquidity and the changes in participation in the stock market, specifically in the case of the smallest firms. As market liquidity and economic conditions worsened, there was a fall in participation in small firms (Næs *et al.*, 2011: 30).

Fernández-Amador, Gächter, Larch and Peter (2013) also examined the relevance of the European Central Bank's monetary policy as a determinant of stock market liquidity, focusing the study on Italian, French and German markets. For the sample period spanning January 1999 (i.e. the introduction of the euro) to December 2009, the author included seven different measures of illiquidity as dependent variables in order to capture three different aspects of liquidity. These measures are: the trade volume in euro and the turnover ratio capturing trading activity; Roll impact, turnover price impact and Amihud's (2002) illiquidity ratio, capturing price impact; and relative bid-ask spread and relative Roll (1984) estimate, capturing transaction costs. In measuring the central bank policy, Fernández-Amador *et al.* (2013: 57) used the rolling twelve-month growth rate of base money (i.e. currency circulation plus the reserves held by credit institutions with the Eurosystem) as monetary aggregate. Then, the monetary stance of the central bank was measured using the Euro Overnight Index Average (EONIA), the policy rate and the deviation of the policy rate from a simple Taylor (1993) rule. Similar to Chordia *et al.* (2001, 2004) and Goyenko and Ukhov (2009), the model also included some control variables, such as market returns, volatility of market returns, the euro area industrial production and inflation rate. Using a VAR methodology, it was found that an expansionary monetary policy has a positive impact on aggregate liquidity as well as individual stocks' liquidity. Conversely, contractionary monetary policy leads to a fall in liquidity (Fernández-Amador *et al.*, 2013: 66).

Muktiyanto (2015) examined the determinant factors of liquidity in the Indonesian stock market at the firm level as well as at the market level, during the period 2005 – 2011. To identify the principal factors influencing aggregate market liquidity, the study used a number of liquidity measures based on their conformity to the data and their uni- and multidimensional coverage of market liquidity, as well as their positive and negative perspectives on liquidity. These measures are trading volume, trading value, quoted bid-ask spread, proportional bid-ask spread, quantity depth and value depth (Muktiyanto, 2015: 4). The determinant factors were grouped into four main categories, namely international market indicators, market performance measures, macroeconomic factors and seasonal regularities. The author initially employed OLS regressions to evaluate the relationship between the determinant factors selected and the six market liquidity measures. However, given the assumption of constant variance with the OLS when variance in time series data is naturally non-stationary, the risk of estimation inefficiency was countered by incorporating a modelling of conditional variance with the ARCH model (Muktiyanto, 2015: 5). The results of the analysis showed that international market volatility has a negative effect on domestic liquidity, as trading value and value depth significantly fell with volatility of the S&P and Nikkei indices, while trading costs significantly increased. Moreover, while trading activity and market liquidity is marginally influenced by announcements of macroeconomic indicators, aggregate market liquidity is strongly negatively affected by financial crisis, term spreads, short term interest rates and domestic market volatility. Additionally, liquidity was found to be positively related to market returns and historical market trends. Finally, strong evidence of seasonal regularities within a week was uncovered, with a fall in liquidity on Mondays and a gradual rise during the week reaching a peak on Thursdays, a fall in market liquidity around holidays and a rise in market liquidity during the month of Ramadan (Muktiyanto, 2015: 103).

More recently, Brandao-Marques (2016: 6) studied stock market liquidity in the Chilean stock market which is relatively large but illiquid. The study analysed the cyclical behaviour and the resilience of liquidity in the Chilean market by using time series; and panel regressions was employed on data from 23 emerging market economies covering the period from 2003 to 2014, to assess explanatory factors of liquidity. They initially made use of a regime switching approach on an aggregate stock market liquidity measure that was derived from a high-low spread metric, to evaluate and describe the likelihood of the market being in a low or high liquidity regime at any point in time. Then, the author hypothesized that an economy's stock market liquidity is determined by the market's size and depth, volatility, the country's political and economic environment, global risk appetite, corporate governance and institutional quality (Brandao-Marques, 2016: 13). The importance of each of these factors was examined through the use of a panel regression and the Amihud measure was used as a proxy for market illiquidity. It was found that market liquidity improved with better protection of minority shareholders. Moreover, in markets with higher cross holdings and substantial ownership of a country's market capitalization by corporate conglomerates, the relatively lower degree of transparency could cause low market liquidity. In fact, a bigger room for the use of asymmetric information is created through lower transparency, to the dissatisfaction of market makers, who then will need higher bid-ask spreads. The author also highlighted the possibility that the positive relationship between liquidity and investor protection is a mere reflection of the cross-country variation of the importance of institutional investors, like insurance companies, pension funds and mutual funds. In addition, the results identified the possibility of market liquidity depending more commonly on the quality of the legal institutions (Brandao-Marques, 2016: 15).

Tayeh (2016) also investigated the determinants of stock market liquidity in the Jordanian exchange that is the Amman Stock Exchange (ASE). Collected on a daily instead of a higher frequency data period for the period 1 January 2000 to 31 December 2014, the data sets included high, low and closing prices, best ask and bid prices, number of shares outstanding, trading volume and number of trades. The study included nine daily measures of market liquidity, namely quoted spread, proportional quoted spread, Roll's (1984) effective spread, modified effective spread, Corwin and Schultz's (2012) high-low spread estimator, market turnover ratio, volume, number of trades and trading value. Tayeh (2016: 49) built the time-series market liquidity used in the study by computing the cross-sectional average of a liquidity measure for all stocks traded on a certain date. Moreover, the empirical analysis was conducted by regressing, using the GMM estimation method, the daily percentage changes in market liquidity on a set of market control variables, a dummy for the day of the week and a dummy for the month of the year. The market control variables are the daily return of market index and market volatility. The results of the analysis showed an asymmetry in the response of market liquidity to simultaneous market movements. In effect, market liquidity was seen to rise in up market conditions and to fall in down market conditions (Tayeh, 2016: 49). Furthermore, a relationship was found between market liquidity and recent market movements. That is, a rise in quoted and proportional quoted spread was linked to a recently rising market; while a fall in effective spread and the high-low spread was linked to a recently falling market.

However, a recently falling market negatively affected proportional quoted bi-ask spread, while it positively affected turnover ratio and trading value. In addition, the negative estimated coefficient in the regression of trading value, as well as the positive estimated coefficient of market volatility in the regressions of effective spread, modified effective spread and high-low spread indicated that volatility leads to a decrease in market liquidity. Conversely, when considering the regressions of quoted spread and proportional quoted spread, it was deduced that liquidity rises with market volatility. Finally, distinctive monthly and weekly regularities in market liquidity were identified. While Sundays are characterized by considerable drops in liquidity, the end of week is characterized by inconclusive results. The results of quoted spread and proportional quoted spread regressions found a significant drop in market liquidity in December and February; while a rise in market liquidity in January relative to the other months of the year is identified from the results of the regression of trading activity measures (Tayeh, 2016: 57).

On the African sphere, Hattingh (2014) studied the effect of technology and the changes in microstructure on equity market liquidity in the Johannesburg Stock Exchange (JSE). The study which covered the period 2 July 2005 – 1 July 2013, made use of a portfolio event study methodology to determine whether or not statistically significant abnormal returns were produced with the introduction of the new trading engine on the JSE on 2nd July 2012. The sample period was first divided into three time frames named the estimation window or control period, the event window and the post-event window. Then, using market capitalisation as a measure of liquidity, the data sample was also divided into three portfolios consisting of the Top 40 stocks, the medium liquidity stocks and low liquidity stocks (Hattingh, 2014: 80). The results of the event study showed no evidence that the trading engine upgrade impacted liquidity overall. Hattingh (2014: 91) argued that market participants' immunity to technological changes could be the explanation for the findings. In effect, they maintained that technology could just be characterized as the point of access to the market, resulting in its lack of effect on liquidity, whereas liquidity is influenced by factors, such as trading strategies, clearing models, billing methodologies and regulatory changes in the market, which affects market participant behaviour.

Hattingh (2014: 91) also compared three liquidity measures, namely the average spread, turnover ratio and the JSE's liquidity measurement (i.e. annualised liquidity of the JSE central order book), to computer trading activity (i.e. low latency trading and algorithmic trading) in an attempt to investigate the impact of increases in orders due to advanced trading technology and new trading strategies on trading volumes and market liquidity. The authors concluded that there is not enough statistically significant or conclusive evidence showing an exact relationship between the liquidity measures and computer trading orders, even though it seems that there is a positive relationship between trading engine upgrade, computer trading orders, market capitalization, spreads and trading activity.

Similarly, Zito (2014) investigated the relationship between algorithmic trading and stock market liquidity in the JSE over the period 1 July 2011 – 28 June 2013. The author built an algorithmic trading proxy defined as the number of trades per 1000 shares of volume traded, which was normalized in a bid to eliminate the effect of market conditions. Then, the study included four measures of liquidity in order to capture four different aspects of liquidity. The zero-return measure and the proportional bid-ask spread were used to measure tightness and width. The price impact measure or Amihud's (2002) illiquidity ratio was used to measure depth and resiliency, while the stock turnover ratio was used to measure immediacy. After running regression analysis, Zito (2014: 87) found mixed results regarding the significance of relationships between the four liquidity measures and algorithmic trading. Although there was an improvement in immediacy (i.e. stock turnover ratio), its relationship to algorithmic trading was found to be statistically insignificant. Similarly, there was an improvement in the tightness and width component (i.e. proportional bid-ask spread), but the relationship with algorithmic trading was found to be statistically insignificant. Conversely, there was an improvement in the price impact measure of depth and resiliency, as well as a statistically significant relationship with algorithmic trading (Zito, 2014: 88).

In reviewing the New Economic Partnership for Africa's Development (NEPAD) development policy, Hearn and Piesse (2012) focused their analysis around the issues relating to liquidity migration and the loss of price discovery mechanism existing in an integrated union with one dominant market. For this, they narrowed the study to the Namibia market which the first one to completely integrated with the South African market. The data sample consisted of local currency converted into US dollar values of daily stock closing, bid and ask prices, traded volumes and total number of shares outstanding for a number of firms primarily listed on the Namibian stock exchange and another group primarily listed on the JSE for the period 1st January 1998 - 30th June 2009. The authors introduced a new, simple and intuitive measure of liquidity, called the proportion of zero daily returns in a month. Firstly, three sets of OLS regressions were employed to evaluate the relationships between the bid ans ask spread and the new liquidity measure as well as other common measures such as Amihud's (2002) price-impact indicator, Liu's (2006) multidimensional trading speed and the turnover measure. The results of the analysis showed that simple measures of liquidity such as the turnover volume-based measure and the newly introduced proportion of zero returns are more effective than the conventional measures (i.e. Amihud (2002) price-impact and Liu (2006) multidimensional trading speed measure) at measuring liquidity in emerging and frontier markets like Namibia, where there exist conditions of severe illiquidity (Hearn and Piesse, 2012: 20).

Secondly, the data was transformed into annual averages of monthly values in order to investigate the relationship between the level of liquidity and disparities in institutional quality based on the World Bank's six annual Bank Governance indicators. The institutional quality criteria used in the analysis are control of corruption, rule of law, political stability and absence of violence/terrorism, regulatory quality, voice and accountability, and government effectiveness. The authors introduced each of the indicators individually in the models alongside some control variables to examine the effect of each of them on liquidity. They employed a random effects estimator in the panel regression because of the lack of variation in the institutional variables for each country (Hearn and Piesse, 2012: 17). Hearn and Piesse (2012: 20) found evidence of strong links between liquidity and the control of corruption and rule of law measures of institutional quality. Additionally, the price-discovery process was found to be highly sensitive to regulatory quality, political stability and the control of corruption. Hearn and Piesse (2012: 20) concluded that the wider institutional environment is therefore crucial to maximize the benefits received by smaller markets in an integrated union.

Hearn (2014) uses evidence from the West African region to make inference on the implications of liquidity cost resulting from the attraction of regional primary listings. Three low-frequency liquidity measures were used as dependent variables in examining the effect of liquidity-based transaction costs. These measures are the LOT (1999) proportion of zero daily returns, Liu (2006) multidimensional indicator and the bid-ask spread. Hearn (2014: 3) argues that the study makes a unique contribution to the existing literature by depicting the informational asymmetries prevailing across integrated regional markets like the BRVM and regionally oriented markets like Ghana and Nigeria. These asymmetries emphasize liquidity-based transaction costs that large well known firms from distant outlying regions incur on centralized exchanges. Hence, Hearn (2014: 4) also contributes to the literature by investigating the contrasting effect of regional listings on level of liquidity within a regional market setting such as the main ones in the West African developing region, namely BRVM, Ghana and Nigeria.

The starting date of the study period differed across markets due to the considerable disparity in historical availability of data. The data sample started from September 1998 for the BRVM, July 2007 for Ghana and October 2009 for Nigeria; while it ended in June 2012 for all markets (Hearn, 2014: 12). The data consisted of end of day bid and ask quotes, trading volume and total numbers of shares outstanding for the exchanges. The model included a number of firm governance controls defined as a series of binary dummy variables to take into account the particular types of governance and ownership arrangements. These arrangements are a long-run foreign partner, the participation of state or related government entities, the participation of foreign and domestic venture capital, the retained presence of an entrepreneur/founder on the board, and whether or not there is affiliation of the firm to the extended network of family or business group (Hearn, 2014: 10). Some market control variables were also included in the model, such as market capitalization, traded volume, return volatility and stock price. Additionally, a binary dummy variable was introduced to control for the periof of civil unrest in Cote d'Ivoire between December 2010 and May 2011. The results from the study showed evidence of the association between a rise in illiquidity of firms from distant outlying regions and the attraction of these more distant or foreign regional listings. However, the increased brand awareness incured by the firms primary listed on central markets mitigates this increase in illiquidity to a certain extent. Finally, it was seen that a civil war has a considerable impact on asymmetric information which is reflected in rising illiquidity (Hearn, 2014: 22).

Finally, Jepkemei (2017) explored the relationship between inflation and stock market liquidity in Kenya, focusing on the period January 2002 – December 2011. The model used the market turnover ratio as a measure of liquidity, while the CPI was employed as a measure of inflation. The model also included two control variables, namely GDP growth rate and interest rate. Using a similar model to Fama and Schwert (1977), the author estimated a linear regression in a bid to test the Fisherian hypothesis for the market considered. Jepkemei's (2017: 345) findings showed evidence of the existence of a negative relationship between stock market liquidity and inflation in Kenya. That is, an increase in inflation rate leads to a fall in aggregate liquidity in the Nairobi Securities Exchange (Jepkemei, 2017: 345).

4.3.4 Conclusion

Based on the discussion in this chapter, it can be concluded that the theoretical literature is rich in the three main theoretical concepts informing the choice of the determinant factors affecting stock market liquidity. According to the market microstructure theory, market liquidity is affected by fluctuation in inventory as well as information asymmetry. The SCP paradigm, in turn, hypothesizes that a firm's market power is the driving factor of liquidity as it improves the firm's future cash flow. This improvement will then stabilize the price of stocks and increase liquidity. Lastly, based on the evidence of the existence of seasonal regularities in different markets, it is argued that these regularities may play a major role in determining stock market liquidity.

Empirically, although a number of studies exist on the concept of liquidity, the available literature on the drivers of stock market liquidity, particularly on Sub-Saharan African markets, is relatively poor. The common conclusion from most studies suggests that stock market liquidity is affected by monetary policy shocks, financial regulations and market conditions such as returns and volatility. Finally, distinctive monthly and weekly regularities in market liquidity were identified.

While most of the studies employed simple regression estimation techniques such as the OLS, as well as the unrestricted VAR framework in analysing the relationships between the identified factors and stock market liquidity measures, this study will make use of the Markov Switching Vector Autoregressive (MS-VAR) in a bid to capture the differences in liquidity regimes and identified the factors specific to each regime.

4.4 METHODOLOGY

4.4.1 Introduction

This section will present the chosen methodology for this study as well as the data employed. The preferred econometric framework that will be used to identify the factors determining stock market liquidity in this paper is the Markov Switching Vector Autoregressive (MS-VAR) model. The choice of the MS-VAR was informed by the model's ability to account for discrete and occasional shifts in regimes in the system, said regimes being governed by a hidden Markov chain.

The following subsection 4.4.2 will elaborate on the analytical framework of the MSVAR. Subsection 4.4.3 will present the model specification, while subsection 4.4.4 will describe the data used in the model as well as the descriptive statistics.

4.4.2 Analytical framework

Types of regime-switching models

Since its introduction by Sims (1980), the reduced form of the VAR has risen to the rank of dominant research strategy in empirical macroeconomics (Krolzig, 1998: 3). By incorporating the Markow Switching framework in the model, a class of model was created which allows the estimation of VAR models with changes in regime. In such a system, the VAR process' parameters θ are allowed to be time-varying, while the process itself may be time-invariant and conditional on a regime variable s_t that cannot be observed and indicates the prevailing regime at time t (Krolzig, 1998: 3).

Assuming that M is the number of feasible regimes, such that $s_t \in 1, ..., M$, the conditional probability density of y_t, the observed time series vector, is written as

$$p(y_t|Y_{t-1}, s_t) = \begin{cases} f(y_t|Y_{t-1}, \theta_1) & \text{if } s_t = 1 \\ \vdots & \\ f(y_t|Y_{t-1}, \theta_M) & \text{if } s_t = M \end{cases} \tag{4.1}$$

where θ_m is the vector of VAR parameter in regime $m = 1, \ldots, M$ and Y_{t-1} depicts the observations $\{y_{t-j}\}_{j=1}^{\infty}$. Hence, the time series vector y_t for any given regime s_t, is produced by a VAR (p) process so that:

$$E[y_t|Y_{t-1}, s_t] = v(s_t) + \sum_{j=1}^{p} A_j(s_t)y_{t-j},$$

where u_t is an innovation process such that $u_t = y_t - E[y_t|Y_{t-1}, s_t]$, with a variance-covariance matrix $\sum(s_t)$, and is assumed to be Gaussian: $u_t \sim NID(0, \sum(s_t))$.

