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Lappeenranta University of Technology

School of Business and Management

Master's Degree Programme in Strategic

Finance and Business Analytics

## MASTERS THESIS

Return and Volatility spillovers among stock and Foreign  
Exchange Markets: Empirical Evidence from selected African  
Markets

Benjamin Adjei

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**ABSTRACT**

**Author** Benjamin Adjei  
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 Dr. Sheraz Ahmed  
 Dr. Elena Fedorova

Return and volatility dynamics in financial markets across the world have recently become important for the purpose of asset pricing, portfolio allocation and risk management. However, volatility, which come about as a result of the actions of market participants can help adapt to different situations and perform when it really matters. With recent development and liberalization among financial markets in emerging and frontier markets, the need for how the equity and foreign exchange markets interact and the extent to which return and volatility spillover are spread across countries is of importance to investors and policy makers at large.

Financial markets in Africa have received attention leading to investors diversifying into them in times of crisis and contagion effects in developed countries. Regardless of the benefits these markets may offer, investors must be wary of issues such as thin trading, volatility that exists in the equity and currency markets and its related fluctuations. The study employs a VAR-GARCH BEKK model to study the return and volatility dynamics between the stock and foreign exchange sectors and among the equity markets of Egypt, Kenya, Nigeria, South Africa and Tunisia.

The main findings suggest a higher dependence of own return in the stock markets and a one way return spillover from the currencies to the equity markets except for South Africa which has a weaker interrelation among the two markets. There is a relatively limited integration among the equity markets. Return and volatility spillover is mostly uni-directional except for a bi-directional relationship between the equity markets of Egypt and Tunisia.

The study implication still proves a benefit for portfolio managers diversifying in these African equity markets, since they are independent of each other and may not be highly affected by the influx of negative news from elsewhere. However, there is the need to be wary of return and volatility spillover between the equity and currency markets, hence devising better hedging strategies to curb them.

**Keywords:** Volatility, Returns, Emerging and Frontier Markets, Equity, Foreign Exchange

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## Table of Contents

|  |    |
|--|----|
| ACKNOWLEDGEMENT .....  | 2  |
| 1. INTRODUCTION .....  | 7  |
| 1.1 Research Questions .....   | 11 |
| 1.2 Aims and Objectives .....  | 11 |
| 1.3 Motivation .....   | 12 |
| 1.4 Contribution to Existing Literature.....   | 13 |
| 1.5 Limitation and Scope of the Study.....   | 14 |
| 1.6 Structure of the study.....  | 15 |
| 2. PROFILE, HISTORY AND PERFORMANCE OF EQUITY AND FOREIGN<br>EXCHANGE MARKETS IN AFRICA..... | 16 |
| 2.1 Egypt .....  | 22 |
| 2.2 Kenya .....  | 25 |
| 2.3 Nigeria.....   | 28 |
| 2.4 South Africa.....  | 31 |
| 2.5 Tunisia.....   | 33 |
| 3. LITERATURE REVIEW .....   | 38 |
| 3.1 Returns, volatility and spillovers between Stock and foreign exchange markets.....       | 38 |
| 3.1.1 Previous studies on developed markets.....   | 39 |
| 3.1.2 Previous studies on Emerging and African markets.....                                  | 41 |
| Table 7 Tabulated Previous Studies.....  | 47 |
| 3.2 Returns, volatility and spillovers among equity markets .....                            | 52 |
| 3.2.1 Previous studies on developed markets.....   | 53 |

|  |    |
|--|----|
| 3.2.2 Previous studies on emerging and African markets .....                   | 56 |
| 4. DATA .....  | 62 |
| 4.1 Descriptive Statistics.....  | 62 |
| 4.2 Additional analysis.....   | 64 |
| 4.3 Volatility Clustering.....   | 67 |
| 4.4 Correlations .....   | 67 |
| 5. METHODOLOGY .....   | 70 |
| 5.1 Autoregressive Conditional Heteroscedastic (ARCH) models .....             | 70 |
| 5.2 Generalized ARCH (GARCH) Model.....  | 70 |
| 5.3 Multivariate GARCH (MGARCH) Models .....                                   | 71 |
| 5.3.1 The VECH Model .....   | 71 |
| 5.3.2 The Diagonal VECH Model .....  | 72 |
| 5.3.3 Bivariate VAR-GARCH BEKK model.....                                      | 73 |
| 6. EMPIRICAL RESULTS.....  | 75 |
| 6.1 Mean Return Dependencies.....  | 76 |
| 6.1.1 Own Return Spillover.....  | 76 |
| 6.1.2 Cross Return Spillover .....   | 77 |
| 6.2 Shock and Volatility Spillover (ARCH and GARCH) .....                      | 78 |
| 6.2.1 Cross Shock and Volatility Spillover.....                                | 79 |
| 6.3 Linkages, Stock and foreign Exchange Return and volatility spillover ..... | 80 |
| 6.4 Linkages, Equity markets returns and volatility spillover .....            | 81 |
| 6.5 Regional bloc linkages (Equity markets).....                               | 83 |
| 6.6 Diversification Benefits .....   | 84 |
| 7. CONCLUSIONS.....  | 90 |
| 7.1 Contribution of the study .....  | 91 |