When the definition of the VAR process is conditional on an unobservable regime similar to equation 4.1, the data generating mechanism is described based on assumptions with regards to the regime generating process (Krolzig, 1998: 3). In the case of the MS-VAR, the assumption is that a discrete-state homogenous Markov chain generates the regime s_t, such that:

$$Pr(s_t|\{s_{t-j}\}_{j=1}^{\infty}, \{y_{t-j}\}_{j=1}^{\infty}) = Pr(s_t|s_{t-1}; \rho),$$

where ρ is the vector of parameters of the regime generating process.

The MS-VAR class of models consists of non-linear models merging linear vector autoregressive models with hidden Markov chain models. Krolzig (1998: 6) regroups them into two categories that are the models with switches in their mean and ones with switches in intercept. While the MS-VAR models with switches in intercept are simpler to estimate and more appropriate in a Monte Carlo experiment, the class of models with switches in mean are more complex to estimate since the mean depends on the history of the latent variable (Droumaguet, 2012: 4).

A general class of models exists characterizing a non-linear data generating process as a piecewise linear function through the restriction of the process as linear in each regime, where only a discrete number of regime is achievable, and the said regime being conditioned and unobservable the difference in these models is mainly based on the assumptions of the stochastic process generating the regime. Next to the MS-VAR, the class also includes the mixture of a normal distributions model which can be seen as a restricted MS-VAR with a transition matrix of rank one (Krolzig, 1998: 3). In effect, the model incorporates serially independently distributed regimes such that:

$$Pr(s_t|\{s_{t-j}\}_{j=1}^{\infty}, \{y_{t-j}\}_{j=1}^{\infty}) = Pr(s_t; \rho).$$

This model differs from the MS-VAR models because the transition probabilities are not dependent on the history of the regime, making the conditional probability distribution independent of s_{t-1} and the conditional mean given by $E[y_t|Y_{t-1}]$. However, using this type of model for modelling is restricted because when the intercept term alone is regime dependent, the MS-VAR processes are observationally equivalent to time-invariant VAR processes with non-normal errors (Krolzig, 1998: 3).

Another model included in the general class of models similar to the MS-VAR is the self -exciting threshold autoregressive SETAR (p, d, r) model. This model assumes that the regime-generating process is directly linked to the lagged endogenous variable y_{t-d}. In this case, the probability of $s_t = 1$, the unobservable regime, is:

$$Pr(s_t = 1|\{s_{t-j}\}_{j=1}^{\infty}, \{y_{t-j}\}_{j=1}^{\infty}) = I(y_{t-d} \leq r) = \begin{cases} 1 & \text{if } y_{t-d} \leq r \\ 0 & \text{if } y_{t-d} > r, \end{cases}$$

where r is the given but an unknown threshold. Even though the SETAR and MS-VAR seem to be quite different, numerical applications can show them to be observationally equivalent, making the relation between the alternatives quite close.

The smooth transition autoregressive (STAR) model, which was popularized by Granger and Terasvirta (1993), uses exogenous variables mainly to model the weights of regimes, although the switching rule may also depend on the history of the observed variables y_{t-d}:

$$Pr(s_t = 1|\{s_{t-j}\}_{j=1}^{\infty}, \{y_{t-j}\}_{j=1}^{\infty},) = F(y'_{t-d}\delta - r),$$

where the weight of regime one is determined by a continuous function $F(y'_{t-d}\delta - r)$.

Lastly, the endogenous selection Markov-switching vector autoregressive (EMS-VAR) model, of which all the above-mentioned models are special cases, includes transition probabilities $p_{ij}(.)$ dependent on the observed variable y_{t-d}, such that:

$$Pr(s_t = m|s_{t-1} = i, y_{t-d}) = p_{im}(y'_{t-d}\delta).$$

In this model, additional information on the conditional probability distribution of the regimes is contained in the observed variables:

$$Pr(s_t|\{s_{t-j}\}_{j=1}^{\infty}) \overset{a.e.}{\neq} Pr(s_t|\{s_{t-j}\}_{j=1}^{\infty}, \{y_{t-j}\}_{j=1}^{\infty}).$$

Hence, the Markovian framework no longer applies to this regime generating process. In the EMS-VAR models, contrary to the STAR and SETAR models, it is possible for the threshold to depend on the last regime (Krolzig, 1998:4).

At least three traditions constitute the foundation for the VAR model with Markov switching regimes. Firstly, the linear time-invariant VAR model represents the framework used in analysing the relationship between the variables in the system, the impact of shifts in regimes and the dynamic distribution of innovations to the system. The second tradition is the inclusion of older concepts such as the mixture of a normal distributions model developed by Pearson (1984) and the hidden Markov-chain model attributed to Heller (1965) and Blackwell and Koopmans (1975); while the fundamental statistical methods of the model have been developed by Baum and Petrie (1966) and the probabilistic functions of Markov chains by Baum, Petrie, Soules and Weiss (1970).Thirdly, the creation of the Markov-switching regression model in econometrics was initially attempted by Goldfeld and Quandt (1973), but stayed primitive. Lindgren (1978) was then the first to propose a comprehensive approach to the Markov-switching regression model in the statistical context, while Hamilton (1988) introduced the model in time series analysis (Krolzig, 1998:4).

Markov-switching VAR processes

The Markov-switching VAR is a generalization of the fundamental finite-order VAR model of order p. Considering the K-dimensional time series vector $y_t = (y_{1t}, \ldots, y_{Kt})'$, with $t = 1, \ldots, T$ and order p, y_t can be written as:

$$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t, \tag{4.2}$$

where $y_0, \ldots, y_{1-p}$ are fixed and $u_t \sim IID(0, \Sigma)$.

If $A(L) = I_K - A_1 L - \cdots - A_p L^p$ is denoted as the $(K \times K)$ dimensional lag polynomial, the assumption is that no roots exist on or inside the unit circle $|A(z)| \neq 0$ for $|z| \leq 1$, with L being the lag operator such that $y_{t-j} = L^j y_t$. Assuming that the error term is normally distributed, equation 4.2 can also be described as the intercept form of a stable Gaussian VAR model of order p. Reparametrization of this model as the mean-adjusted form of a VAR model gives:

$$y_t - \mu = A_1(y_{t-1} - \mu) + \cdots + A_p(y_{t-p} - \mu) + u_t, \tag{4.3}$$

where μ is the $(K \times 1)$ vector of the mean of y_t written as $\mu = (I_K - \sum_{j=1}^{p} A_j)^{-1} v$.

The stable VAR model which has time-invariant parameters may become inappropriate when there are shifts in regimes in the time series (Krolzig, 1998:5). Thus, the MS-VAR may be viewed as a general regime switching framework, with the standard idea behind this class of models being that s_t the unobservable regime variable determines the parameters of the underlying data generating process of y_t the observed time series vector. This idea provides the probability of being in a different regime (Krolzig, 1998:5).

The observational equations do not completely describe the data-generating process. The formulation of a model of the regime-generating process is needed for the inference of the progression of regimes based on the data. The Markov switching model is specially characterized by the assumption of a discrete state, discrete time Markov stochastic process governing the unobservable attainment of the regime $s_t \in \{1, \ldots, M\}$. The definition of Markov stochastic process in this case is given by the transition probabilities:

$$p_{ij} = Pr(s_{t+1} = j | s_t = i), \quad \sum_{j=1}^{M} p_{ij} = 1 \quad \forall i, j \in \{1, \ldots, M\}. \tag{4.4}$$

In effect, the assumption about s_t is that it follows an M state Markov process that is ergodic, cannot be simplified and whose transition matrix is presented as:

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1M} \\ p_{21} & p_{22} & \cdots & p_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ p_{M1} & p_{M2} & \cdots & p_{MM} \end{bmatrix} \tag{4.5}$$

where $p_{iM} = 1 - p_{i1} - \cdots - p_{i,M-1}$ for $i = 1, ..., M$.

It is crucial to assume both irreducibility and ergodicity as theoretical properties of the MS-VAR models.

Consider an M-regime Markov switching VAR (p) , when generalizing the mean-adjusted VAR model of order p in equation 4.3, so that:

$$y_t - \mu(s_t) = A_1(s_t)(y_{t-1} - \mu(s_{t-1})) + \cdots + A_p(s_t)(y_{t-p} - \mu(s_{t-p})) + u_t, \tag{4.6}$$

where $\mu(s_t), A_1(s_t), \ldots, A_p(s_t), \sigma(s_t)$ are parameter shift functions and $u_t \sim NID(0, \sigma(s_t))$. The functions describe the dependence of the parameters on s_t, as for instance:

$$\mu(s_t) = \begin{cases} \mu_1 & \text{if } s_t = 1, \\ \vdots & \\ \mu_M & \text{if } s_t = M. \end{cases} \tag{4.7}$$

Following a shift in regime in the depicted model in equation 4.6, a one-time jump immediately occurs in the process mean. Thus, the assumption of a smooth approach of the mean to a new level following the transition from one regime to another is occasionally more plausible. In that case, it may be appropriate to employ a model with a regime-dependent intercept term $v(s_t)$ specified as follows:

$$y_t = v(s_t) + A_1(s_t)yt - 1 + \cdots + A_p(s_t)y_{t-p} + u_t. \tag{4.8}$$

Another differencing feature of the MS-VAR compared to the linear VAR is that in the former, the intercept form and the mean adjusted form as depicted by equation 4.8 and 4.6 respectively are not analogous. In fact, there is a difference in the dynamic adjustments of the observed variables in these forms, following a switch in regime. Although there is an immediate jump of y_t onto its new level as a result of a permanent regime shift in $\mu(s_t)$, a once-off shift in regime in $v(s_t)$ produces an identical dynamic response to a similar shock in the white noise series u_t (Krolzig, 1998:6).

The basic specification of an MS-VAR model conditions all parameters of the autoregression on the regime s_t of the Markov chain so that for each m regime, the VAR(p) parameterization

$v(m)$, σ_m, $A_{1m}, \ldots, A_{jm}$, $m = 1, \ldots, M$, is as:

$$y_t = \begin{cases} v_1 + A_{11}y_{t-1} + \cdots + A_{p1}y_{t-p} + \Sigma_1^{1/2}u_t, & \text{if } s_t = 1 \\ \vdots & \\ v_M + A_{1M}y_{t-1} + \cdots + A_{pM}y_{t-p} + \Sigma_M^{1/2}u_t, & \text{if } s_t = M \end{cases} \tag{4.9}$$

where $u_t \sim NID(0, I_K)$.

When empirically applying the model, the use of a model with only some parameters being conditional of the regime of the Markov chain and other parameters being regime invariant, may be more helpful. Some particular MS-VAR models exist where the autoregressive parameters depend on the regime, while the error term is homo- or heteroskedastic (Krolzig, 1998:6).

A significant array of specifications can be made in the MS-VAR model. Krolzig (1998:6) creates a unique notation for each specification by stating the regime-dependent in conjunction with the general MS(M) term. These models are:

- Markov-switching mean MSM(M)-VAR(p),
- Markov-switching intercept term MSI(M)-VAR(p),
- Markov-switching autoregressive parameters MSA(M)-VAR(p),
- Markov-switching heteroskedasticity MSH(M)-VAR(p).

While in most cases the MSM(M)-VAR(p) and the MSI(M)-VAR(p) models will be adequate enough, additional features may be considered such as a regime dependent covariance structure of the process (Krolzig, 1998:6).

Likelihood-based statistical methods

Considering lagged endogenous variables $Y_t = (y'_{t-1}, y'_{t-2}, \ldots, y'_1, y'_0, \ldots, y'_{1-p})'$ and a given regime ξ_t, the denotation of the conditional probability density function will be $p(y_t|s_t, Yt-1)$.

With the assumption that the error term u_t is normally distributed in equation 4.6 and 4.8, the conditional probability density function can be given as:

$$p(y_t|s_t = \iota_m, Y_{t-1}) = \ln(2\pi)^{-1/2} \ln|\sigma|^{-1/2} \exp\{(y_t - \bar{y}_{mt})' \sigma_m^{-1}(y_t - \bar{y}_{mt})\}, \tag{4.10}$$

where $\bar{y}_{mt} = E[y_t|s_t, Y_{t-1}]$ is the conditional expectation of y_t in regime m. Hence, for a given regime s_t, there is a normal conditional density of y_t similar to the VAR model in equation 4.2 (Krolzig, 1998:6). Therefore:

$$y_t|s_t = m, Y_{t-1} \sim NID(\bar{y}_{mt}, \sigma_m), \tag{4.11}$$

with the conditional means $\bar{y}_{mt}$ summarized the vector $\bar{y}_t$ of the form:

$$\bar{y}_t = \begin{bmatrix} \bar{y}_{1t} \\ \vdots \\ \bar{y}_{Mt} \end{bmatrix} = \begin{bmatrix} v_1 + \sum_{j=1}^{p} A_{1j} y_{t-j} \\ \vdots \\ v_M + \sum_{j=1}^{p} A_{Mj} y_{t-j} \end{bmatrix} \tag{4.12}$$

If the available information set at $t-1$ only includes the pre-sample values collected in Y_{t-1} and the states of the Markov chain up to s_{t-1}, as well as the sample observations, the conditional density of y_t is a mixture of normals:

$$p(y_t|s_{t-1} = i, Y_{t-1}) = \sum_{m=1}^{M} p(y_t|s_{t-1}, Yt-1)Pr(s_t = m|s_{t-1} = i) = \sum_{m=1}^{M}\sum_{i=1}^{M} p_{im}(\ln(2\pi)^{-1/2} \ln|\sigma_m|^{-1/2} \exp\{(y_t - \bar{y}_{mt})'\sigma_m^{-1}(y_t - \bar{y}_{mt})\}) \tag{4.13}$$

The vector ξ_t collects the information on the realization of the Markov chain,

$$\xi_t = \begin{bmatrix} I(s_t = 1) \\ \vdots \\ I(s_t = M) \end{bmatrix}$$

This vector consists of binary variables where the definition of $I(s_t = m)$ the indicator function is as:

$$I(s_t = m) = \begin{cases} 1 & \text{if } s_t = m \\ 0 & \text{otherwise,} \end{cases}$$

so that $\mu(s_t) = \sigma_{m=1}^{M} \mu_m I(s_t = m) = \mathrm{M}\xi_t$, with $\mathrm{M} = [\mu_1, \ldots, \mu_M]$. The unobserved regime of the system is therefore denoted by ξ_t.Similarly, the vector η_t can collect the densities of y_t conditional on Y_{t-1} and s_t such that:

$$\eta_t = \begin{bmatrix} p(y_t|\xi_t = 1, Y_{t-1}) \\ \vdots \\ p(y_t|\xi_t = M, Y_{t-1}) \end{bmatrix}, \tag{4.14}$$

Equation 4.13 can then be written as:

$$p(y_t|\xi_{t-1}, Y_{t-1}) = \eta_t' \mathrm{P}' \xi_{t-1}. \tag{4.15}$$

Because of the assumption that s_t is unobservable, the appropriate information set at $t-1$ only includes the observed time series until time t, while the inference $Pr(\xi_t|Y_\tau)$ has to replace the regime vector ξ_t which is unobserved (Krolzig, 1998:7). The vector $\hat{\xi}_{t|\tau}$ then collects $\xi_{mt|\tau}$ denoting the probabilities $Pr(\xi_t|Y_\tau)$ and is given as:

$$\hat{\xi}_{t|\tau} == \begin{bmatrix} Pr(s_t = 1|Y_\tau) \\ \vdots \\ Pr(s_t = M|Y_\tau) \end{bmatrix} \tag{4.16}$$

Two separate interpretations can stem from equation 4.16. The first one is that the discrete conditional probability distribution of ξ_t given Y_τ is denoted by $\hat{\xi}_{t|\tau}$; while the second one is that $\hat{\xi}_{t|\tau}$ and the conditional mean of ξ_t given Y_τ are equivalent. This is the case because the elements of ξ_t are binary, implying that $\mathrm{E}[\xi_{mt}] = Pr(\xi_{mt} = 1) = Pr(s_t = m)$.

From the above, the conditional probability density of y_t based on Y_{t-1} can be written as:

$$\begin{aligned} p(y_t|Y_{t-1}) &= \int p(y_t, \xi_{t-1}|Y_{t-1}) d\xi_{t-1} \\ &= \int p(y_t|\xi_{t-1}, Y_{t-1}) Pr(\xi_{t-1}|Y_{t-1}) d\xi_{t-1} \\ &= \eta_t' \, \mathrm{P}' \hat{\xi}_{t-1|t-1}, \end{aligned} \tag{4.17}$$

where summation over all possible values of ξ_t is denoted by $\int f(x, \xi_t) d\xi_t := \sum_{m=1}^{M} f(x, \xi_t = \iota_m)$.

The conditional probability density of a sample can be derived similarly to the conditional probability density of an observation y_t and the general approach to set up the likelihood function is as follows:

$$p(Y|\xi) = \prod_{t=1}^{T} p(y_t|\xi_t, Y_{t-1}). \tag{4.18}$$

Equation 4.18 determines the density of the sample $Y \equiv Y_T$ conditional on the states ξ, for given pre-sample values Y_0.

Thus, the calculation of the joint probability distribution of states and observations can be done as:

$$p(Y, \xi) = p(Y|\xi) Pr(\xi) = \prod_{t=1}^{T} p(y_t|\xi_t, Y_{t-1}) \prod_{t=2}^{T} Pr(\xi_t|\xi_{t-1}) Pr(\xi_1). \tag{4.19}$$

The following marginal density then gives the unconditional density of Y:

$$p(Y) = \int p(Y, \xi) d\xi. \tag{4.20}$$

To maximize a MS-VAR model likelihood function, estimates of the transition probabilities governing the Markov chain as well as the parameters of the autoregression parameters have to be obtained through an iterative estimation technique (Krolzig, 1998:8). The parameter vector denoted $\lambda = (\theta, \rho)$ then represents the chosen parameter vector maximizing the likelihood for given observations Y_T.

The Expectation Maximization algorithm introduced by Dempster, Laird and Rubin (1977) and developed by Hamilton (1990) for the MS-VAR class of model is implemented to estimate the maximum likelihood of the model (Krolzig, 1998:8). In the EM algorithm, each iteration involves two steps. In the expectation step, instead of the unknown true parameter vector, the last maximization step's estimated parameter vector $\lambda^{(j-1)}$ is passed through the smoothing and filtering algorithms. An estimate of the smoothed probabilities $Pr(\xi|Y, \lambda^{(j-1)})$ of the unobserved states ξ_t is delivered through the process. The second step, i.e. maximization, involves the derivation of an estimate of the parameter vector λ as a solution of the first order conditions related to the likelihood function, where $Pr(\xi|Y, \lambda^{(j-1)})$ already derived in the last expectation step replace $Pr(\xi|Y, \lambda)$, the conditional regime probabilities (Krolzig, 1998:8). The process continues with updating the filtered and smoothed probabilities using the new parameter vector λ in the next expectation step. This guarantees a rise in the value of the likelihood function at every step.

For the interpretation of MS-VAR models, regime built in this fashion are crucial instruments as they represent the best inference on the hidden state of the economic process, by which the unobserved regimes are assigned probabilities conditional on the available information set. Thus, following the definition of the conditional density, the conditional distribution of the regime vector ξ should be:

$$Pr(\xi|Y) = \frac{p(Y, \xi)}{p(Y)}.$$

Therefore, marginalizing $Pr(\xi|Y)$ will lead to the derivation of the desired conditional regime probabilities.

4.4.3 Model Specification

Based on the literature, the factors that are assumed to have an impact on stock market liquidity ($\mathbf{LIQ}_i t$) and are examined in this study are:

- Domestic market return $\mathbf{R}_{it}$;

- Domestic market volatility $\mathbf{VOL}_{it}$;
- Domestic macroeconomic conditions: Inflation $\mathbf{INF}_{it}$, discount rate $\mathbf{DR}_{it}$ and exchange rate $\mathbf{EXR}_{it}$;
- Global investor risk appetite $\mathbf{VIX}_{it}$;
- Seasonal regularities: Day of the week $\mathbf{Day}_{it}$ and Month of the year $\mathbf{Month}_{it}$.

For the purpose of this study, the reduced form of the MS-VAR model, known of as the MSIAH-VAR(p) model is employed. The model then follows this specific autoregressive system after Cholesky decomposition:

$$y_t = \beta_{0(s_t)} + \beta_{i(s_t)} y_{t-i} + \sigma_{(s_t)}\epsilon_t \tag{4.21}$$

where

$$\epsilon_t \sim N(0, \Sigma_{S_t}) \tag{4.22}$$

S_t is the state at time t and Σ_{S_t} is the reduced form of the covariance matrix of S_t. Y_t is a vector of dependent variables. In this case, $Y_t = Amihud_t$ for each country i at time t.

The study considers an MS (2)-VAR(p) with time-varying transition probabilities (TVTP) which are one period forecasts, *ex post*. The MSVAR model in equation 4.21 specifies the mean equation that is driven by the underlying regime S_t. These transition probabilities, $p_t^{11}, p_t^{12}, p_t^{22}$and p_t^{21}, are conditional on information up to $t-1$, i.e. $\Im_{t-1}$, such that:

$$p_t^{11} = P(S_t = 1|S_{t-1} = 1, \Im_{t-1}; \xi^1) = \frac{exp(\Im'_{t-1}\xi(S_{t-1} = 1))}{1 + exp(\Im'_{t-1}\xi(S_{t-1} = 1))} \tag{4.23}$$

$$p_t^{12} = 1 - p_t^{11} \tag{4.24}$$

$$p_t^{22} = P(S_t = 2|S_{t-1} = 2, \Im_{t-1}; \xi^2) = \frac{exp(\Im'_{t-1}\xi(S_{t-1} = 2))}{1 + exp(\Im'_{t-1}\xi(S_{t-1} = 2))} \tag{4.25}$$

$$p_t^{21} = 1 - p_t^{22} \tag{4.26}$$

The potential factors that can affect liquidity and that are listed above are introduced as the information variables for the time varying transition probabilities. Due to the limitation of the Matlab MSVAR package to estimate models with more than five arguments, the potential information variables are interchanged in order to estimate twelve different models in which market return R is always included, for each market under consideration. Therefore, the vector of information variables included in model one to twelve are specified as follows:

$$\Im_{1,t-1} = \begin{bmatrix} R_{t-1} \\ VOL_{t-1} \\ DR_{t-1} \end{bmatrix};$$

$$\Im_{2,t-1} = \begin{bmatrix} R_{t-1} \\ VOL_{t-1} \\ DAY_{t-1} \end{bmatrix};$$

$$\Im_{3,t-1} = \begin{bmatrix} R_{t-1} \\ VOL_{t-1} \\ MONTH_{t-1} \end{bmatrix};$$

$$\Im_{4,t-1} = \begin{bmatrix} R_{t-1} \\ VIX_{t-1} \\ DR_{t-1} \end{bmatrix};$$

$$\Im_{5,t-1} = \begin{bmatrix} R_{t-1} \\ VIX_{t-1} \\ DAY_{t-1} \end{bmatrix};$$

$$\Im_{6,t-1} = \begin{bmatrix} R_{t-1} \\ VIX_{t-1} \\ MONTH_{t-1} \end{bmatrix};$$

$$\Im_{7,t-1} = \begin{bmatrix} R_{t-1} \\ DR_{t-1} \\ DAY_{t-1} \end{bmatrix};$$

$$\Im_{8,t-1} = \begin{bmatrix} R_{t-1} \\ DR_{t-1} \\ MONTH_{t-1} \end{bmatrix};$$

$$\Im_{9,t-1} = \begin{bmatrix} R_{t-1} \\ VOL_{t-1} \\ EXR_{t-1} \end{bmatrix};$$

$$\Im_{10,t-1} = \begin{bmatrix} R_{t-1} \\ VIX_{t-1} \\ EXR_{t-1} \end{bmatrix};$$

$$\Im_{11,t-1} = \begin{bmatrix} R_{t-1} \\ EXR_{t-1} \\ DAY_{t-1} \end{bmatrix};$$

$$\Im_{12,t-1} = \begin{bmatrix} R_{t-1} \\ EXR_{t-1} \\ MONTH_{t-1} \end{bmatrix}.$$

Because both the DR and the INF are correlated and provide the same information to the market, only the DR was included in the MSVAR TVTP models. From the above specifications, the expected illiquidity at time t is given by:

$$Amihud_{it} = P(S_t = 1|\Im_{i,t-1})Amihud_{it}(S_t = 1) + P(S_t = 2|\Im_{i,t-1})Amihud_{it}(S_t = 2) \quad (4.27)$$

where

$$P(S_t = 1|\Im_{i,t-1}) = p_t^{11} + p_t^{21} \quad (4.28)$$

and

$$P(S_t = 2|\Im_{i,t-1}) = p_t^{22} + p_t^{12} \quad (4.29)$$

for each model i.

The use of the MSVAR with TVTP was informed by the attempt to identify factors that could affect periods of high illiquidity, as well as the shift to improved liquidity. With the TVTP, the identification of the significant factors influencing the probability of a stock market being highly illiquid is facilitated. Contrary to the fixed transition probabilities (FTP), the TVTP assumes that the regime switching is endogenous.

4.4.4 Data and Descriptive statistics

The data sample consists of daily values of the variables included in the model for four Sub-Saharan African stock markets, namely the Nigeria Stock Exchange (NGSE), the Nairobi Stock Exchange (NSE), the Johannesburg Stock Exchange (JSE) and the Bourse Regionale des Valeurs Mobilieres (BRVM). Due to the unavailability of data, there is a difference in the period covered by the data samples for each of the countries. The sample period for each market is given in Table 4.1.

Market return The domestic market returns for each market is computed using the daily closing prices of the all share index, following the formula:

$$R_d^I = ln\frac{I_d}{I_{d-1}} \times 100 \tag{4.30}$$

where R_d^I is the continuously compounded rate of change in the price of index I on day d and I_d is the closing price of index I on day d.

The daily closing values of the JSE All Share index were obtained from the JSE, while the daily closing values of the BRVM Composite, Nigeria All Share index and Nairobi All Share index were obtained from the Investing.com website. Due to the potential correlation of R_t to the liquidity measure, the variable was lagged before entering the model.

Market volatility The proxy used for daily volatility for each market is the conditional variance series of the computed daily returns, estimated by maximum likelihood in a GARCH framework[4]. The higher the volatility in stock prices, the more onerous market making becomes since dealers inventory costs increase with the level of risk. Thus, highly volatile stock markets should be related to low liquidity (Brandao-Marques, 2016:11).

Macroeconomic conditions The variables used in the study to measure macroeconomic conditions are *the inflation rate*, *the discount rate* and *the exchange rate*. *Inflation* is measured as the annual rate of inflation explicitly computed as the percentage change month on month of the previous year of the CPI for each country. Because the highest frequency at which prices are collected in most countries is monthly, the time series was converted into daily frequency by using the monthly value for a specific month for every day of that month. For example, it was assumed that the inflation rate for January 2009 was the same from 1 January to 31 January 2009. *The discount rate* is the rate at which commercial banks borrow from the central bank and is a benchmark for all other interest rates on the capital markets. This rate is expected to reflect the stance of monetary policy. The values for the CPI and the discount rate for each country was collected from the International Financial Statistics database of the IMF. It is generally believed that a country with a good/stable macroeconomic environment attracts more domestic and foreign investors to its capital market. Thus, the stability of macroeconomic environment should improve the level of liquidity (Brandao-Marques, 2016 :11). *The exchange rate* is the representative rate quoted as a local currency units per US Dollar. Since there are some unresolved theoretical issues concerning liquidity especially in Africa which also justifies empirical quests, the exchange rate is included in the study, following the emphasis on the markets' microstructure and macroeconomic fundamentals.

Global investor risk appetite The variable used as a proxy for global risk aversion is the daily return on the CBOE Volatility Index (VIX), which is the S&P500 implied volatility index from the Chicago Board Options Exchange. This index represents a leading indicator of market expectations of near-term volatility and is generally considered the world's primary barometer of market volatility and investor sentiment (CBOE, 2017). The rationale behind the inclusion of this factor is that due to an increasing interest of global investors in engaging in local markets,

[4]For more details on the estimation of the conditional variance series in a GARCH framework, refer to Chapter 2.

periods of low volatility and high global risk appetite should also be characterized by higher liquidity. In contrast, when financial volatility is high, market makers may lose their ability to provide liquidity services as they will be more likely to deal with financial restrictions.

Seasonal regularities The seasonal regularities in stock market liquidity are taken into account by including two dummy variables in the model. The *day of the week* dummy categorizes trading days from Sunday to Wednesday, assigning the value of one if the trading day is Sunday, Monday, Tuesday or Wednesday, and zero if otherwise. The *month of the year* dummy categorizes the trading month from February to December, assigning the value the value of one if the trading day falls between February and December, and zero if otherwise.

Liquidity Measures

Measuring liquidity and transaction costs is notoriously difficult (Bekaert, Harvey and Lundblad, 2006:6). However, a wide range of liquidity measures have been developed to capture different aspects or dimensions of market liquidity. In general, the liquidity measures are classified into four categories based on the conventional definition of liquidity which highlights its four dimensions: trading quantity, trading speed, trading cost, and price impact (Choe and Yang, 2008: 1). In the first category of liquidity measure characterized as a concept of trading quantity, the different measures included are trading amount, number of trades, volume and turnover. The second category which characterizes liquidity as a concept of price impact regroups measures such as Pastor and Stambaugh's (2003) reversal measure, Kyle's (1985) lambda (λ), Amihud's (2002) illiquidity measure and Amivest liquidity ratio. The third category which characterizes liquidity as a concept of trading cost regroups measures such as the proportional bid-ask spread, amortized spread and Roll's (1984) spread. Finally, the last category characterizes liquidity as a notion of trading speed and includes measures such as the proportion of zero daily return, Liu's (2006) measure and Lesmond, Ogden and Tricinka (LOT)'s (1999) transaction cost.

Since detailed microstructure data is usually readily accessible in developed markets, the challenges associated with the construction of the above-mentioned liquidity measures are minimal.

Unfortunately, the same does not apply to emerging and developing markets where such data is not easily accessible. Specifically, the unavailability of bid and ask prices, as well as dollar volume data on a daily basis in non-developed markets makes the application of Amihud's (2002) illiquidity measure and Pastor and Stambaugh (2003)'s reversal measure challenging (Bekaert *et al.*, 2006:6). Moreover, the use of volume data presents some challenges related to trends and outliers which may be exacerbated in developing market data.

However, despite the challenges associated with the application of Amihud's (2002) illiquidity measure in emerging and developing markets, this measure has nonetheless been identified as the most reliable measure of liquidity that can replace high frequency measures such as the bid-ask spread, since it was found to perform significantly well when compared to other liquidity measure (cf. Choe and Yang, 2008). Therefore, the measure of liquidity used in this study is Amihud's (2002) illiquidity measure computed as:

$$Amihud_t^i = \frac{1}{Days_t^i} \sum_{d=1}^{Days_t^i} \frac{|R_{td}^i|}{V_{td}^i} \tag{4.31}$$

where $Days_t^i$ is the number of valid observation days in year t for index i in year t; R_{td}^i is the return; and V_{td}^i is the volume of traded on day d in year t. If there is a greater movement in an index price in response to a smaller volume traded, the index will record a high Amihud (2002) measure, meaning high illiquidity.

This measure is appropriate for the current study as it incorporates three dimensions of liquidity that are price impact, trading cost and trading quantity. When estimating the Amihud illquidity measure for the different markets, the scale has to be adjusted where the trading volume is much larger than the return. Thus, the measure is multiplied by 10^6 in the case of the BRVM, 10^9 for the JSE and the NGSE, and 10^8 for the NSE.

Descriptive statistics

Table 4.1 below, gives a summary of the descriptive statistics of seven variables included in the models for each market (excluding DAY and MONTH). The table shows statistics such as the mean, median, maximum, minimum, standard deviation, skewness and kurtosis for the seven

Table 4.1: Descriptive statistics

Panel A: BRVM

	Amihud	R	VOL	INF	DR	VIX	EXR
Mean	8.195	0.047	0.624	1.026	2.673	-0.072	6.285
Median	2.359	0.028	0.509	0.724	2.500	-0.449	6.251
Maximum	377.245	3.399	5.924	3.497	3.250	40.101	6.452
Minimum	0.000	-5.959	0.399	-0.931	2.500	-26.482	6.159
Std Deviation	19.741	0.759	0.372	1.298	0.263	7.447	0.090
Skewness	8.439	-0.141	5.495	0.309	1.161	0.685	0.300
Kurtosis	120.717	8.573	51.505	1.964	2.804	6.103	1.455
Period covered	25 November 2011 - 30 December 2016						

Panel B: JSE

	Amihud	R	VOL	INF	DR	VIX	EXR
Mean	3.369	0.029	0.872	5.691	5.738	-0.138	2.388
Median	2.629	0.048	0.724	5.864	5.500	-0.346	2.371
Maximum	28.641	4.159	2.810	7.024	7.00	40.101	2.819
Minimum	0.000	-3.621	0.200	3.914	5.00	-26.482	2.006
Std Deviation	3.176	0.915	0.483	0.687	0.690	7.284	0.213
Skewness	2.357	-0.181	1.233	-0.629	0.729	0.505	0.116
Kurtosis	13.607	4.385	4.266	2.799	2.349	5.613	1.950
Period covered	28 November 2011 - 30 December 2016						

Panel C: NSE

	Amihud	R	VOL	INF	DR	VIX	EXR
Mean	2.668	0.034	3.982	7.541	10.632	-0.044	4.480
Median	1.658	0.041	0.669	6.470	12.00	-0.642	4.462
Maximum	43.384	3.489	1196.161	19.720	14.00	40.547	4.668
Minimum	0.000	-5.141	0.180	3.173	6.00	-35.059	4.308
Std Deviation	3.402	0.687	42.592	4.009	2.708	7.491	0.093
Skewness	4.174	-0.412	22.172	1.607	-0.812	0.708	0.279
Kurtosis	32.434	7.821	538.996	4.784	2.052	6.519	2.124
Period covered	23 June 2009 - 30 December 2016						

Panel D: NGSE

	Amihud	R	VOL	INF	DR	VIX	EXR
Mean	13.124	0.009	0.978	11.164	10.792	-0.035	5.155
Median	1.489	-0.006	0.636	10.559	12.000	-0.625	5.076
Maximum	19082.25	11.758	15.762	18.568	14.000	49.708	5.830
Minimum	0.000	-8.741	0.308	7.692	6.000	-35.059	4.982
Std Deviation	456.629	1.044	1.120	2.908	2.614	7.578	0.187
Skewness	41.747	0.727	5.569	0.826	-0.935	0.855	2.025
Kurtosis	1743.900	18.468	49.534	2.921	2.327	7.138	6.528
Period covered	06 October 2009 - 30 December 2016						

Source: Author's estimations

datasets for each market.

The mean of the Amihud (2002) measure is seen to be the highest in the NGSE, followed by the BRVM and the lowest in the NSE. The highest maximum value of the measure was also recorded in the NGSE, which is substantially higher than in any of the other three markets. However, with a relatively low median of the illiquidity measure in each of the markets, the maximum and minimum values of the measure highlight the presence of outliers, with extremely high and extremely low illiquidity. The standard deviation values of the Amihud measure show that of all the four markets, market liquidity in the NGSE appears to be more volatile than the others. However, this market also records the second highest volatility mean, after the JSE, for the sample period covered.

The distribution of daily returns R is seen to be negatively skewed for the BRVM, the NSE and the JSE, while the skewness in the NGSE daily returns is more pronounced than it is for the other three indices. This means that, for these markets' all share indices, there are more negative than positive returns observations. The reverse is true for the remaining the NGSE.