|  |     |
|--|-----|
| 8. REFERENCES.....                                     | 94  |
| APPENDICES .....                                       | 101 |
| Appendix 1: ARCH Effects Test Results .....            | 101 |
| Appendix 2: Augmented Dickey Fuller Test Results ..... | 103 |
| Appendix 3 Volatility of series .....                  | 110 |

### List of Tables

|  |    |
|--|----|
| Table 1 Egyptian stock exchange (EGX) -Equity Trading Statistics .....   | 24 |
| Table 2 Nairobi stock exchange (NSE 20) – equity trading statistics..... | 26 |
| Table 3 Nigerian stock exchange (NSE) Equity trading statistics .....    | 29 |
| Table 4 Johannesburg stock exchange (JSE) Trading equity statistics..... | 32 |
| Table 5 Tunis stock exchange – Equity trading statistics .....           | 34 |
| Table 6 Intra-African exports and Imports (Top 5 destinations).....      | 36 |
| Table 7 Tabulated Previous Studies.....                                  | 47 |
| Table 8 Tabulated previous studies (1.1) .....                           | 48 |
| Table 9 Tabulated previous studies (1.2) .....                           | 49 |
| Table 10 Tabulated previous studies (1.3) .....                          | 50 |
| Table 11 Tabulated previous studies(1.4) .....                           | 51 |
| Table 12 Descriptive Statistics.....                                     | 65 |
| Table 13 Correlations .....  | 69 |
| Table 14 EGYPT, GARCH 1.1 results.....                                   | 85 |
| Table 15 NIGERIA GARCH 1.1 Results .....                                 | 86 |
| Table 16 SOUTH AFRICA GARCH 1.1 Results .....                            | 87 |
| Table 17 KENYA GARCH 1.1 Results.....                                    | 88 |
| Table 18 TUNISIA GARCH 1.1 Results.....                                  | 89 |

**List of Figures**

|   |    |
|---|----|
| Figure 1 : Africa, Developed and emerging markets yield-to-date return on investments ..... | 19 |
| Figure 2 Emerging market exchange rate regimes in 2008 .....                                | 22 |
| Figure 3 Egyptian Pound to the US dollar (WMR) .....  | 25 |
| Figure 4 Kenyan Shilling to the US Dollar (WMR) .....                                       | 28 |
| Figure 5 Nigerian Naira to US Dollar (WMR) .....  | 31 |
| Figure 6 South Africa Rand to the US \$ (WMR) .....   | 33 |
| Figure 7 Tunisian Dinar to the US Dollar (WMR).....   | 35 |
| Figure 8 Stock price movements in & US .....  | 37 |
| Figure 9 Graphical Presentation of series .....   | 66 |

## 1. INTRODUCTION

Globalization coupled with capital account liberalization recently, in many emerging and frontier markets. This has resulted in the free flow of capital investments, predominantly from developed markets to countries in Asia, Africa, Eastern Europe and Southern America. Many of such emerging and frontier economies as referred to today, have come a long way with democratic governance, accountability and improvements in their economic management, which has resulted in strengthened institutions and regulatory systems. All these have to a larger extent made them attractive destination choice for many investors, since business is naturally known to flourish in environments that has the ingredients for it (Kuttu, 2012). Emerging economies as at end of 2012 are known to have contributed 38% of global GDP, which could rise to 63% by the year 2050, while their stock markets are expected to expand rapidly alongside the expected development (Standard Chartered Bank, 2013).

Portfolio investment flows to Africa, as compared to decades before has also increased significantly around over 200 billion US Dollars with over 43% of these investments in stock portfolio originating from the USA (UNDP, 2013). Furthermore, according to the International Monetary Fund (IMF) wealth report of 2012, Africa which currently has no representation in the top 10 economies of the world at the moment will have Nigeria and Egypt by 2050, which shows a balance of shift in global economic power and Africa's rise.

Over the years, the world has experienced series of financial crisis with the recent been the 2008-2009 global financial crisis. With these happenings, it is noted that, the most advanced markets in the world were the most hit (with slow growth in the Euro zone and the United States), and this gives enough reasons for diversifying investments into emerging economies and frontier markets. In many case, some analysts and fund managers around the world believe that most of the developed equity and bond markets alike are overvalued, which triggers bubbles and sell-off risks. These sell-off risks and the possibility of bubbles in developed financial markets raises the need for diversification. In recent years, countries such as Brazil, Russia, India, China and South Africa (BRIC nations) together with certain emerging and frontier markets have come to aid of investors and corporations when there are slowdowns in the developed world.



The issue of portfolio diversification and investments can be backed up with real growth in for example Europe and Africa. It is important to now therefore that, diversification of a pool of financial portfolio can be a means to success in investment management, thus making fund managers, corporations and private individuals reach financial goals and reduce risks at the same time. A look at available statistics showed that, during the crisis period and beyond shows that real GDP in the European Union has ranged between 0.4%, -4.5%, 2.0% and 1.6% between 2008 and 2011. African economies on one hand during the period showed sustainable growth with 0.0%, -2.6%, 1.7% and 1.3% in 2008, 2009, 2010 and 2011 respectively. Furthermore, Sub-Sahara Africa, which is known to have diverse economies and mostly not backed strong unions and institutions such as the European Union managed to grow 3% to 5.6% during the same period of the crisis (Kuttu, (2012); Europa (2014)). Comparing to the advanced economies that were highly hit by the crisis, the issue of portfolio diversification becomes a necessity for financial managers and potential investors. According to the Global Competitiveness Report (2013), Sub Sahara Africa alone registered a steady growth of 5% in 2013, and there are still expectations on an increase in its growth in the years ahead. For these and many reasons, it is therefore important for fund managers, corporations and investors alike to focus and concentrate on the needs for diversifying into these markets.

Foreign investments that go into emerging economies are in different forms where the stock market in such countries aid in equity investments through the purchase of shares, bonds etc. Since such investments are flowing from mostly developed economies, there is therefore a wary for stock markets performances (issues of volatility and liquidity) and foreign exchange rate risks. It is imperative to say therefore that, the level of investment flows into emerging and frontier markets have led to linkages and interrelation between stock and the foreign exchange rate markets, which is the same case in every part of the world (Kanas, 2000).

Stock prices, exchange rates and other relevant information which helps investors and fund managers make decisions always change from time to time, hence the importance of a study to look into how these dynamics move together. Therefore, it is important to note that, the stock market and the exchange rate markets in every country are two important variables which come together to serve a purpose by

contributing to financial development, and makes diversification ideas a reality, thus, investors are affected by the dynamics and behaviors of these two markets in every country. One can confidently say that, rational investors today use available information, use also econometric tools to know how well their portfolios perform. In this regard, taking the investors point of view into account, ignoring the dynamics of stock markets and foreign exchange markets in a particular market will not only make their knowledge on information fall short, but also assume the existence of efficient markets, which in reality is known not to be the case.

Volatility is a natural occurrence which happens to be with financial markets and mostly caused as a result of irrational nature of participants. Although this happens, the irrational behavior lasts in the short term. Therefore, this collective behavior of the market participants may lead to fluctuations in prices of financial securities, hence, known as volatility. How volatile a stock or a currency becomes is relatively due to the price and volume movements and demand respectively, which in any case is a strong indicator of how risky the variable (stock/currency) is. According to Andersen (1996) information flow to a particular market is related directly to the volatility stock returns, hence, can be related to any other financial variable. This goes on to prove that, volatility clustering exists in higher tendency in developed markets where prices of stocks and currencies change rapidly during the trading day. Contrary to this opinion, Xue and Gencay (2012) also believe that volatility clustering is at times caused by multiple trading frequencies and the availability of thin trading (which lead to serial correlation in returns), which may be the case in most emerging and frontier markets, specifically in Africa and some parts of Asia.