For most of the variables in all four markets, except INF, DR and EXR, the kurtosis is above three (the expected value for a normal distribution). This means that the distributions of Amihud, R, VOL and VIX are leptokurtic. In other words, these variables have higher peaks and fatter tails (i.e. a higher probability of extreme values), relative to normal distributions. This emphasizes the non-normality of the variables in all four markets. This is especially true for Amihud in the BRVM and NGSE, and VOL in the NSE, showing extremely high probability of extreme values.

Table 4.2 presents the correlations and corresponding p-values of the seven variables for each market considered.

The correlation coefficients are only statistically significant in the case of the BRVM and NSE. Similarly, the correlation coefficient between R and Amihud is found to be negative for all markets and statistically significant in the BRVM and the NSE only. While in the JSE and the NGSE the probability is statistically insignificant.

In the BRVM, VOL, DR, INF and EXR are significantly correlated to Amihud. However, EXR is found to be negatively correlated to Amihud, while VOL, INF and DR are found to be positively correlated with Amihud. The correlation coefficient between VOL and Amihud is positive and statistically significant, although it is considerably small at 0.079. As can be expected, DR is significantly positively correlated to INF in all markets, except in the NGSE where DR and INF are negatively correlated. In the JSE, however, VOL is positively and significantly correlated to Amihud. DR is positively and significantly correlated to VOL and INF In most markets, there is a negative and statistically insignificant correlation coefficient

Table 4.2: Correlations and p-values

Panel A: BRVM

VARIABLES	Amihud	R	VOL	INF	DR	VIX	EXR
Amihud	1.000						
R	-0.065	1.000					
	(0.022)						
VOL	0.078	0.151	1.000				
	(0.006)	(0.000)					
INF	0.219	0.022	0.009	1.000			
	(0.000)	(0.437)	(0.757)				
DR	0.267	0.011	0.035	0.825	1.000		
	(0.000)	(0.693)	(0.222)	(0.000)			
VIX	-0.027	-0.002	0.008	-0.010	-0.013	1.000	
	(0.340)	(0.946)	(0.7824)	(0.731)	(0.659)		
EXR	-0.119	-0.019	-0.019	-0.148	-0.423	0.002	1.000
	(0.000)	(0.496)	(0.498)	(0.000)	(0.000)	(0.938)	

Panel B: JSE

VARIABLES	Amihud	R	VOL	INF	DR	VIX	EXR
Amihud	1.000						
R	-0.053	1.00					
	(0.069)						
VOL	0.169	0.030	1.000				
	(0.000)	(0.299)					
INF	-0.022	0.012	0.023	1.000			
	(0.459)	(0.668)	(0.430)				
DR	-0.002	-0.025	0.405	0.241	1.000		
	(0.949)	(0.386)	(0.000)	(0.000)			
VIX	0.010	-0.265	-0.055	-0.009	0.002	1.000	
	(0.718)	(0.000)	(0.059)	(0.746)	(0.958)		
EXR	0.045	-0.034	0.484	0.026	0.836	0.019	1.000
	(0.123)	(0.245)	(0.000)	(0.377)	(0.000)	(0.517)	

Panel C: NSE

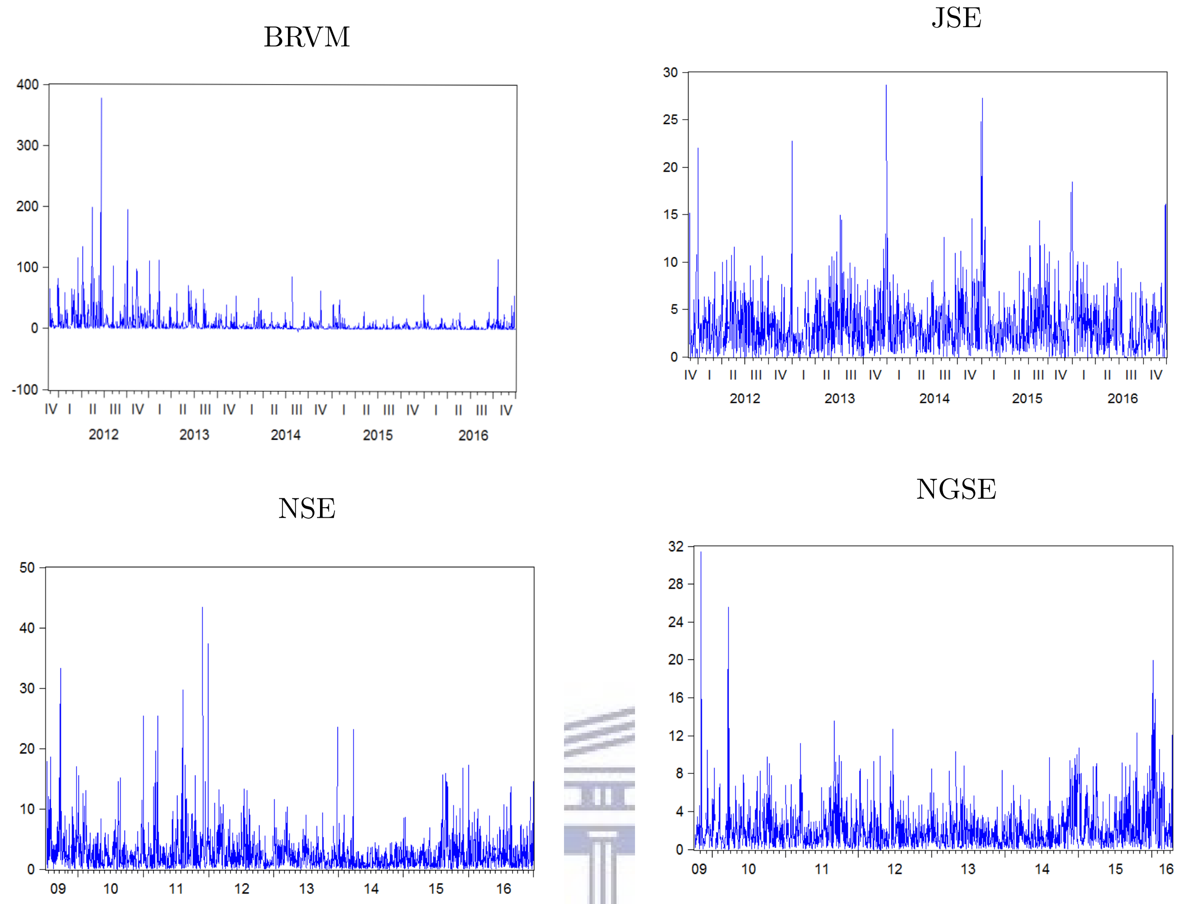
VARIABLES	Amihud	R	VOL	INF	DR	VIX	EXR
Amihud	1.000						
R	-0.082	1.000					
	(0.000)						
VOL	-0.014	-0.080	1.000				
	(0.558)	(0.000)					
INF	0.118	-0.076	-0.014	1.000			
	(0.000)	(0.001)	(0.543)				
DR	-0.105	0.003	0.046	0.113	1.000		
	(0.000)	(0.890)	(0.049)	(0.000)			
VIX	-0.003	0.053	0.002	-0.001	-0.003	1.000	
	(0.902)	(0.024)	(0.928)	(0.983)	(0.888)		
EXR	-0.036	-0.091	0.016	0.143	0.703	0.006	1000
	(0.123)	(0.000)	(0.498)	(0.000)	(0.000)	(0.804)	

Panel D: NGSE

VARIABLES	Amihud	R	VOL	INF	DR	VIX	EXR
Amihud	1.000						
R	-0.003	1.000					
	(0.899)						
VOL	-0.004	0.062	1.000				
	(0.862)	(0.009)					
INF	0.021	0.036	-0.072	1.000			
	(0.373)	(0.135)	(0.003)				
DR	0.011	-0.001	0.067	-0.207	1.000		
	(0.646)	(0.957)	(0.005)	(0.000)			
VIX	-0.006	0.075	-0.036	-0.006	-0.005	1.000	
	(0.797)	(0.002)	(0.131)	(0.801)	(0.839)		
EXR	0.018	-0.025	0.107	0.462	0.567	-0.004	1.000
	(0.450)	(0.290)	(0.000)	(0.000)	(0.000)	(0.851)	

Note: p-values in parenthesis
Source: Author's estimations

Figure 4.5: Amihud's (2002) illiquidity measure



Source: Author's estimations

between VIX and Amihud. EXR is strongly positively correlated to DR in all markets, except in the BRVM where the correlation is negative.

From the plots in Figure 4.5, it can be seen that the liquidity series were quite volatile in all the markets, with periods of extreme illiquidity.

The next section will present the empirical analysis conducted and the interpretation of the findings will be given.

4.5 EMPIRICAL ANALYSIS AND FINDINGS

4.5.1 Introduction

The main objective of this section is to present the empirical analysis conducted in this study using the Markov-Switching Vector Autoregressive (MS-VAR) model explained in the previous section. The MSVAR model in this study is an adaptation of Martinez Peria's (2002), and Mandilaras and Bird's (2010) model. However, in their study, Martinez Peria (2002) applied the MS-VAR with time-varying transition probabilities (TVTP) model to date periods of speculative pressure in countries of the European Monetary System. In her model, the data was pooled for all the countries and one model was estimated while controlling for country-specific effects through dummy variables. Conversely, this study is along the lines of Mandilaras and Bird's (2010) and the MSVAR with TVTP is estimated for each country separately. First, the unit root test will be conducted on all variables included in the model for each market considered. Then, a series of 2-regime MS-VAR models will be estimated using the Amihud (2002) illiquidity measure to model liquidity. Finally, the granger causality test will be conducted. The last subsection concludes the section.

4.5.2 Unit root test

Each variable included in the models is subjected to the Augmented Dickey Fuller (ADF) test to examine stationarity. The test equation included both an intercept and a trend, and the AIC was used for the optimal lag order in the ADF test. The results are presented in Table 4.3 below.

From the table it can be seen in all four markets, that all of the variables are stationary in levels (i.e. they are $I(0)$), except INF, DR and EXR which are stationary only at first difference (i.e they are $I(1)$). Thus, INF, DR and EXR will be differenced once before being introduced in the models.

Table 4.3: Results of the unit root tests

In levels				
Variables	BRVM	JSE	NSE	NGSE
Amihud	-21.944(0.000)***	-12.728(0.000)***	-19.049(0.000)***	-41.734(0.000)***
R	-35.308(0.000)***	-35.956(0.000)***	-29.985(0.000)***	-27.124(0.000)***
VOL	-17.058(0.000)***	-6.025(0.000)***	-22.421(0.000)***	-12.281(0.000)***
INF	-1.720(0.7417)	-1.815(0.697)	-2.212(0.482)	-0.068(0.995)
DR	-1.446(0.847)	-2.138(0.523)	-1.789(0.710)	-1.579(0.801)
VIX	-7.352(0.000)***	-7.334(0.000)***	-5.076(0.000)***	-5.649(0.000)***
EXR	-1.808(0.700)	-3.031(0.124)	-1.872(0.668)	-0.893(0.955)
First differences				
Variables	BRVM	JSE	NSE	NGSE
Amihud	-14.696(0.000)***	-18.576(0.000)***	-17.313(0.000)***	-19.715(0.000)***
R	-19.568(0.000)***	-19.009(0.000)***	-18.340(0.000)***	-20.187(0.000)***
VOL	-16.289(0.000)	-20.434(0.000)***	-19.561(0.000)***	-26.385(0.000)***
INF	-34.989(0.000)***	-34.913(0.000)***	-4.690(0.001)***	-41.817(0.000)***
DR	-35.105(0.000)***	-35.039(0.000)***	-42.722(0.000)***	-41.824(0.000)***
VIX	-35.255(0.000)***	-37.204(0.000)***	-20.850(0.000)***	-20.378(0.000)***
EXR	-39.64982(0.000)***	-34.568(0.000)***	-39.853(0.000)***	-44.636(0.000)***

Source: Author's estimations

Note: The MacKinnon (1996) one sided p-values are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

4.5.3 Lag order and regimes selection

Some warnings exist against the application of particular statistical criteria when selecting the number of regimes to include in the MS models. For example, Psaradakis and Spagnolo's (2003) Monte Carlo analysis revealed that the procedures based on optimization of complexity-penalized likelihood measures and those that exploit the ARMA representation admitted by the Markov-switching processes (i.e. the Akaike Information Criterion), may be correct in their estimation of the state dimension, only when the hidden Markov chain is somewhat persistent, and the changes in parameters are not too small. Therefore, the number of regimes chosen in this model involve a degree of subjectivity. The two-regime model was selected for its consistency to the criterion of parsimony. In effect, in the vector autoregressive framework, the available degrees of freedom drop as quickly as the increase in the number of estimated parameters. Furthermore, it is intuitive to model the process with two regimes in the liquidity application of the model in emerging and developing markets as the data shows the prevalence of either a highly illiquid state or a relatively liquid state.

Additionally, still in the spirit of keeping the model parsimonious, the MSVAR models are fitted with $p \leq 2$ lags and the model which minimizes the Schwartz Information Criterion (SIC) is chosen . Thus, for all models, and for all four countries, an MS(2)-VAR(2) is estimated.

4.5.4 MS-VAR model with TVTP estimation

Table 4.4 presents the results of the TVTP estimation as well as the MSVAR parameters' estimations when market returns R, market volatility VOL and discount rate DR are simultaneously included in the TVTP equation. The parameters ξ_0, ξ_1, ξ_2 and ξ_3 represent the coefficients of the intercept, R, VOL and DR, respectively, in the transition probabilities of staying in regime one and the transition probabilities of switching from regime two to regime one. The results presented in panel A indicate that for the NGSE and NSE, the coefficient of R in the TVTP equation is not statistically significant for both regimes. In the JSE, the coefficient of R is only statistically significant in the transition probabilities of switching from regime two to regime one; while in the BRVM, the coefficient of R is statistically significant for both regimes. In fact, all coefficients are statistically significant in the transition probabilities of both regimes in the BRVM. Only the coefficient of the constant vector (i.e. the intercept) ξ_0 in the first regime is statistically significant in the case of the JSE; while all coefficients are statistically significant in the transition probabilities of switching from regime two to regime one. Only *VOL* and the intercept in regime one are statistically significant for the NGSE. In the JSE, the transition probabilities of switching from regime two to regime one is significantly affected by *R*, *VOL* and *DR*, although the coefficient of *R* is considerably smaller compared to the coefficient of *VOL*. In this case, *R* and *DR* have a negative effect on the transition probabilities, as the coefficient is negative.

The first liquidity regime appears to be more persistent in the BRVM than they are in any of the other three markets. In the BRVM, regime one lasts more than 9.45 days.

When observing *DR* in the models summarized in Tables 4.5 - 4.11, it can be seen that the coefficient of DR is statistically significant in the transition probabilities equations for both regimes and for all models in the case of the JSE (at the one percent and five percent level of significance) and in the case of the NGSE at the 10 percent level of significance. The signs of the coefficients of DR in the JSE indicate that the probability of illiquidity in the JSE remaining in regime one increases with an increase in the discount rate in South Africa, and the probability of illiquidity shifting from regime two to regime one decreases with an increase in the discount rate. The reverse occurs in the NGSE. In effect,the signs of the coefficients of DR in the NGSE indicate that the probability of illiquidity in the NGSE remaining in regime one decreases with an increase in the discount rate in Nigeria, and the probability of illiquidity shifting from regime two to regime one increases with an increase in the discount rate In the NSE, the coefficient of DR is only statistically significant in the transition probabilities equation of liquidity remaining in regime one. The sign of the coefficient also shows that the probability of illiquidity in the NSE remaining in regime one decreases with an increase in the discount rate in Kenya.

The coefficient of VIX is seen to be statistically significant in the transition probabilities equations of the regime staying in the first state in the NSE. In the JSE, however, the coefficient of this variable which represents global investors' confidence is found to be statistically significant only in the transition probabilities equation of switching from regime two to regime one. In both cases, the coefficients have a positive sign which suggests the probability of illiquidity in the NSE remaining in regime one increases with an increase in global investors' confidence, and that the probability of illiquidity in the JSE switching from regime two to regime one increases with an increase in global investors' confidence.

The coefficient of VOL is also found to be statistically significant in transition probabilities equations of liquidity switching from regime two to regime one in the NSE as can be seen in model three presented in Table 4.6. In the JSE, the coefficient of VOL is statistically significant at the one percent level of significance in the transition probabilities equation of liquidity changing from regime two to regime one in model one (cf. Table 4.4). The parameter estimates for model two and three presented in Table 4.5 and 4.6 show that the coefficient of VOL is statistically significant at the one percent level of significance in the transition probabilities equation of both liquidity regimes. Models one and two for the NGSE also found the coefficient of *VOL* to be statistically significant at the five percent and one percent level of significance, respectively, in the transition probabilities equations of liquidity remaining in regime one.

The coefficient of *EXR* is seen to be statistically significant in the transition probabilities equations of both regimes in the BRVM. In the NSE, however, the coefficient of the exchange rate variable is found to be statistically significant only in the transition probabilities equation of the regime staying in the first state. In the case of the NSE, the coefficients have a positive sign which suggests that the probability of illiquidity in the NSE remaining in regime one increases with an increase in the exchange rate (i.e. a depreciation of the Kenyan shilling). Similarly, in the case of the BRVM, the coefficients are mainly positive implying that the probability of illiquidity in the BRVM being in either regimes with an increase in the exchange rate (i.e. a depreciation of the Francs CFA).

The coefficients of both the Day and Month dummies showed no evidence of being statistically significant in the transition probabilities equations of both liquidity regimes for all markets except the BRVM.

Generally, in the NSE, JSE and the NGSE, grouping the indicators together in the TVTP equations produces a better fit than fitting them individually. This can be seen by comparing the loglikelihood of the models when indicators are grouped (presented in Table 4.4 to 4.15) and the loglikelihood obtained by fitting the indicators individually (presented in Table C1 to C4 in the Appendix C). Only the fit of either *VIX* or *DR* in the BRVM is better based on the loglikelihood compared to the indicators included in the TVTP equation in pairs. However, the two methods produce the same results.