It is important to note that, the stock market and the exchange rate markets in every country are two important variables which come together to serve a purpose by contributing to financial development, and makes diversification ideas a reality, thus, investors are affected by the dynamics and behaviors of these two markets in every country. Therefore, having adequate knowledge of how these two financial variables which aid in foreign and local investments to a larger extent help in reducing losses, thereby making proper hedges against the risks and movements that exist between them and make the required returns from such portfolio investments (Morales, 2008). Many African stock markets are noted to be illiquid and also characterized by thin trading while on the other hand; exchange rates have over the years performed

poorly against the major currencies. For example, the Ghana cedi becoming the worst performing currency in the world during the year 2014 by falling 40% against the United States Dollar alone (Financial Times, Bloomberg, 2014). It is therefore important to note that, as foreign investors go into emerging African markets, there is the tendency to brace up with risks associated with equity and currencies in terms of volatility. By knowing this, foreign investors, multinational corporations etc. would be able to hedge against fluctuations in both markets.

According to Bonga-Bonga (2013), international equity investors mostly take into consideration the rate at which stock indexes and the destination currency changes over time, which in effect guides them in allocating portfolios. Volatility dynamics among stock and exchange rate markets and among equity markets is a necessity to understand the riskiness involved in portfolio allocation by financial managers and potential investors. For this reason, taking into consideration the recent financial crisis and certain unpredictability surrounding some currencies in Africa has made it a necessity to how the stock and exchange rate markets interact, thereby knowing the movements among them would give adequate information about expected returns when investing in a foreign currency to be able to make required returns (Bonga-Bonga and Hoveni, 2011; Aloui, 2007).

To this far, it is therefore important to know that, spillovers and shocks that may arise from the interaction of the markets under consideration are important in making any decision to invest. Bonga-Bonga (2013) emphasizes that, where persistent shocks exist in a particular market, it could be attributed to be one major source for financial crisis, thereby, understanding of them in especially emerging and frontier markets are important. It is therefore important to know that, understanding the role of each market in volatility spillovers and how different equity markets inter-relate gives the need to focus on diversification of portfolio. Kanas (2000) in a study, also make a point that, international diversification as has been spoken of many times would be of no importance if issues relating to volatility spillovers between stock and exchange rate markets are ignored. This is to say that, expected returns would not be received in the long run. Interestingly, Griffin, Nadari and Stulz (2007), reveal that many investors are of the attitude of trading more in markets where there lies higher volatility. The idea behind the author's opinion may be a source from a saying such as "*does higher risk imply higher returns*". For this reason, since many of these

African countries and their respective markets are in the early stages of development, it is important to know how investment can be controlled and vice versa from the results obtained from this study.

This study examines whether there exist volatility spillovers between the foreign exchange and stock markets of some major African countries, namely; Egypt, Kenya, Nigeria, South Africa and Tunisia. For the purpose of this study, the countries under selection is mainly due to the fact that, they are among the fastest growing emerging economies in the world and also there have been a dramatic improvements in reforms towards globalization in these during the past years due to the receipt in foreign direct, portfolio and stock investments in the past decades. Also, the study will look at the extent to which there are volatility spillovers among African stock markets. This will help to know whether one can predict a market from the other due to the information contained in them. The study is therefore of emphasis to exploring the potentials in African equity and foreign exchange markets and the potentials they might have for portfolio diversification by potential investors and financial managers.

### **1.1 Research Questions**

- 1. Are there any existence of linkages (return and volatility spillover) between foreign exchange and the stock market of the respective countries? If yes, which market is the source?*
- 2. Are there a level of integration/segmentation among the equity markets in Africa, and what may be the reasons?*
- 3. Are there any existence of linkages in the equity markets among countries belonging to the same regional bloc?*
- 4. Can fund managers and potential investors benefit from portfolio diversifications in emerging and frontier markets in Africa?*

### **1.2 Aims and Objectives**

Over the past decades, financial liberalization activities in many emerging countries have led to gradual financial development. This development has come about as a result of the removal of certain constraints such as flow of foreign portfolio investments, foreign direct investments, the abolishing of interest and exchange rate controls etc. As a result of this, the stock and exchange rate markets go hand in

hand to helping investors and business practitioners in deciding where to place their portfolios and many more related activities. The study aims to examine volatility dynamics of exchange rate and stock returns in various African countries. By deciding to go international, it is important for corporations and investors to understand the linkages between equity and currency markets may affect their decisions in relation to risk management, etc.