4.5.5 Granger causality / Block exogeneity test

The results from the Granger causality tests are summarized in Tables 4.16 to 4.19. In the BRVM, there is uni-directional causality from *DR*, *EXR* and *INF* to *Amihud*. In other words, the discount rate, the exchange rate and inflation both Granger cause illiquidity. Similarly, the day of the week Granger causes illiquidity. In contrast, *R* and *VOL* do not Granger cause

Table 4.4: MSVAR with TVTP model one

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	7.381 (0.000)***	-2.064 (0.987)**	1.071 (0.298)***	1.103 (0.316)***
ξ_1: R	0.251 (0.000)***	0.037 (0.086)	-0.234 (0.126)*	-0.064 (0.073)
ξ_2: VOL	-0.787 (0.000)***	0.344 (0.234)	-0.001 (0.001)	0.193 (0.092)**
ξ_3: DR	-2.028 (0.000)***	0.262 (0.185)	-0.071 (0.029)**	-0.055 (0.028)
$S_t = 2$				
ξ_0	12.815 (0.000)***	2.336 (0.886)***	1.384 (0.707)**	-0.356 (0.677)
ξ_1: R	-0.565 (0.000)***	-0.348 (0.173)**	0.705 (0.524)	-0.113 (0.204)
ξ_2: VOL	6.809 (0.000)***	0.867 (0.277)***	0.020 (0.041)	0.154 (0.323)
ξ_3: DR	7.069 (0.000)***	-0.529 (0.165)***	-0.049 (0.054)	0.087 (0.064)
LogL	-4397.909	-1761.156	-2852.291	-2774.761

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	3.66 (0.00)***	1.31 (0.05)***	0.76 (0.05)***	0.54 (0.04)***
β_1	0.06 (0.00)***	0.07 (0.03)***	0.15 (0.03)***	0.10 (0.03)***
β_2	0.02 (0.00)***	0.09 (0.03)***	0.06 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	39.24 (0.00)***	0.16 (0.10)*	-0.82 (0.21)***	-0.94 (0.19)***
β_1	0.56 (0.00)***	0.09 (0.06)	0.43 (0.09)***	0.06 (0.15)
β_2	0.35 (0.00)***	-0.05 (0.05)	-0.02 (0.05)	0.04 (0.10)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	9.45 days	1.67 days	2.61 days	3.96 days
$S_t = 2$	1.00 days	1.96 days	1.25 days	1.32 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	38.694 (0.000)***	0.253 (0.037)***	0.706 (0.054)***	0.704 (0.061)***
$\Sigma_{S_t=2}$	2102.918 (0.000)***	1.391 (0.089)***	1.515 (0.170)***	3.014 (0.291)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.5: MSVAR with TVTP model two

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	1.698 (0.000)***	-0.744 (0.325)**	0.234 (0.192)	0.273 (0.214)
ξ_1: R	0.187 (0.000)***	0.042 (0.093)	-0.002 (0.012)	-0.094 (0.088)
ξ_2: VOL	-0.562 (0.000)***	0.511 (0.202)**	-0.024 (0.023)	0.513 (0.159)***
ξ_3: DAY	-0.006 (0.000)***	0.026 (0.173)	0.009 (0.040)	-0.039 (0.145)
$S_t = 2$				
ξ_0	13.061 (0.000)***	-0.393 (0.308)	0.540 (0.268)**	0.567 (0.357)
ξ_1: R	-10.445 (0.000)***	-0.324 (0.201)	-0.402 (0.472)	-0.103 (0.197)
ξ_2: VOL	89.494 (0.000)***	-0.387 (0.486)**	0.060 (0.083)	-0.348 (0.189)*
ξ_3: DAY	-0.485 (0.000)***	0.202 (0.209)	0.449 (0.265)*	0.512 (0.354)
LogL	-4437.362	-1766.442	-3973.825	-2775.087

B- MSVAR Model parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	3.68 (0.00)***	1.29 (0.06)***	0.73 (0.05)***	0.54 (0.04)***
β_1	0.06 (0.00)***	0.08 (0.03)***	0.13 (0.03)***	0.11 (0.03)***
β_2	0.03 (0.00)***	0.09 (0.03)***	0.07 (0.03)***	0.07 (0.03)***
$S_t = 2$				
β^0	38.89 (0.00)***	0.10 (0.12)	-0.69 (0.18)***	-0.89 (0.17)***
β_1	0.51 (0.00)***	0.12 (0.07)*	0.48 (0.09)***	0.02 (0.11)
β_2	0.48 (0.10)***	-0.04 (0.05)	-0.02 (0.06)	0.03 (0.11)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	10.68 days	1.64 days	2.36 days	3.95 days
$S_t = 2$	1.00 days	1.82 days	1.26 days	1.44 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	39.088 (0.000)***	0.277 (0.050)***	0.697 (0.057)***	0.705 (0.057)***
$\Sigma_{S_t=2}$	2086.026 (0.000)***	1.402 (0.094)***	1.715 (0.157)***	3.015 (0.282)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.6: MSVAR with TVTP model three

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	1.521 (0.000)***	-0.676 (0.429)	0.046 (0.239)	0.832 (0.397)**
ξ_1: R	0.184 (0.000)***	0.044 (0.094)	-0.132 (0.184)	-0.064 (0.145)
ξ_2: VOL	-0.551 (0.000)***	0.518 (0.208)***	-0.031 (0.031)	0.212 (0.161)
ξ_3: MONTH	0.181 (0.000)***	-0.098 (0.352)	0.197 (0.253)	-0.306 (0.303)
$S_t = 2$				
ξ_0	55.174 (0.000)***	-0.526 (0.495)	4.562 (19.018)	4.819 (85.255)
ξ_1: R	27.439 (0.000)***	-0.325 (0.194)*	0.433 (0.620)	-0.125 (0.431)
ξ_2: VOL	63.510 (0.000)***	0.495 (0.243)**	0.035 (0.048)***	-0.137 (0.271)
ξ_3: MONTH	59.896 (0.000)***	0.237 (0.408)	-3.888 (19.014)	-4.268 (85.317)
LogL	-4437.022	-1766.869	-4199.946	-2774.538

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	3.68 (0.00)***	1.29 (0.06)***	0.75 (0.05)***	0.53 (0.05)***
β_1	0.06 (0.00)***	0.08 (0.03)***	0.13 (0.03)***	0.11 (0.03)***
β_2	0.03 (0.00)***	0.09 (0.03)***	0.07 (0.03)***	0.07 (0.03)***
$S_t = 2$				
β^0	38.89 (0.00)***	0.12 (0.12)	-0.67 (0.18)***	-0.90 (0.17)***
β_1	0.51 (0.00)***	0.12 (0.07)*	0.47 (0.09)***	-0.02 (0.23)
β_2	0.48 (0.00)***	-0.04 (0.05)	0.00 (0.02)	0.03 (0.14)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	10.66 days	1.61 days	2.30 days	4.30 days
$S_t = 2$	1.00 days	1.85 days	1.28 days	1.45 days

D- Covariance Matrix

$\Sigma_{S_t=1}$	39.053 (0.000)***	0.270 (0.047)***	0.681 (0.055)***	0.699 (0.060)***
$\Sigma_{S_t=2}$	2085.224 (0.000)***	1.401 (0.093)***	1.709 (0.167)***	3.061 (0.300)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.7: MSVAR with TVTP model four

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	6.600 (0.707)***	-2.841 (1.000)***	1.055 (0.314)***	1.259 (0.309)***
ξ_1: R	0.444 (0.046)***	-0.050 (0.117)	-0.262 (0.127)**	-0.051 (0.070)
ξ_2: VIX	-0.012 (0.009)	-0.043 (0.026)	0.026 (0.011)**	-0.002 (0.008)
ξ_3: DR	-1.786 (0.247)***	0.446 (0.166)***	-0.074 (0.030)	-0.050 (0.028)*
$S_t = 2$				
ξ_0	2.069 (2466.875)	2.015 (0.832)**	1.621 (0.746)**	-0.171 (0.580)
ξ_1: R	2.153 (286.428)	-0.169 (0.175)	0.572 (0.416)	-0.109 (0.160)
ξ_2: VIX	-8.897 (316.535)	0.036 (0.017)**	0.009 (0.017)	-0.013 (0.025)
ξ_3: DR	9.230 (800.113)	-0.363 (0.142)***	-0.059 (0.058)	0.103 (0.059)*
LogL	-4663.444	-1767.271	-2848.759	-2778.739

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	4.17 (0.40)***	1.31 (0.05)***	0.75 (0.05)***	0.51 (0.04)***
β_1	0.07 (0.01)***	0.08 (0.03)***	0.15 (0.03)***	0.09 (0.02)***
β_2	0.09 (0.01)***	0.09 (0.03)***	0.06 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	61.22 (2.58)***	0.18 (0.09)*	-0.80 (0.18)***	-1.03 (0.19)***
β_1	-0.86 (0.08)***	0.09 (0.06)	0.47 (0.08)***	0.19 (0.13)
β_2	0.63 (0.05)***	-0.01 (0.04)	-0.01 (0.05)	0.11 (0.11)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	17.52 days	1.66 days	2.48 days	4.16 days
$S_t = 2$	1.38 days	2.12 days	1.21 days	1.23 days

D- Covariance Matrix

$\Sigma_{S_t=1}$	62.128 (1.454)***	0.242 (0.036)***	0.718 (0.054)***	0.738 (0.058)***
$\Sigma_{S_t=2}$	445.907 (6.863)***	1.419 (0.088)***	1.564 (0.160)***	3.179 (0.321)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.8: MSVAR with TVTP model five

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	1.297 (0.000)***	-0.385 (0.301)	0.270 (0.256)	0.787 (0.160)***
ξ_1: R	0.074 (0.000)***	-0.077 (0.139)	-0.069 (0.227)	-0.047 (0.066)
ξ_2: VIX	-0.002 (0.000)	-0.048 (0.039)	0.028 (0.012)**	-0.002 (0.007)
ξ_3: DAY	0.036 (0.000)	0.009 (0.128)	-0.073 (0.187)	-0.057 (0.131)
$S_t = 2$				
ξ_0	216.856 (0.000)***	-0.161 (0.210)	0.717 (0.269)***	0.654 (0.317)**
ξ_1: R	135.063 (0.000)***	-0.117 (0.179)	-0.383 (0.761)	-0.186 (0.181)
ξ_2: VIX	-2.228 (0.000)***	0.034 (0.018)*	0.007 (0.026)	-0.008 (0.026)
ξ_3: DAY	231.212 (0.000)***	0.192 (0.201)	0.471 (0.306)	0.557 (0.395)
LogL	-4431.868	-1771.556	-2852.202	-2779.835

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	3.62 (0.00)***	1.32 (0.06)***	0.72 (0.05)***	0.50 (0.04)***
β_1	0.06 (0.00)***	0.08 (0.03)***	0.13 (0.03)***	0.09 (0.02)***
β_2	0.03 (0.00)***	0.09 (0.03)***	0.07 (0.03)**	0.07 (0.02)***
$S_t = 2$				
β^0	38.33 (0.00)***	0.17 (0.11)	-0.73 (0.23)***	-1.07 (0.19)***
β_1	0.31 (0.00)	0.11 (0.06)*	0.51 (0.09)***	0.20 (0.16)
β_2	0.56 (0.00)***	0.00 (0.03)	-0.01 (0.10)	0.13 (0.11)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	10.70 days	1.56 days	2.42 days	4.42 days
$S_t = 2$	1.01 days	2.09 days	1.22 days	1.21 days

D- Covariance Matrix

$\Sigma_{S_t=1}$	37.489 (0.000)***	0.238 (0.043)***	0.719 (0.069)***	0.754 (0.058)***
$\Sigma_{S_t=2}$	2033.567 (0.000)***	1.409 (0.088)***	1.721 (0.176)***	3.230 (0.336)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.9: MSVAR with TVTP model six

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	233.222 (948.041)	-0.497 (0.619)	0.145 (0.317)	1.228 (0.335)***
ξ_1: R	0.189 (0.099)*	-0.092 (0.163)	-0.192 (0.124)	-0.040 (0.083)
ξ_2: VIX	0.001 (0.007)	-0.055 (0.057)	0.026 (0.011)**	-0.005 (0.009)
ξ_3: MONTH	-231.514 (948.039)	0.059 (0.424)	0.174 (0.269)	-0.446 (0.309)
$S_t = 2$				
ξ_0	96.121 (Inf)	-0.095 (0.317)	4.468 (15.216)	4.173 (32.249)
ξ_1: R	-56.583 (Inf)	-0.113 (0.187)	0.471 (0.413)	-0.132 (0.202)
ξ_2: VIX	-8.519 (45.057)	0.034 (0.020)*	0.006 (0.019)	0.002 (0.037)
ξ_3: MONTH	89.279 (1090.363)	0.045 (0.319)	-3.541 (15.185)	-3.668 (32.252)
LogL	-4756.258	-1772.080	-2851.719	-2777.973

B- MSVAR Model parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	4.33 (0.32)***	1.32 (0.06)***	0.73 (0.05)***	0.50 (0.04)***
β_1	0.07 (0.01)***	0.08 (0.03)***	0.14 (0.03)***	0.11 (0.02)***
β_2	0.10 (0.01)***	0.09 (0.03)***	0.06 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	37.29 (5.54)***	0.18 (0.12)	-0.82 (0.20)***	-0.96 (0.18)***
β_1	-0.77 (0.24)***	0.11 (0.07)**	0.49 (0.08)***	-0.00 (0.02)
β_2	4.55 (0.34)***	0.00 (0.02)	0.01 (0.04)	0.07 (0.12)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	24.33 days	1.52 days	2.59 days	4.79 days
$S_t = 2$	1.03 days	2.10 days	1.21 days	1.40 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	88.973 (3.982)***	0.233 (0.046)***	0.723 (0.056)***	0.734 (0.059)***
$\Sigma_{S_t=2}$	443.789 (41.431)***	1.411 (0.089)***	1.614 (0.189)***	3.223 (0.329)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.10: MSVAR with TVTP model seven

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	6.374 (0.000)***	-2.617 (0.971)***	1.075 (0.301)***	1.235 (0.319)***
ξ_1: R	0.179 (0.000)***	0.040 (0.099)	-0.220 (0.124)*	-0.055 (0.073)
ξ_2: DR	-1.774 (0.000)***	0.436 (0.166)***	-0.072 (0.029)**	-0.046 (0.027)*
ξ_3: DAY	0.012 (0.000)***	0.016 (0.106)	0.022 (0.098)	-0.039 (0.143)
$S_t = 2$				
ξ_0	6.910 (0.000)***	2.327 (1.091)**	1.161 (0.681)*	-0.086 (0.433)
ξ_1: R	-17.341 (0.000)***	-0.280 (0.189)	0.580 (0.458)	-0.127 (0.176)
ξ_2: DR	24.678 (0.000)***	-0.423 (0.184)**	-0.043 (0.055)	0.073 (0.044)*
ξ_3: DAY	11.610 (0.000)***	0.261 (0.210)	0.382 (0.268)	0.340 (0.412)
LogL	-4538.996	-1769.318	-2851.992	-2778.603

B- MSVAR Model parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	3.94 (0.00)***	1.26 (0.06)***	0.75 (0.05)***	0.52 (0.04)***
β_1	0.06 (0.00)***	0.07 (0.03)***	0.15 (0.03)***	0.09 (0.02)***
β_2	0.02 (0.00)***	0.09 (0.03)***	0.06 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	67.49 (0.00)***	0.12 (0.12)	-0.83 (0.21)***	-1.03 (0.19)***
β_1	0.02 (0.00)	0.09 (0.07)	0.44 (0.09)***	0.19 (0.14)
β_2	0.16 (0.00)***	-0.03 (0.05)	-0.02 (0.06)	0.12 (0.11)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	13.94 days	1.85 days	2.64 days	4.17 days
$S_t = 2$	1.00 days	1.93 days	1.23 days	1.24 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	45.413 (0.000)***	0.283 (0.057)***	0.713 (0.055)***	0.735 (0.058)***
$\Sigma_{S_t=2}$	446.4796 (0.000)***	1.458 (0.104)***	1.521 (0.173)***	3.154 (0.319)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.11: MSVAR with TVTP model eight

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	280.550 (0.000)***	-2.612 (0.982)***	0.907 (0.365)**	1.605 (0.416)***
ξ_1: R	0.113 (0.000)***	0.033 (0.101)	-0.197 (0.117)*	-0.054 (0.068)
ξ_2: DR	-1.917 (0.000)***	0.436 (0.167)***	-0.074 (0.028)***	-0.044 (0.028)
ξ_3: MONTH	-273.669 (0.000)***	-0.022 (0.158)	0.218 (0.266)	-0.408 (0.300)
$S_t = 2$				
ξ_0	9.871 (0.000)***	2.340 (1.105)**	5.275 (28.875)	1.937 (7.242)
ξ_1: R	-31.353 (0.000)***	-0.270 (0.186)	0.579 (0.445)	-0.096 (0.163)
ξ_2: DR	38.174 (0.000)***	-0.406 (0.178)**	-0.037 (0.052)	0.089 (0.067)
ξ_3: MONTH	11.072 (0.000)***	0.042 (0.253)	-4.048 (28.696)	-2.114 (7.086)
LogL	-4691.026	-1770.174	-2851.194	-2776.707

B- MSVAR Model parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	4.23 (0.00)***	1.26 (0.06)***	0.76 (0.05)***	0.51 (0.04)***
β_1	0.06 (0.00)***	0.07 (0.03)***	0.15 (0.02)***	0.10 (0.02)***
β_2	0.06 (0.00)***	0.09 (0.03)***	0.06 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	50.72 (0.00)***	0.12 (0.11)	-0.83 (0.19)***	-1.03 (0.20)***
β_1	-0.25 (0.00)***	0.10 (0.07)	0.43 (0.08)***	0.13 (0.15)
β_2	1.30 (0.00)***	-0.03 (0.05)	-0.02 (0.06)	0.11 (0.11)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	18.20 days	1.82 days	2.63 days	4.34 days
$S_t = 2$	1.00 days	1.94 days	1.25 days	1.26 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	68.946 (0.000)***	0.279 (0.053)***	0.703 (0.049)***	0.738 (0.059)***
$\Sigma_{S_t=2}$	463.372 (0.000)***	1.457 (0.102)***	1.503 (0.172)***	3.170 (0.323)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.12: MSVAR with TVTP model nine

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	-12.074 (3.626)***	-1.380 (1.183)	8.995 (4.269)**	2.464 (2.017)
ξ_1: R	0.056 (0.086)	0.030 (0.085)	-0.195 (0.130)	-0.054 (0.071)
ξ_2: VOL	-0.237 (0.149)	0.363 (0.226)	0.005 (0.008)	0.217 (0.115)*
ξ_3: EXR	2.070 (0.576)***	0.373 (0.528)	-1.935 (0.975)**	-0.376 (0.392)
$S_t = 2$				
ξ_0	-12.389 (7.005)*	1.503 (1.126)	4.277 (5.026)	-3.288 (5.484)
ξ_1: R	0.226 (0.077)***	-0.232 (0.181)	0.314 (0.435)	-0.109 (0.188)
ξ_2: VOL	-0.146 (0.184)	0.724 (0.288)**	-0.018 (0.013)	0.064 (0.289)
ξ_3: EXR	2.038 (1.121)*	-0.902 (0.504)*	-0.751 (1.111)	0.740 (1.059)
LogL	-3973.331	-1720.803	-2857.174	-2774.761

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	1.90 (0.09)***	1.32 (0.05)***	0.74 (0.05)***	0.53 (0.04)***
β_1	0.01 (0.00)***	0.07 (0.03)***	0.14 (0.03)***	0.11 (0.02)***
β_2	0.01 (0.00)***	0.08 (0.03)***	0.07 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	21.08 (2.33)***	0.18 (0.10)*	-0.80 (0.23)***	-0.92 (0.17)***
β_1	0.04 (0.10)	0.04 (0.06)	0.43 (0.09)***	-0.001 (0.01)
β_2	0.41 (0.10)***	-0.03 (0.05)	-0.01 (0.77)	0.03 (0.10)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	4.54 days	1.76 days	2.69 days	4.22 days
$S_t = 2$	1.59 days	2.05 days	1.24 days	1.39 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	3.936 (0.333)***	0.257 (0.042)***	0.722 (0.058)***	0.706 (0.059)***
$\Sigma_{S_t=2}$	1017.425 (84.343)***	1.407 (0.092)***	1.597 (0.191)***	3.073 (0.303)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.13: MSVAR with TVTP model ten

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	-0.909 (12.950)	0.324 (0.890)	15.522 (14.971)	2.224 (1.863)
ξ_1: R	0.281 (0.143)**	0.176 (0.099)*	0.874 (0.258)***	-0.043 (0.068)
ξ_2: VIX	0.001 (0.020)	-0.002 (0.010)	-0.013 (0.030)	-0.001 (0.007)
ξ_3: EXR	0.432 (2.061)	0.270 (0.368)	-2.662 (3.283)	-0.287 (0.362)
$S_t = 2$				
ξ_0	-2.326 (0.000)***	-116.886 (207.207)	-113.433 (126.597)	-2.937 (5.178)
ξ_1: R	8.119 (0.000)***	-49.533 (86.679)	3.358 (3.803)	-0.136 (0.160)
ξ_2: VIX	1.037 (0.000)***	-2.213 (3.664)	-0.524 (0.490)	-0.011 (0.026)
ξ_3: EXR	-2.111 (0.000)***	62.489 (109.939)	22.515 (25.813)	0.744 (1.015)
LogL	-4655.351	-1728.920	-2910.030	-2780.477

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	1.80 (0.18)***	0.92 (0.04)***	0.37 (0.03)***	0.50 (0.04)***
β_1	0.06 (0.01)***	0.06 (0.03)**	0.16 (0.03)***	0.09 (0.02)***
β_2	0.04 (0.01)***	0.06 (0.03)***	0.06 (0.03)**	0.07 (0.02)***
$S_t = 2$				
β^0	19.23 (1.55)***	-0.91 (0.30)***	-0.28 (0.10)***	-1.03 (0.20)***
β_1	-0.09 (0.04)**	0.41 (0.16)***	0.00 (0.01)	0.17 (0.16)
β_2	0.04 (0.04)	-0.11 (0.13)	-0.12 (0.07)*	0.13 (0.11)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	26.70 days	5.94 days	360.41 days	4.35 days
$S_t = 2$	17.90 days	1.29 days	131.36 days	1.24 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	20.213 (0.308)***	0.676 (0.044)***	1.368 (0.051)***	0.744 (0.059)***
$\Sigma_{S_t=2}$	587.163 (27.224)***	2.063 (0.302)***	1.607 (0.155)***	3.236 (0.336)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.14: MSVAR with TVTP model eleven

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	-10.040 (3.889)***	-2.171 (1.217)*	8.898 (4.326)**	2.120 (1.809)
ξ_1: R	0.038 (0.092)	0.008 (0.077)	-0.224 (0.127)*	-0.049 (0.066)
ξ_2: EXR	1.763 (0.619)***	0.892 (0.490)*	-1.913 (0.990)*	-0.261 (0.352)
ξ_3: DAY	-0.029 (0.105)	-0.067 (0.214)	0.033 (0.115)	-0.055 (0.130)
$S_t = 2$				
ξ_0	-34.512 (194.222)	0.522 (1.112)	3.391 (5.137)	-1.762 (4.176)
ξ_1: R	0.240 (0.101)**	-0.114 (0.187)	0.498 (0.476)	-0.172 (0.174)
ξ_2: EXR	2.592 (1.313)**	-0.293 (0.460)	-0.590 (1.136)	0.469 (0.812)
ξ_3: DAY	18.542 (195.184)	0.300 (0.236)	0.396 (0.285)	0.534 (0.395)
LogL	-4096.918	-1726.781	-2853.389	-2779.667

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	2.18 (0.11)***	1.28 (0.07)***	0.74 (0.05)***	0.50 (0.04)***
β_1	0.01 (0.00)**	0.07 (0.03)***	0.15 (0.03)***	0.09 (0.02)***
β_2	0.01 (0.00)***	0.08 (0.03)***	0.06 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	21.01 (2.48)***	0.14 (0.13)	-0.85 (0.24)***	-1.06 (0.19)***
β_1	-0.10 (0.09)	0.05 (0.07)	0.46 (0.09)***	0.20 (0.16)
β_2	0.35 (0.10)***	-0.01 (0.06)	-0.02 (0.06)	0.13 (0.11)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	6.45 days	1.88 days	2.70 days	4.36 days
$S_t = 2$	2.67 days	2.01 days	1.21 days	1.22 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	5.881 (0.551)***	0.279 (0.060)***	0.722 (0.058)***	0.750 (0.058)***
$\Sigma_{S_t=2}$	1028.813 (84.567)***	1.458 (0.103)***	1.549 (0.198)***	3.225 (0.334)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.15: MSVAR with TVTP model twelve

A- State variables coefficients estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
ξ_0	-32.403 (167.343)	-1.157 (1.109)	8.541 (4.163)**	2.299 (2.121)
ξ_1: R	0.021 (0.087)	0.100 (0.110)	-0.200 (0.120)*	-0.048 (0.069)
ξ_2: EXR	2.479 (0.612)***	0.595 (0.432)	-1.873 (0.951)**	-0.214 (0.411)
ξ_3: MONTH	17.614 (167.029)	0.148 (0.293)	0.210 (0.261)	-0.444 (0.304)
$S_t = 2$				
ξ_0	-5.249 (6.828)	1.936 (2.086)	7.953 (15.204)	0.158 (0.937)
ξ_1: R	0.216 (0.075)***	-0.557 (0.668)	0.506 (0.439)	-0.111 (0.185)
ξ_2: EXR	0.921 (1.082)	-0.429 (0.799)	-0.658 (1.181)	0.755 (1.169)
ξ_3: MONTH	-0.274 (0.240)	-0.087 (0.507)	-4.140 (14.634)	-3.391 (6.200)
LogL	-4006.293	-1728.367	-2852.857	-2777.950

B- MSVAR parameters estimates

	BRVM	JSE	NSE	NGSE
$S_t = 1$				
β^0	1.83 (0.09)***	1.07 (0.09)***	0.74 (0.05)***	0.51 (0.04)***
β_1	0.01 (0.00)***	0.06 (0.03)**	0.15 (0.03)***	0.10 (0.03)***
β_2	0.01 (0.00)***	0.08 (0.03)***	0.06 (0.02)***	0.07 (0.02)***
$S_t = 2$				
β^0	18.70 (2.15)***	-0.31 (0.29)	-0.85 (0.23)***	-1.00 (0.21)***
β_1	0.08 (0.00)	0.20 (0.14)	0.45 (0.08)***	0.06 (0.17)
β_2	0.39 (0.10)***	-0.07 (0.08)	-0.02 (0.05)	0.09 (0.13)

C- Expected Duration of Regimes

	BRVM	JSE	NSE	NGSE
$S_t = 1$	3.56 days	2.90 days	2.69 days	4.59 days
$S_t = 2$	1.62 days	1.30 days	1.23 days	1.31 days

D- Covariance Matrix

	BRVM	JSE	NSE	NGSE
$\Sigma_{S_t=1}$	3.637 (0.292)***	0.495 (0.093)***	0.711 (0.053)***	0.739 (0.062)***
$\Sigma_{S_t=2}$	958.255 (74.946)***	1.671 (0.214)***	1.536 (0.206)***	3.222 (0.333)***

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

illiquidity, but illiquidity is found to Granger cause market return and market volatility. No Granger causality was found between *VIX* and the month of the year and illiquidity.

In the JSE, there is uni-directional causality from *R* to *Amihud*. That is, market returns Granger cause illiquidity in the JSE. Moreover, there is bi-directional causality between *VOL* and *Amihud*. This means that market volatility Granger causes illiquidity; and illiquidity also Granger causes market volatility in the JSE. There is no causality between any of the other variables and illiquidity.

In the NSE, bi-directional causality was found between *DR* and *Amihud*. That is, the discount rate Granger causes illiquidity, at the one percent level of significance. Interestingly, the Granger causality found that from illiquidity to the discount rate, even at the five percent level of significance, does not make economic sense. This is the case as, based on economic theory, DR is said to be independently determined by the monetary policy authority. Furthermore, there is uni-directional causality between *INF* and *Amihud*, *EXR* and *Amihud*, and *Day* and *Amihud* at the five percent level of significance; as well as between *VIX* and *Amihud* at the 10 percent level of significance. Hence, it can be concluded that changes in inflation, exchange rates, global investor's confidence and the day of the week Granger cause changes in illiquidity in the NSE. No other causality was found between the remaining variables and *Amihud*.

Finally, the Granger causality test in the NGSE indicated bi-directional causality between *VOL* and *Amihud* at the one percent level of significance and between *VIX* and *Amihud* at the five percent and one percent level of significance. That is, market volatility Granger causes illiquidity, and illiquidity Granger causes market volatility. Moreover, global investors' confidence Granger causes illiquidity, and illiquidity Granger causes global investors' confidence. In addition, uni-directional causality was found between *Day* and *Amihud*, and *EXR* and *Amihud* at the five percent level of significance meaning that changes in exchange rates and the day of the week Granger cause illiquidity. There was no further causality between the other information variables and *Amihud* in the NGSE.

Table 4.16: Granger causality test on the eight variables - BRVM

Null Hypothesis:	F-Statistic	p-value
$AMIHUD$ does not Granger Cause R	4.116	0.017**
R does not Granger Cause $AMIHUD$	0.066	0.936
$AMIHUD$ does not Granger Cause VOL	23.151	1.E-10***
VOL does not Granger Cause $AMIHUD$	1.107	0.331
$AMIHUD$ does not Granger Cause VIX	0.581	0.560
VIX does not Granger Cause $AMIHUD$	0.854	0.426
$AMIHUD$ does not Granger Cause INF	0.774	0.461
INF does not Granger Cause $AMIHUD$	23.323	1.E-10***
$AMIHUD$ does not Granger Cause DR	0.119	0.888
DR does not Granger Cause $AMIHUD$	33.391	8.E-15***
$AMIHUD$ does not Granger Cause EXR	0.163	0.849
EXR does not Granger Cause $AMIHUD$	8.780	0.000***
$AMIHUD$ does not Granger Cause DAY	2.465	0.086*
DAY does not Granger Cause $AMIHUD$	3.758	0.024**
$AMIHUD$ does not Granger Cause $MONTH$	2.244	0.107
$MONTH$ does not Granger Cause $AMIHUD$	1.144	0.319

Source: Author's estimations

Note: *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.17: Granger causality test on the seven variables - JSE

Null Hypothesis:	F-Statistic	p-value
R does not Granger Cause $AMIHUD$	3.993	0.019**
$AMIHUD$ does not Granger Cause R	1.417	0.243
VOL does not Granger Cause $AMIHUD$	8.018	0.000***
$AMIHUD$ does not Granger Cause VOL	36.110	6.E-16***
VIX does not Granger Cause $AMIHUD$	1.766	0.172
$AMIHUD$ does not Granger Cause VIX	0.322	0.724
INF does not Granger Cause $AMIHUD$	1.059	0.347
$AMIHUD$ does not Granger Cause INF	0.179	0.836
DR does not Granger Cause $AMIHUD$	0.202	0.817
$AMIHUD$ does not Granger Cause DR	0.740	0.478
EXR does not Granger Cause $AMIHUD$	0.987	0.373
$AMIHUD$ does not Granger Cause EXR	0.044	0.957
DAY does not Granger Cause $AMIHUD$	0.711	0.491
$AMIHUD$ does not Granger Cause DAY	1.097	0.334
$MONTH$ does not Granger Cause $AMIHUD$	1.836	0.160
$AMIHUD$ does not Granger Cause $MONTH$	0.991	0.372

Source: Author's estimations

Note: *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.18: Granger causality test on the seven variables - NSE

Null Hypothesis:	F-Statistic	p-value
R does not Granger Cause $AMIHUD$	1.182	0.307
$AMIHUD$ does not Granger Cause R	0.194	0.824
VOL does not Granger Cause $AMIHUD$	0.785	0.456
$AMIHUD$ does not Granger Cause VOL	2.071	0.126
VIX does not Granger Cause $AMIHUD$	2.757	0.064*
$AMIHUD$ does not Granger Cause VIX	1.883	0.153
INF does not Granger Cause $AMIHUD$	3.365	0.035**
$AMIHUD$ does not Granger Cause INF	1.093	0.336
DR does not Granger Cause $AMIHUD$	6.261	0.002***
$AMIHUD$ does not Granger Cause DR	3.235	0.039**
EXR does not Granger Cause $AMIHUD$	3.884	0.021**
$AMIHUD$ does not Granger Cause EXR	2.916	0.054*
DAY does not Granger Cause $AMIHUD$	4.173	0.016**
$AMIHUD$ does not Granger Cause DAY	0.414	0.661
$MONTH$ does not Granger Cause $AMIHUD$	0.275	0.760
$AMIHUD$ does not Granger Cause $MONTH$	1.791	0.167

Source: Author's estimations

Note: *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table 4.19: Granger causality test on the seven variables - NGSE

Null Hypothesis:	F-Statistic	p-value
R does not Granger Cause $AMIHUD$	0.350	0.705
$AMIHUD$ does not Granger Cause R	0.455	0.634
VOL does not Granger Cause $AMIHUD$	7.307	0.001***
$AMIHUD$ does not Granger Cause VOL	68.551	2.E-29***
VIX does not Granger Cause $AMIHUD$	4.316	0.014**
$AMIHUD$ does not Granger Cause VIX	7.775	0.000***
INF does not Granger Cause $AMIHUD$	0.749	0.473
$AMIHUD$ does not Granger Cause INF	0.454	0.635
DR does not Granger Cause $AMIHUD$	0.351	0.704
$AMIHUD$ does not Granger Cause DR	0.284	0.753
EXR does not Granger Cause $AMIHUD$	3.291	0.037**
$AMIHUD$ does not Granger Cause EXR	0.781	0.458
DAY does not Granger Cause $AMIHUD$	3.264	0.039**
$AMIHUD$ does not Granger Cause DAY	0.247	0.782
$MONTH$ does not Granger Cause $AMIHUD$	0.826	0.438
$AMIHUD$ does not Granger Cause $MONTH$	0.173	0.841

Source: Author's estimations

Note: *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

4.5.6 Discussion of the results and conclusion

This section presented the empirical analysis and the findings of the MSVAR framework used to investigate the determinants of aggregate liquidity in the four Sub-Saharan stock markets highlighted in this study. The Augmented Dickey Fuller (ADF) test used to investigate stationarity in each of the variables included in the model showed that almost all the variables are $I(0)$ at the one percent level of significance for all four markets. Only INF and DR were found to be $I(1)$ at the one percent level of significance in all four markets. The time series were thus differenced once for the purpose of this analysis.

Twelve models were estimated. The results showed that in the NGSE and JSE, the DR is statistically significant in the transition probabilities equations of both regimes. These results also indicate that the probability of illiquidity in the JSE remaining in regime one increases with an increase in the discount rate in South Africa. The results also indicate that for the NGSE and NSE, market return is not statistically significant for both regimes in the TVTP equation. In the JSE, the coefficient of market returns is only statistically significant in the transition probabilities of switching from regime two to regime one; while in the BRVM, the coefficient of market returns is statistically significant for both regimes. In fact, all coefficients are statistically significant in the transition probabilities of both regimes in the BRVM. Only the intercept in the first regime is statistically significant in the case of the JSE; while all coefficients are statistically significant in the transition probabilities of switching from regime two to regime one. Only domestic volatility and the intercept in regime one are statistically significant for the NGSE. In the JSE, the transition probabilities of switching from regime two to regime one is significantly affected by market returns, domestic volatility and discount rate, although the coefficient of market returns is considerably smaller compared to the coefficient of domestic volatility. In this case, market returns and discount rate have a negative effect on the transition probabilities, as the coefficient is negative. The first liquidity regime is found to be more persistent in the BRVM than they are in any of the other three markets. In the BRVM, regime one lasts more than 9.45 days.