There might be certain similarities among stock markets in Europe or some parts of Asia, but the African markets due to issues like infrequent trading and overdependence of the much advanced markets can always put investors into doubt. Return and volatility transmissions among equity markets are mostly another important factor when diversifying portfolio investments. Most often, countries who belong to the same economic bloc may exhibit shocks and spillovers among themselves. As documented in the findings of Chukwuogor-Ndu and Kasibhatla (2007), Aggrawal and Kyaw (2005) and Darrat and Zhong (2005), there were proven linkages between the equity markets of countries belonging to the North American Free Trade Agreement (NAFTA). The study therefore aim to establish whether or not there are any linkages among the equity markets of the countries included in the study and if investors can hold true information obtained from one African market to be the case for the other and to know if the markets still possess potentials for portfolio diversification or not.

### **1.3 Motivation**

As has been elaborated already, many African counties have been the recipient of foreign portfolio and direct investments. It is therefore important to know that, any decision that are taken by policy makers in these countries towards exchange rate directly affects may aspects of the economy including the stock markets, and the opposites direction. It can be said that, studies in the area of volatility, interrelations of stock and exchange rate markets on Africa are very low as compared to those done on the developed markets. So far no specific study has been found to investigate the area of study taking into account countries from Middle East and North Africa (MENA) and Sub-Sahara Africa (SSA). For this background, the study is motivated to include countries emanating from all corners of the African continent to help satisfy the study objectives. It is therefore believed that, an in-depth analysis of

results from the selected countries to a larger extent help to contribute to existing literature in the area of the study.

Secondly, the opportunities exhibited by emerging economies (projected by Standard chartered Bank to own 63% of the global GDP by 2050) all over the world through the expansion of their financial markets and other indicators has given an important reason to have a study that focuses on such African countries. By having the potential and for the fact that academic literature have been of importance to supplementing managerial decision making gives importance to having this study. We can therefore say that, financial managers can come up with investment strategies for higher opportunities, adequate hedging strategies to make the markets more attractive and the room to make arbitrage profits.

Finally, it is worth mentioning that majority of the studies related to the area of study on Africa mostly employ univariate models. The study aim to contribute to examining volatility dynamics using the VAR-GARCH BEKK model.

#### **1.4 Contribution to Existing Literature**

As mentioned already, there have been a handful of studies or interrelations and volatility dynamics on stock returns and exchange rates. Kuttu (2012) in a study has examined how negative news in Ghana and Nigeria affects the exchange rate and equity markets in respective countries. This study may be one of the few done on African markets as a whole, while the main focus is on the developed markets. The main issue is, most of these studies which relates to this study and subject are made on the developed markets or on Asia (such studies include, Aloui, C. (2007), Choi, Fang & Fu (2009), Granger, Huang & Yang (2000), Yang & Doong (2004), Kanas, A. (2002)). For this reason, it can be said that, the African markets are the least researched and can be said that there is a limited study in the area concerning Africa, and as a whole, there is a limited research of business and finance on Africa. Whereas the African markets are also characterized as frontier or emerging, it is important to do more to provide enough evidence.

Most often, there is the lack of data on most African countries which makes academic research very difficult. In this study, data spanning from a longer period of time is been employed which is a contributing factor to remedy the problem which may have been one major reason for the limited amount of research on African

markets. On the issue of relationships between the stock and exchange rate markets, there are also a few studies, whereas they are done mostly on the developed markets as already mentioned. Most of these results, as in (Phylaktis & Ravazzolo (2000), Ajayi & Mangone (1996), Granger, Huang & Yang (2000) and Huzaimi & Liew (2004)) come with mixed results as well, such as significant relationships and also at times unrelated results (see for example Nieh & Lee (2001)). It is therefore important to have a look at some African countries to know whether or not the results would be similar to those already studied on the developed countries.

Unlike previous studies, this thesis aim to contribute to the literature on interrelations between equity and foreign exchange markets and African markets by focusing on a multivariate analysis framework. Also, the motivation and contribution may be a result of cross-listing availability among the countries included in the study. Among such cross listings include AngloGold Ashanti, Stanbic Bank, British oxygen company Limited (listed on; South Africa, Kenya and Nigeria). The study will therefore be useful for these multinationals in dealing with the dynamics of the markets included in the study in the respective countries.