The discount rate is statistically significant in the transition probabilities equations for both regimes and for all models in the case of the JSE (at the one percent and five percent level of significance) and in the case of the NGSE at the 10 percent level of significance. Moreover, the probability of illiquidity in the JSE remaining in regime one increases with an increase in the discount rate in South Africa, and the probability of illiquidity shifting from regime two to regime one decreases with an increase in the discount rate. The reverse occurs in the NGSE where the probability of illiquidity remaining in regime one decreases with an increase in the discount rate in Nigeria, and the probability of illiquidity shifting from regime two to regime one increases with an increase in the discount rate. In the NSE, the discount rate is only statistically significant in the transition probabilities equation of liquidity remaining in regime one. Furthermore, the probability of illiquidity in the NSE remaining in regime one decreases with an increase in the discount rate in Kenya.

The coefficient of global investors' confidence is seen to be statistically significant in the transition probabilities equations of the regime staying in the first state in the NSE. In the JSE, however, the coefficient of this variable which represent global investors' confidence is found to be statistically significant only in the transition probabilities equation of switching from regime two to regime one. In both cases, the coefficients have a positive sign which suggests the probability of illiquidity in the NSE remaining in regime one increases with an increase in global investors' confidence, and that the probability of illiquidity in the JSE switching from regime two to regime one increases with an increase in global investors' confidence.

Domestic volatility was found to be statistically significant in transition probabilities equations of liquidity switching from regime two to regime one in the NSE. In the JSE, domestic volatility is statistically significant at the one percent level of significance in the transition probabilities equation of liquidity changing from regime two to regime one in model one and statistically significant at the one percent level of significance in the transition probabilities equation of both liquidity regimes in model two and three. Models one and two for the NGSE also found domestic volatility to be statistically significant at the five percent and one percent level of significance, respectively, in the transition probabilities equations of liquidity remaining in regime one.

The exchange rate was found to be a determinant of both regimes in the BRVM. In the NSE, however, the exchange rate variable is found to be significant only for the illiquidity regime staying in the first state. In the case of the NSE, the coefficients have a positive sign which suggests that the probability of illiquidity in the NSE remaining in regime one increases with a depreciation of the Kenyan shilling. Similarly, in the case of the BRVM, the coefficients are mainly positive implying that the probability of illiquidity in the BRVM being in either regimes increases with a depreciation of the Francs CFA.

However, no evidence was found of the effect of the day of the week and the month of the year on the transition probabilities of both liquidity regimes for all markets except the BRVM.

The Granger causality test showed that changes in the discount rate and inflation Granger cause changes in illiquidity in the BRVM and the NSE. Only in the JSE changes in market return were found to Granger cause changes in illiquidity while changes in market volatility were found to Granger cause changes in illiquidity in the JSE and the NGSE. Moreover, changes in global investors' confidence and the days of the week were found to Granger cause changes in illiquidity in the NSE and the NGSE; while changes in exchange rates were found to Granger cause changes in illiquidity in all markets except the JSE. Interestingly, changes in illiquidity were also found to Granger cause changes in market returns in the BRVM, as well as changes in market volatility in the BRVM, JSE and NGSE. In addition, changes in illiquidity Granger cause changes in global investors' confidence in the NGSE.

As can be observed from the above results, the indicators that significantly affect illiquidity differ from one market to the next. In most of the markets, there is a consensus that increase in the discount rate leads to an increase in illiquidity, while a depreciation of the local currency increases the level of illiquidity (i.e. decreases the level of liquidity). This makes economic sense as an increase in the discount rate increases the rate at which investors will borrow from the financial institution to finance their investment (i.e. the lending rate). This will affect both the liquidity demand and supply side of the market by decreasing the amount of bids to buy as well as offer or bids to sell. The markets hence becomes more illiquid. Similarly, a depreciation of the domestic currency, despite making transactions more attractive to the securities' buyers, makes transactions less attractive for the securities' sellers. This is especially the case in the two West African countries as well as the East African market, where periods of social and political crises have led to financial instability and frequent depreciation of the currencies. The South African currency does not seem to have a significant impact on the level of liquidity on the JSE as it is more stable than the other three currencie.

The relative isolation of the BRVM from other global markets, as well as its relatively small size may serve as an explanation of the fact that the liquidity levels in this market are not affected by the global investors' sentiment. Intuitively, most participants in the BRVM, especially in recent year, could be more attracted to the market because of the high returns recorded. This explains the effect of market returns on the level of illiquidity.

4.6 CONCLUSION AND RECOMMENDATIONS

4.6.1 Summary of findings

The study aimed at investigating the concept of liquidity in Sub-Saharan African stock markets by examining the patterns of aggregate market liquidity in the four selected Sub-Saharan African stock markets over time, as well as by investigating the relevance of the mainstream determinants of market liquidity in these markets. The focus was on four relatively well-established markets in the region, namely the Johannesburg Stock Exchange (JSE), Nairobi Securities Exchange (NSE), Nigerian Stock Exchange (NGSE) and la Bourse Regionale des Valeurs Mobilieres (i.e. West African regional stock exchange, BRVM).

African markets have made considerable efforts to position themselves in line with their developed counterparts. This includes a restructuring of the market microstructure through the establishment of central depository systems as well as supervisory and monitoring institutions. The markets also embraced technological innovations by adopting automated electronic trading and settlement systems, and shortening their settlement cycles. However, despite all these improvements and the implementation of regulatory reforms aimed at protecting investors and improving information dissemination, the markets in Sub-Saharan Africa remain small and highly illiquid. With the exception of the JSE, which is the biggest in the region in terms of market capitalization and the most liquid in terms of turnover ratio and value traded ratio, the three other Sub-Saharan African markets under consideration in this study remain small and relatively illiquid with both the turnover ratio and the value traded ratio at less than 10 percent as of 2015.

The theoretical literature highlights three main theoretical concepts informing the choice of the determinant factors affecting stock market liquidity. According to the market microstructure theory, market liquidity is affected by fluctuation in inventory as well as information asymmetry. The SCP paradigm, in turn, hypothesizes that a firm's market power is the driving factor of liquidity as it improves the firm's future cash flow. This improvement will then stabilize the price of stocks and increase liquidity. Lastly, based on the evidence of the existence of seasonal regularities in different markets, it is argued these regularities may play a major role in determining stock market liquidity.

Although the empirical literature contains a number of studies on the concept of liquidity, the drivers of stock market liquidity, particularly in Sub-Saharan African markets, have seldom been investigated. The common conclusion from most studies suggests that stock market liquidity is affected by monetary policy shocks, financial regulations and market conditions such as returns and volatility. Finally, distinctive monthly and weekly regularities in market liquidity were identified.

While most of the studies employed simple regression estimation techniques such as the OLS, as well as the unrestricted VAR framework in analysing the relationships between the identified factors and stock market liquidity measures, this study employed the Markov Switching Vector Autoregressive (MS-VAR) with time varying transition probabilities (TVTP) that were estimated for each country separately in a bid to capture the differences in liquidity regimes and identify the factors specific to each regime.

The estimations were divided into twelve separate models. The results of the estimations showed that the discount rate is a determining factor for both liquidity regimes in the NGSE and the JSE. In the JSE, the probability of illiquidity remaining in regime one increases (decreases) with an increase (decrease) in the discount rate in South Africa. Apart from the cases of the JSE and the BRVM, market returns were not found to be determinants of market liquidity in the NGSE and NSE. In the JSE, market returns were found to determine the transition probabilities of switching from regime two to regime one, while in the BRVM market returns determined the transition probabilities of both regimes.

Moreover, the probability of illiquidity in the JSE remaining in regime one increases with an increase in the discount rate in South Africa, and the probability of illiquidity shifting from regime two to regime one decreases with an increase in the discount rate. The reverse occurs in the NGSE where the probability of illiquidity remaining in regime one decreases with an increase in the discount rate in Nigeria, and the probability of illiquidity shifting from regime two to regime one increases with an increase in the discount rate In the NSE, the probability of illiquidity remaining in regime one decreases with an increase in the discount rate in Kenya.

The evidence shows that global investors' confidence is a determining factor of the illiquidity regime staying in the first state in the NSE. In the JSE, however, global investors' confidence is a determining factor of the illiquidity regime switching from regime two to regime one. In both cases, the coefficients have a positive sign which suggests that the probability of illiquidity in the NSE remaining in regime one increases with an increase in global investors' confidence, and that the probability of illiquidity in the JSE switching from regime two to regime one increases with an increase in global investors' confidence.

Furthermore, domestic volatility was found to be a determining factor of illiquidity switching from regime two to regime one in the NSE. In the JSE, domestic volatility was also found to be a determining factor of the illiquidity regime changing from regime two to regime one in model one and a determining factor of both liquidity regimes in model two and three. Models one and two for the NGSE also found domestic volatility to affect the probabilities of liquidity remaining in regime one.

Finally, no evidence was found of the effect of the day of the week and the month of the year on the transition probabilities of both liquidity regimes for all markets except the BRVM.

The Granger causality test showed that changes in the discount rate and inflation Granger cause changes in illiquidity in the BRVM and the NSE. Only in the JSE, changes in market return were found to Granger cause changes in illiquidity; while changes in market volatility were found to Granger cause changes in illiquidity in the JSE and the NGSE. Moreover, changes in global investors' confidence and the days of the week were found to Granger cause changes in illiquidity in the NSE and the NGSE. Interestingly, changes in illiquidity were also found to Granger cause changes in market returns in the BRVM, as well as changes in market volatility in the BRVM, JSE and NGSE. In addition, changes in illiquidity Granger cause changes in global investors' confidence in the NGSE.

4.6.2 Implications and policy recommendations

The results of this study have important implications for regulators and policy makers. Firstly, the significance of global investors' sentiment in the TVTP equation for regime one in the NSE and the JSE suggests that global financial and economic conditions and other factors that can affect global investors' confidence, should be closely monitored by South African and Kenyan authorities in order to effectively counter the adverse effects of a change in investors' confidence on their domestic market's liquidity. Secondly, the significance of market volatility in the TVTP equations in the NSE, JSE and NGSE should inform the decision by stock market authorities in Kenya, South Africa and Nigeria to take the necessary measures aimed at keeping volatility in these markets as low as possible, which will effectively improve liquidity in the Kenyan, South African and Nigerian markets.

Furthermore, the significance of the discount rate in the TVTP equation of regime one in all four markets as well as the Granger causality identified from the discount rate and illiquidity in the BRVM and NSE imply that the monetary policy authorities should be cautious about changes in the discount rate, if it wants to keep market illiquidity low. Moreover, inflation rate should be kept as low as possible in order to reduce its effect on market illiquidity. Finally, because illiquidity was found to Granger cause market return in the BRVM and market volatility in the BRVM, JSE and NGSE, the authorities from these markets should focus on further improving market microstructure, trading and settlement systems as well provide sound investors protection regulations, which were found to be ways of improving market liquidity.

4.6.3 Limitations of the study and areas of further research

The empirical analysis conducted in this study was limited by the unavailability of trading volume data and market microstructure data such as intra-day values of stock prices as well as bid and ask prices. This issue restricted the study to the estimation of only a limited number of liquidity measures. Moreover, the unavailability of the data may have affected the estimation of the Amihud (2002) illiquidity measure. This imposed the use of interpolation to replace the missing values and increased the risk of data mining. As this study could be regarded as a starting point of a comprehensive investigation of market liquidity in the Sub-Saharan African Markets, it could be interesting to broaden the scope of the analysis by analysing the presence of the contagion effects on stock market liquidity among Sub-Saharan African countries.

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Appendix C

Table C.1: TVTP indicators: BRVM

$S_t = 1$								
ξ_0	0.961***	1.006***	1.325***	1.006***	6.399***	0.775***	30.801	-12.42
	(0.099)	(0.066)	(0.066)	(0.073)	(0.000)	(0.083)	(20172.361)	(3.635
ξ_1: R	-0.263*							
	(0.137)							
ξ_1: VOL		-0.211***						
		(0.041)						
ξ_1: VIX			-0.003					
			(0.008)					
ξ_1: INF				-0.211***				
				(0.042)				
ξ_1: DR					-1.863 ***			
					(0.000)			
ξ_1: Day						0.039		
						(0.101)		
ξ_1: Month							-29.980	
							(20172.379)	
ξ_1: EXR								2.103*
								(0.578
$S_t = 2$								
ξ_0	0.293*	0.586***	521.325	0.586***	-0.471***	0.319**	-1.870***	-11.56
	(0.155)	(0.131)	(1.171e+11)	(0.130)	(0.000)	(0.135)	(0.133)	(6.792
ξ_1: R	0.002							
	(0.174)							
ξ_1: VOL		-0.186***						
		(0.063)						
ξ_1: VIX			-30.738					
			(6.832e+09)					
ξ_1: INF				-0.186***				
				(0.063)				
ξ_1: DR					5.629***			
					(0.000)			
ξ_1: Day						-0.047		
						(0.158)		
ξ_1: Month							2.122***	
							(0.163)	
ξ_1: EXR								1.893*
								(1.085
LogL	-3986.969	-3969.428	-4445.813	-3969.428	-4409.374	-3988.496	-4038.229	-3979.
AIC	7.997e+03	7.962e+03	8.915e+03	7.963e+03	8.843e+03	8.001e+03	8.100e+03	7.983e
SIC	8.059e+03	8.024e+03	8.977e+03	8.024e+03	8.904e+03	8.062e+03	8.162e+03	8.044e

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table C.2: TVTP indicators: JSE

$S_t = 1$								
ξ_0	-0.151	-0.688**	-0.363	-0.832	-2.541***	-0.086	-0.164	0.043
	(0.099)	(0.277)	(0.234)	(0.934)	(0.974)	(0.358)	(0.322)	(0.417)
ξ_1: R	0.047							
	(0.111)							
ξ_1: VOL		0.494**						
		(0.201)						
ξ_1: VIX			-0.041					
			(0.028)					
ξ_1: INF				0.125				
				(0.160)				
ξ_1: DR					0.426**			
					(0.170)			
ξ_1: Day						-0.018		
						(0.141)		
ξ_1: Month							0.048	
							(0.270)	
ξ_1: EXR								0.352*
								(0.181)
$S_t = 2$								
ξ_0	0.285	-0.257	-0.015	1.056	2.397**	0.165	0.233	-28.463
	(0.177)	(0.298)	(0.089)	(0.843)	(1.124)	(0.384)	(0.541)	(34.649)
ξ_1: R	-0.302							
	(0.242)							
ξ_1: VOL		0.466*						
		(0.246)						
ξ_1: VIX			0.033**					
			(0.016)					
ξ_1: INF				-0.137				
				(0.144)				
ξ_1: DR					-0.404**			
					(0.187)			
ξ_1: Day						0.276		
						(0.247)		
ξ_1: Month							0.076	
							(0.457)	
ξ_1: EXR								14.400
								(16.986)
LogL	-1774.325	-1768.591	-1773.094	-1774.691	-1771.407	-1774.478	-1775.251	-1732.119
AIC	3.573e+03	3.561e+03	3.570e+03	3.573e+03	3.567e+03	3.573e+03	3.574e+03	3.488e+0
SIC	3.634e+03	3.622e+03	3.631e+03	3.635e+03	3.628e+03	3.634e+03	3.636e+03	3.549e+0

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table C.3: TVTP indicators: NSE

$S_t = 1$								
ξ_0	0.367	0.200	0.143	-0.010	1.012***	1.041***	0.057	8.929*
	(0.326)	(0.242)	(0.241)	(0.488)	(0.373)	(0.241)	(0.469)	(5.227)
ξ_1: R	-0.173							
	(0.129)							
ξ_1: VOL		-0.023						
		(0.029)						
ξ_1: VIX			0.028**					
			(0.012)					
ξ_1: INF				0.045				
				(0.027)				
ξ_1: DR					-0.069**			
					(0.034)			
ξ_1: Day						-0.656**		
						(0.304)		
ξ_1: Month							0.245	
							(0.328)	
ξ_1: EXR								-1.947
								(1.198)
$S_t = 2$								
ξ_0	0.962***	0.703***	0.846***	1.174***	1.175*	-5.370	2.550	4.463
	(0.256)	(0.243)	(0.221)	(0.414)	(0.699)	(3.465e+05)	(8.263)	(5.494)
ξ_1: R	0.452							
	(0.694)							
ξ_1: VOL		0.057						
		(0.157)						
ξ_1: VIX			0.009					
			(0.016)					
ξ_1: INF				-0.058*				
				(0.034)				
ξ_1: DR					-0.032			
					(0.057)			
ξ_1: Day						5.415		
						(3.465e+05)		
ξ_1: Month							-1.768	
							(8.138)	
ξ_1: EXR								-0.814
								(1.212)
LogL	-2857.701	-2856.868	-2853.959	-2856.959	-2854.734	-2871.355	-2856.819	-2855.8
AIC	5.739e+03	5.738e+03	5.732e+03	5.738e+03	5.733e+03	5.767e+03	5.738e+03	5.736e-
SIC	5.805e+03	5.804e+03	5.798e+03	5.804e+03	5.799e+03	5.833e+03	5.804e+03	5.802e-

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Table C.4: TVTP indicators: NGSE

$S_t = 1$								
ξ_0	0.758***	0.315	0.752***	0.325	1.265***	0.785***	1.230***	2.339
	(0.143)	(0.220)	(0.144)	(0.359)	(0.303)	(0.167)	(0.327)	(1.959)
ξ_1: R	-0.043							
	(0.067)							
ξ_1: VOL		0.470**						
		(0.187)						
ξ_1: VIX			-0.002					
			(0.007)					
ξ_1: INF				0.044				
				(0.028)				
ξ_1: DR					-0.052*			
					(0.028)			
ξ_1: Day						-0.055		
						(0.146)		
ξ_1: Month							-0.442	
							(0.300)	
ξ_1: EXR								-0.310
								(0.380)
$S_t = 2$								
ξ_0	0.800**	0.647**	0.802**	1.764***	-0.282	0.631*	4.344	-3.564
	(0.349)	(0.289)	(0.365)	(0.682)	(0.588)	(0.325)	(13.969)	(5.207)
ξ_1: R	-0.148							
	(0.164)							
ξ_1: VOL		-0.256						
		(0.189)						
ξ_1: VIX			-0.009					
			(0.026)					
ξ_1: INF				-0.120**				
				(0.052)				
ξ_1: DR					0.106*			
					(0.058)			
ξ_1: Day						0.489		
						(0.403)		
ξ_1: Month							-3.888	
							(13.912)	
ξ_1: EXR								0.847
								(1.011)
LogL	-2780.959	-2777.519	-2781.883	-2780.572	-2779.760	-2781.227	-2779.008	-2781.554
AIC	5.586e+03	5.579e+03	5.588e+03	5.585e+03	5.584e+03	5.586e+03	5.582e+03	5.587e+0
SIC	5.651e+03	5.645e+03	5.653e+03	5.651e+03	5.649e+03	5.652e+03	5.648e+03	5.653e+0

Source: Author's estimations

Note: Standard errors are in the parenthesis. *, **, *** implies significance at 10 percent, 5 percent and 1 percent level, respectively.