Taking into consideration research on volatility spillovers, there is a similar case where there aren't enough studies on Africa. Choi, Fang and Fu (2009), Yang and Doong (2004) Aloue (2007) and Kanas (2000) are some of the many studies that are mostly about the developed markets and some parts of the Asian economy. On the other hand, related studies such as, Bonga-Bonga (2013), Kumar (2013) and Mishra, Swain & Malhorta (2007) are just the few ones that have specifically written about the South Africa, India and Brazil, which are typical emerging countries from the BRICS group. In the light of this, the study focusing on the selected African countries in a justification to contribute to the already existing work on both the developed and some emerging economies.

### **1.5 Limitation and Scope of the Study**

In this study, the focus is on some selected African countries by taking into account countries which come from both the Middle East and North Africa (MENA) and the Sub-Sahara Africa region taking into account the equity and foreign exchange markets. The focus therefore is in each of these individual countries, whether there

exists volatility between the two markets examined under the study, while, a look is also taken concerning whether or not there exists volatility transmissions across the various countries in their stock markets. Also with a study on African markets, there are mostly problems that have been mentioned already. There are challenges such as lack of data from databases which at times may lead to dropping certain countries out of a sample. For this reason, the chosen countries to the best of the researcher's knowledge have data availability which not all African countries might have. Another instance relates to the lack of literature on Africa except for a few others and literature such as Bonga-Bonga (2013), Bonga-Bonga & Hoveni (2011), Adjasi, Biekpe & Osei (2011) and Kumar (2013).

### **1.6 Structure of the study**

The thesis has been organized as follows: Chapter focuses to introduce the study on the importance for which the study need to be conducted, therefore contains the research questions, motivation for the study, contribution to existing study and limitations. Furthermore, chapter two tends to delve into the specific equity and foreign exchange markets of the countries studied. The history and recent performance of the respective countries are written in details with regards to the stock and foreign exchange markets. Whereas there are some academic work already done around the topic of the study in different parts of the world, the chapter three looks at these previous studies to know the findings and what various authors say with regards to interrelations among the equity and foreign exchange markets and among equity markets of different countries. Empirical methodology and modelling issues employed in the study is presented in chapter four. The data obtained for the study and certain preliminary statistical properties, further analysis to help make it fit for the empirical analysis are presented in chapter five. Chapter six therefore is focused on discussing the empirical findings. This section also looks to answer the research questions and how these results are important for real case scenarios. Lastly, conclusions are made from the whole study on the basis of the empirical results obtained, thus making recommendations for future and further studies.



## **2. PROFILE, HISTORY AND PERFORMANCE OF EQUITY AND FOREIGN EXCHANGE MARKETS IN AFRICA**

In recent years, African stock exchanges and foreign exchange markets have gone through developments that may not have existed some decades ago, for example, shifting from issues like manual trading to electronic trading, although thin trading is a major characteristic, there can be said that, improvements have been made, etc. For instance, Africa as a whole, had a total of 5 equity markets as of 1989, but there is currently a total of 29 exchanges while 21 of them are members and regulated by the Africa Securities Exchange Association (ASEA) (Kuttu, 2012). The ASEA serves as a body helping to progress the rise of Africa for a sound economic growth (ASEA, 2013).

As mentioned earlier, most of these equity markets in Africa today have improved in making the markets becoming liquid and more efficient by using electronic platforms for trading. African equity markets are therefore important to be considered by portfolio investors ranging from reasons such as; having nine (9) of the twenty (20) fastest growing economies in the world, a projected growth of the entire economy from 1.1 trillion to 3.9 trillion in the next five (5) years coupled with promising economic growth and rate of FDI inflows makes various sectors of many African economies looking brighter for the near future (African capital markets, 2014).

In this study, most of the information relating to the equity markets of Africa is guided by the ASEA in its annual yearbook publication. As a non-profit making organization, ASEA was established in Kenya during the early 1990's, with the aim of fostering a unique cooperation through information delivery and sharing among stock exchanges in Africa. Through its hard work, ASEA is gradually emerging as the mouthpiece of African stock exchanges vis-à-vis African governments and international organizations like the African Union, the African Development Bank and the World Bank. At the moment, ASEA has launched an African index with the FTSE which serves a purpose of becoming an attractive benchmark for investor's investing on African stock markets and also as a reference which has helped in the creation of the market vectors Africa (ETF) index (ASEA,

In most cases, although there are some developmental issues relating to African markets, it can be said that, many big companies shun the idea of listing on such markets, making them underutilized in many cases. A United Nations Development

Programme (UNDP) (2003) report on equity markets in Africa describes that the achievement of the goal of portfolio diversification by investors and financial managers can be said to have been achieved since certain African countries showed potential for investors. The report further explain that, the equity markets have provided some attractive returns over the years with attractive price/earnings ratio as compared to the developed markets which are mostly affected by certain trends in the business environment. The UNDP report further states that, two out of the top 5 performing exchanges as at the release of the report were African, by taking into account country market capitalization, outperformed the developed and emerging markets indices, with a specific example been the Johannesburg stock exchange. This to an extent explains the already mentioned developmental success chalked by these African equity markets over recent years.

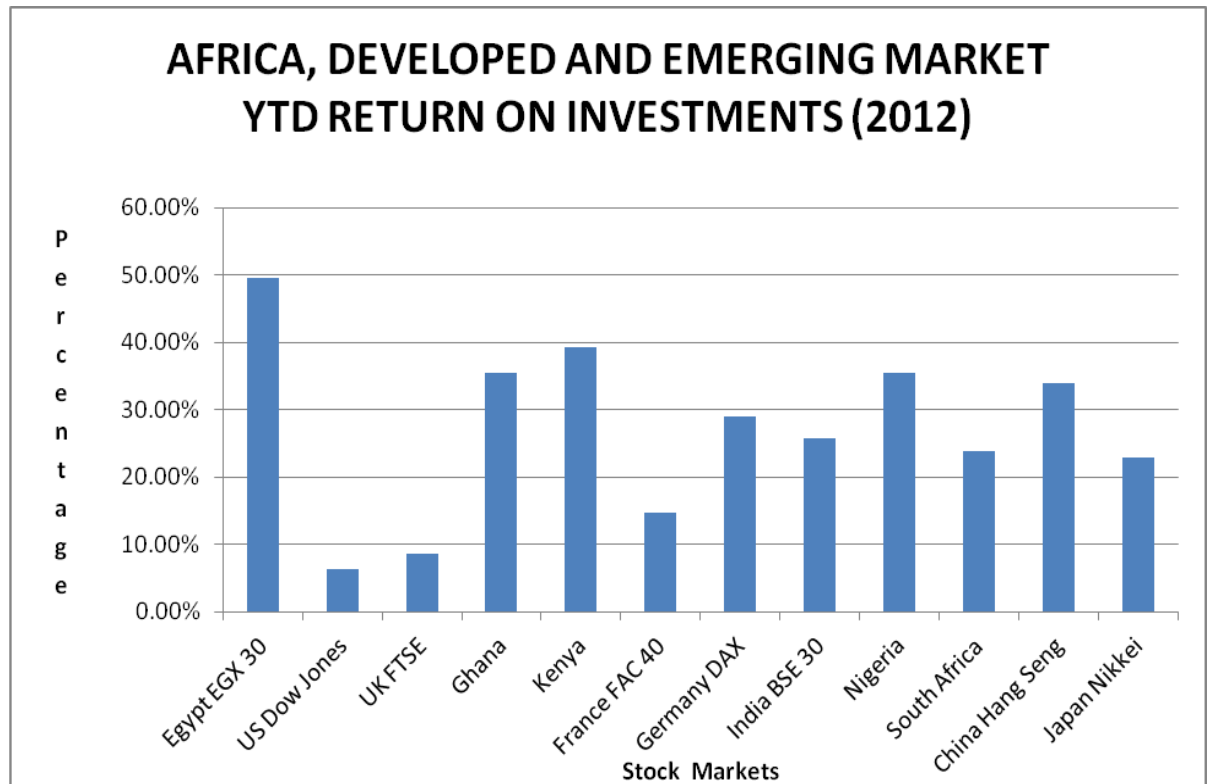
In spite of all these, taking into account all the African equity markets, majority of them can still be described as frontier equity markets, with exception of South Africa and some of the North African stock markets. This is as a result of the illiquid nature and thin trading issues and small market capitalizations. Although strives are been made towards developing them, most of these markets are characterized by the lack of information delivery, inappropriate or not up to date electronic trading systems which affect real-time availability of market information, high transaction costs, lack of accounting and disclosure standards and also social issues such as political instability, bureaucracy and many more problems.

Two decades ago, many African countries in their desire to reduce government finances towards the running of institutions resorted to liberalizing their markets in many ways of which privatization of state owned were one of the major activities. The benefits of such free market reforms were witnessed by encouraging most foreign companies to list on the stock exchanges of such countries. According to Nelis (2005), between 1991 and 2001, there was total revenue of \$9 billion accumulating to African governments as a result of privatization with countries such as South Africa, Ghana, Nigeria, Zambia and the Ivory Coast becoming some of the major players.