Chapter 5

CONCLUSION

5.1 Summary of findings

The increase in the number of stock exchanges in the Sub-Saharan African region, from 11 in 1996 to about 20 in recent years, highlights the considerably speedy growth of the equity market sector in Sub-Saharan Africa. Although these still small and relatively illiquid markets only constitute a relatively small proportion of the world market capitalization, investors' interest in the region continues to grow due to the region's robust growth prospects, decreased political instability, improved macroeconomic management and strong global commodity demand. Furthermore, research has shown that more advanced capital markets could play a crucial role in efficiently mobilizing resources in Sub-Saharan Africa. Thus, in an attempt to further boost the broader economic impact of the Sub-Saharan African exchanges, propositions were made, such increasing the level of integration between national exchanges, financial integration in existing monetary unions and harmonization of regulation in the region. This thesis, which consisted of three standalone essays, aimed at closely examining several financial and economic aspects of selected Sub-Saharan African stock markets. Each essay focused on four Sub-Saharan African stock exchanges, namely, the Nigeria Stock exchange, the Nairobi Securities Exchange, the Johannesburg stock Exchange and the West African Exchange, as they constitute more than

80 percent of the total market capitalization in the region.

The first essay aimed at investigating the existence of stock price co-movements and volatility linkages among the four selected Sub-Saharan African markets, as well between the markets and two developed markets, namely the New York Stock Exchange and the London Stock Exchange. Using a sample of daily closing prices of the chosen markets' All Share indices for the period 2 January 2009 – 31 December 2016, bivariate and multivariate Johansen cointegration tests were conducted to examine the existence of price co-movements between the six markets. Evidence of cointegration was found between all six markets. The short-run relationships among the markets were tested with the aid of the VECM framework. The results showed that in the short run, changes in lagged stock returns of the developed stock markets led to a depression of almost all African stock markets except for the Nigerian case, where stock returns are only depressed by changes in lagged stock returns of the other African stock markets. The JSE is the only African market where stock returns are significantly and positively impacted by changes in lagged stock returns of the FTSE. Moreover, although the BRVM is the only market that does not significantly affect the JSE in the short run, its stock returns are in turn depressed by changes in lagged returns of the JSE. A further analysis was conducted by running the Granger causality test and the impulse response functions.

The presence of bi-directional causality was found between the NYSE and BRVM and NGSE, NYSE and JSE, and NYSE and FTSE at the five percent level of significance. Moreover, uni-directional causalities were uncovered between from the FTSE to the NGSE, NSE and JSE, showing that the returns from the selected markets in Sub-Saharan Africa are not completely isolated from shocks coming from developed countries as well as shocks occurring among themselves. The impulse response functions showed that the BRVM does not significantly respond to a shock to any of the other five markets, whether African or others, and a shock to the BRVM does not lead to a statistically significant response from any of the other markets. Moreover, the JSE's response to a shock to any of the African markets is not statistically significant; although the JSE's response to a shock to the NYSE, as well as to the FTSE, is strongly positive but statistically significant for a few days only. In turn, a shock to the JSE produces significant responses from the NGSE, the NYSE and the FTSE. Both the NGSE and NSE are significantly responsive to each other's innovations; while they both also significantly respond to innovations in the NYSE and FTSE.

The test of time varying correlation between the markets found high persistence of volatility in most pairwise correlation among the stock markets except for NGSE and NSE, NSE and BRVM, NSE and NYSE, NSE and FTSE. This shows that the conditional correlations are not constant for the pairs NSE-FTSE, JSE-NYSE, JSE-FTSE, BRVM-FTSE, NYSE-FTSE. Only the pairwise correlations for the NGSE and JSE, JSE and NYSE, show strong evidence of varying patterns in the correlation dynamic paths for the entire sample period. For most of the other pairs, the patterns in the correlation dynamic paths show small variations, and even seem to be constant.

When analyzing volatility trends and linkages, volatility in almost all of the markets found to decrease over time, except in the NSE where volatility is increasing, which can be considered as a sign of increasing investors' confidence in the stock markets. Furthermore, bi-directional causality in volatility was found between the NGSE and NSE, NGSE and JSE, JSE and NYSE, JSE and FTSE, and the NYSE and FTSE. In the remaining cases, changes in volatility are found to be independent.

The impulse response functions also confirmed that there are limited returns and volatility linkages among the African markets. Furthermore, only the NGSE, NSE and JSE are significantly affected by innovations in the developed markets. This confirms the theoretical view that countries that sharing strong economic ties are more likely to have their stock markets co-move. The UK and the USA being major trading partners of the English-speaking African countries considered in this study, it was anticipated that movements on these developed markets would affect the developing ones.

The second essay focused on investigating the relationship between financial liberalization and the development of stock markets in Sub-Saharan Africa. In the region, financial liberalization was not a uniform process across the Sub-Saharan African region. Most economies joined the movement in the 1980s, and while some undertook many reforms in the same year, others adopted a gradual method to liberalization by implementing only a couple of measures per year. Although most countries took considerable steps towards liberalization since 1980, a great number of them are still found with a low liberalization index in 2014. There was also some reversal of the reforms initially adopted due to their adverse effects on economic growth and development, or in the face of tough economic conditions experienced.

For different time periods specific to each country considered, quarterly values of the stock market development index (DEVINDEX), the capital account liberalization index (CAPLIB), stock market liberalization index (STOCKLIB), financial liberalization index (FINLIB), as well as two control variables (i.e. Inflation and Investment) were collected and used to conduct the empirical analysis. To examine each form of liberalization in isolation, a Bayesian VAR model was estimated for each country. The impulse response functions showed that the initial response of stock market development to an increase in capital account liberalization is negative in both Nigeria and Kenya. Although the response quickly becomes and stays positive, it starts dying out by the fifth year. Besides a positive yet considerably small initial response of stock market development to capital account liberalization in the WAEMU, the subsequent trend is similar to the Nigeria and Kenya. Conversely, a small negative initial response of stock market development is observed in South Africa, which remains constant and negative even after the fifth year.

The response of stock market development to an increase in stock market liberalization was found to be initially negative in all four markets. In South Africa, the effect of stock market liberalization on stock market development is relatively greater and more persistent than in the other countries where the response starts dying out after five years. Interestingly, the WAEMU market development was more responsive to stock market liberalization than it was to capital account liberalization. Lastly, the initial response of stock market development to an increase in financial sector liberalization was found to be negative in both South Africa and Kenya, while it was positive in Nigeria and nonexistent in the WAEMU. Although, in Kenya the response only became positive after the first year, it shows a persistence even after the fifth year. The response of the development index in South Africa, which recovers earlier than in Kenya, also has the same persistence. In the WAEMU and Nigeria, however, the response of stock market development increased, but was not persistent and started dying out by the fifth year.

The third essay aimed at investigating the concept of market liquidity in Sub-Saharan African stock markets by analyzing the patterns of aggregate market liquidity in the four chosen Sub-Saharan African markets, also by investigating the relevance of the mainstream determinants of market liquidity in the chosen markets. Considerable efforts have been made by African markets over the years to position themselves in line with their developed counterparts. This includes a restructuring of the market microstructure through the establishment of central depository systems as well as supervisory and monitoring institutions. The markets also embraced technological innovations by adopting automated electronic trading and settlement systems, and shortening their settlement cycles. These improvements and the implementation of regulatory reforms aimed at protecting investors and improving information dissemination, still come short of enhancing the Sub-Saharan African markets' size and liquidity levels. With the exception of the JSE, which is the biggest in the region in terms of market capitalization and the most liquid in terms of turnover ratio and value traded ratio, the three other Sub-Saharan African markets under consideration in this study remain small and relatively illiquid with both the turnover ratio and the value traded ratio at less than 10 percent as of 2015.

The empirical analysis in this study made use of the Markov Switching Vector Autoregressive (MS-VAR) framework with time varying transition probabilities (TVTP). The results of the estimations showed that the discount rate is a determining factor for both liquidity regimes in the NGSE and the JSE. In fact, in the JSE, the probability of illiquidity remaining in regime one increases (decreases) with an increase (decrease) in the discount rate in South Africa. Apart from the cases of the JSE and the BRVM, market returns were not found to be determinants of market liquidity in the NGSE and NSE. In the JSE, market returns were found to determine the transition probabilities of switching from regime two to regime one, while in the BRVM market returns determined the transition probabilities of both regimes. Moreover, the probability of illiquidity in the JSE remaining in regime one increases with an increase in the discount rate in

South Africa, and the probability of illiquidity shifting from regime two to regime one decreases with an increase in the discount rate. The reverse occurs in the NGSE where the probability of illiquidity remaining in regime one decreases with an increase in the discount rate in Nigeria, and the probability of illiquidity shifting from regime two to regime one increases with an increase in the discount rate. In the NSE, the probability of illiquidity remaining in regime one decreases with an increase in the discount rate in Kenya.

The evidence showed that global investors' confidence is a determining factor of the illiquidity regime staying in the first state in the NSE. In the JSE, however, global investors' confidence is a determining factor of the illiquidity regime switching from regime two to regime one. In both cases, the coefficients have a positive sign which suggests that the probability of illiquidity in the NSE remaining in regime one increases with an increase in global investors' confidence, and that the probability of illiquidity in the JSE switching from regime two to regime one increases with an increase in global investors' confidence.

Furthermore, domestic volatility was found to be a determinant of illiquidity switching from regime two to regime one in the NSE. In the JSE, domestic volatility was also found to be a determining factor of both liquidity regimes. Models one and two for the NGSE also found domestic volatility to affect the probabilities of liquidity remaining in regime one. Finally, no evidence was found of the effect of the day of the week and the month of the year on the transition probabilities of both liquidity regimes for all markets except the BRVM.

The Granger causality test showed that changes in the discount rate and inflation Granger cause changes in illiquidity in the BRVM and the NSE. Only in the JSE, changes in market return were found to Granger cause changes in illiquidity; while changes in market volatility were found to Granger cause changes in illiquidity in the JSE and the NGSE. Moreover, changes in global investors' confidence and the days of the week were found to Granger cause changes in illiquidity in the NSE and the NGSE. Interestingly, changes in illiquidity were also found to Granger cause changes in market returns in the BRVM, as well as changes in market volatility in the BRVM, JSE and NGSE. In addition, changes in illiquidity Granger cause changes in global investors' confidence in the NGSE.

5.2 Contribution of the study

The first essay exposes a generous context and stylized facts on the selected Sub-Saharan African stock markets regarding their evolution and economic and financial interdependence. This context constitutes a crucial step in understanding the trends in price and volatility spillovers. The detailed analytics of intra-regional trade between the selected regions coupled with the results of the empirical analysis clarified the state of integration among the selected markets and the policy interventions that could be implemented. Although the level of interdependence between the markets remain quite low, there is still significant spillovers between the Nigerian Stock market and the Nairobi Stock exchange. As argued in the discussion, this confirms the hypothesis that the existence of strong economic and financial ties between two countries and a third party country could lead to interdependence and spillover between these two countries. Also, the results of the study confirmed the information based theory that highlights the importance of firm-level an market-level information to determination of the degree of synchronicity among stocks. In effect, in an efficient market where newly available information is immediately reflected in stock prices, changes in prices on a dominant market may serve as a signal to investors in less dominant markets, who will in turn make investment decision based on the information from the dominant market. This illustrated by the spillover found from the JSE and NYSE to the other African markets, as well as the spillovers between the JSE and the more developed markets.

The second essay uncovered an heterogeneous effect of both capital account liberalization and financial sector liberalization on stock market development in Africa. This evidence deviates from the common emphasis on stock market development being largely a result of increased market activity and investor participation. In effect, a market like the JSE which have the highest level of liquidity and investors participation compared to the other three markets, has a short- and long-run negative response to an increase in capital liberalization, and a short-run negative response to an increase in financial sector liberalization. It can be posited that the heterogeneity in the responses may stem from the type of liberalization implemented and as well as the regional locational effects on the markets.

The third essay revealed the significant influence of macroeconomic factors and policies such as the monetary policy, inflation and exchange rate on liquidity in Sub-Saharan African markets. Although the liquidity effects varied across regimes and across markets, a consensus was established that increase in the discount rate leads to an increase in illiquidity, while a depreciation of the local currency increases the level of illiquidity (i.e. decreases the level of liquidity). Despite the fact that a number of studies have previously documented the relationship between macroeconomic variables and stock market liquidity levels, this work presents new and slight different evidence, as a closer look it taken at liquidity effects. The study also departs from the heavy microstructure emphasis in the literature maintaining that low liquidity occurs as a result of low investor participation.

5.3 Implications and policy recommendations

The results found in this thesis have important implications for investors, regulators and policy makers. The limited co-movements and volatility spillovers reveal an existing opportunity to diversify investment portfolio. In effect, being aware of the volatility linkages between markets could help investors in minimizing the volatility of their portfolios. In addition, these results could also assist in arbitrage and stock market predictability exercises. Furthermore, the stronger responsiveness of returns and volatility to domestic shocks compared to foreign shocks imply that policymakers should put an emphasis on domestic macroeconomic stability in order to maintain financial stability. Policymakers in South Africa and Nigeria more specifically should, however, remain vigilant to volatility crises in the developed economies as they tend to have a more significant effect on their domestic markets volatility. Lastly, the importance of the existing regional trade and financial linkages might encourage the diversification of the exports base as a natural macroeconomic strategy in an attempt to limit the harmful effects of volatility into the domestic stock markets, created by a slow-down in the demand for certain exports.

The existence of negative correlation between stock market development inflation in all four markets, suggests that policy makers in the Sub-Saharan African countries considered in the study should pay special attention to inflation targeting policies in order to positively contribute to enhancing the markets. Likewise, the positive correlation found between stock market development and the liberalization of stock markets and the financial sector in all four countries, also advocate for the opening of financial markets to international investors, as well as the deepening of the sector. These implications are confirmed by the positive long-run response of stock market development to all three forms of liberalization in all the markets considered. More emphasis should therefore be put on improving financial openness process and removing of the restrictions in the financial sectors of the respective economies, as this will help deliver credit to the private sector more effectively, efficiently evaluate credit and surveil public-sector.

Moreover, with global investors' sentiment identified as a determinant of market liquidity in the NSE and the JSE, South African and Kenyan authorities should closely monitor global financial and economic conditions as well as other factors that can affect global investors' confidence, in order to effectively counter the adverse effects of a change in investors' confidence on their domestic market's liquidity. On the other hand, the significance of market volatility as a determinant of market liquidity in the NSE, JSE and NGSE should inform the decision by stock market authorities in Kenya, South Africa and Nigeria to take the necessary measures aimed at keeping volatility in these markets as low as possible, which will effectively improve liquidity in the Kenyan, South African and Nigerian markets. In addition, the results of the empirical analysis suggest that discount rate should be avoided as far as possible in order to keep market illiquidity low in the BRVM and NSE. The same applies to the inflation rate which should be kept as low as possible in order to reduce its effect on market illiquidity. Finally, because illiquidity was found to Granger cause market return in the BRVM and market volatility in the BRVM, JSE and NGSE, the authorities from these markets should focus on further improving market microstructure, trading and settlement systems as well provide sound investors protection regulations, which were found to be ways of improving market liquidity.

5.4 Limitations of the study and areas of further research

This thesis was limited by the unavailability of values for business days being holidays in the different markets considered. This imposed the use of interpolation to replace the missing values and increases the risk of data mining. The risk of data mining was also present in the second essay with the use of issue of the Newton's method of interpolation to create a dataset in quarterly frequencies from time series of annual frequencies, for most of the variables selected for the analysis and in most of the countries considered. This could have also affected the robustness of the results. Thus, the results of these analysis should be interpreted with caution. Moreover, the empirical analysis conducted in the third essay was limited by the unavailability of trading volume data and market microstructure data such as intra-day values of stock prices as well as bid and ask prices. This issue restricted the study to the estimation of only a limited number of liquidity measures. Moreover, the unavailability of the data may have affected the estimation of the Amihud (2002) illiquidity measure.

While the study was only confined to four Sub-Saharan African countries, it could be interesting to deepen the analysis by including more African countries while accounting for differences in size and level of development. Furthermore, it could be of interest to examine the impact of current account liberalization on stock markets' performance in the region. In addition, this thesis could be regarded as a starting point of a comprehensive investigation of market liquidity in the Sub-Saharan African Markets. It could therefore be interesting to broaden the scope of the analysis by analysing the presence of the contagion effects on stock market liquidity among Sub-Saharan African countries using a panel time series framework.

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