Most African countries (for example, Kenya and Ghana) through liberalization have benefited by themselves issuing treasury debt on their stock exchanges which may

not have been possible some years ago. It can therefore be said that, such activities have led to increase in competitiveness in capital markets of such countries. With such evidences, it can be concluded that, African equity markets are gradually becoming a channel for portfolio diversification and “*represent the final frontier of global capital*”.

On the performance of African stock exchanges in recent years, it can be said that Africa has over the years given investors the required returns on investments. According to ventures Africa (2012) report, the Egyptian stock market in 2012 emerged as the most appreciating stock market in the world with a 49.56% yield-to-date (YTD) return on investment , whereas the Kenyan stock exchange recorded 39.32% return on investment in the same year. In the figure below, it can be seen that, some of these major stock exchanges including those of Nigeria, Ghana and South Africa appreciated with 35.45% and 23.81% returns to investors respectively. The Egyptian stock market with its recent performance can be attributed to sound political atmosphere, although it suffered political crisis through the ousting of Hosni Mubarak has bounced back. All these recent performances by the countries in Africa tell that, there is still opportunities and room for improvement which can bring benefits to investors. By comparing with the yield-to-date performances of the developed markets (including; US Dow Jones Average, UK FTSE All Share Index, France FAC 40 Index, German DAX Index, China’s Hang Seng, India BSE 30 index 25.82% and Japan Nikkei 225), it can be said that the African counterparts are the most attractive on returns. The main reason for most of the European markets performing less as compared to the African markets in 2012 can be attributed to the sovereign debt crisis that were face by some countries since the early 2009. By the performance of the African markets, it can be said that, it will therefore help drive the migration of investors into emerging and frontier markets such as India, South Africa, Egypt, Nigeria and other African countries.



**Figure 1 Africa, Developed and emerging markets yield-to-date return on investments**

(Source: Ventures Africa, Wall Street Journal, Proshare)

Emerging and frontier markets all over the world have been noted to have become a destination for portfolio investments, especially during financial crisis which most often affect the advanced economies the most. Due to these investment activities, foreign exchange markets have become a significant part of financial development in every country. The exchange rate of a country against another currency is always quoted as the number of home currency needed to purchase the foreign currency.

The foreign exchange markets in Africa and other emerging and frontier markets some decades ago were one of the most complicated markets. Unlike the developed countries, have maintained restrictions on foreign currency restrictions, of which the countries under the study are of no exception. Over the years, various foreign exchange policies and regimes have been operated in the respective countries. During this era, the foreign exchange market was characterized by insufficient amounts of foreign currency, restrictive government licensing and at times outright

ban on foreign currency use by individuals (Osei, 1995). With these restrictions and closed market operations and systems, it contributed to illegal markets (popularly known as black markets) to respond to demand for foreign currency.

As financial liberalization became an issue in developing economies, emerging and frontier markets have had relaxed rules towards dealing and demanding for foreign currencies in most African countries. This means that, countries have moved on and have adopted one or more exchange rate regimes which control the money supply in relation to home and foreign currencies. However, central banks mostly maintain the monopoly of the distribution of foreign currencies. Regardless of attracting portfolio investments and other foreign investments, the foreign exchange markets in Africa as a whole still remains relatively small in size and also has a few active players. The central banks in various countries are the major players who control a higher percentage of transactions. In addition to the governmental control of a larger portion of foreign exchange trades, most African countries have put in place other structures whose operations aid in obtaining currencies when needed. They include;

- The interbank market where two or more banks trade among themselves
- Foreign exchange bureaus operated by private entrepreneurs across all parts of the country. They usually offer services to individuals, tourists and small and medium enterprises (SME's)
- The corporate market where multinational firms and other companies make transactions with established banks.
- Finally, there are unofficial markets, popularly known as the black markets. Prices in such ventures mostly differ from quoted prices from banks or the central banks.

Although the central banks control the exchange rates in most African countries, the movements in these currencies are determined by certain major currencies such as the US Dollar, Euro, and the Pound sterling etc. Dollarization in many African countries has also led to situations where the home currency depreciates constantly against the major currencies or the US dollar. There also exist certain informal dollarization, popularly known as currency unions, where countries come together to run a currency board. In the case of emerging and frontier markets, the largest currency unions known includes; the West African Economic and Monetary Union,

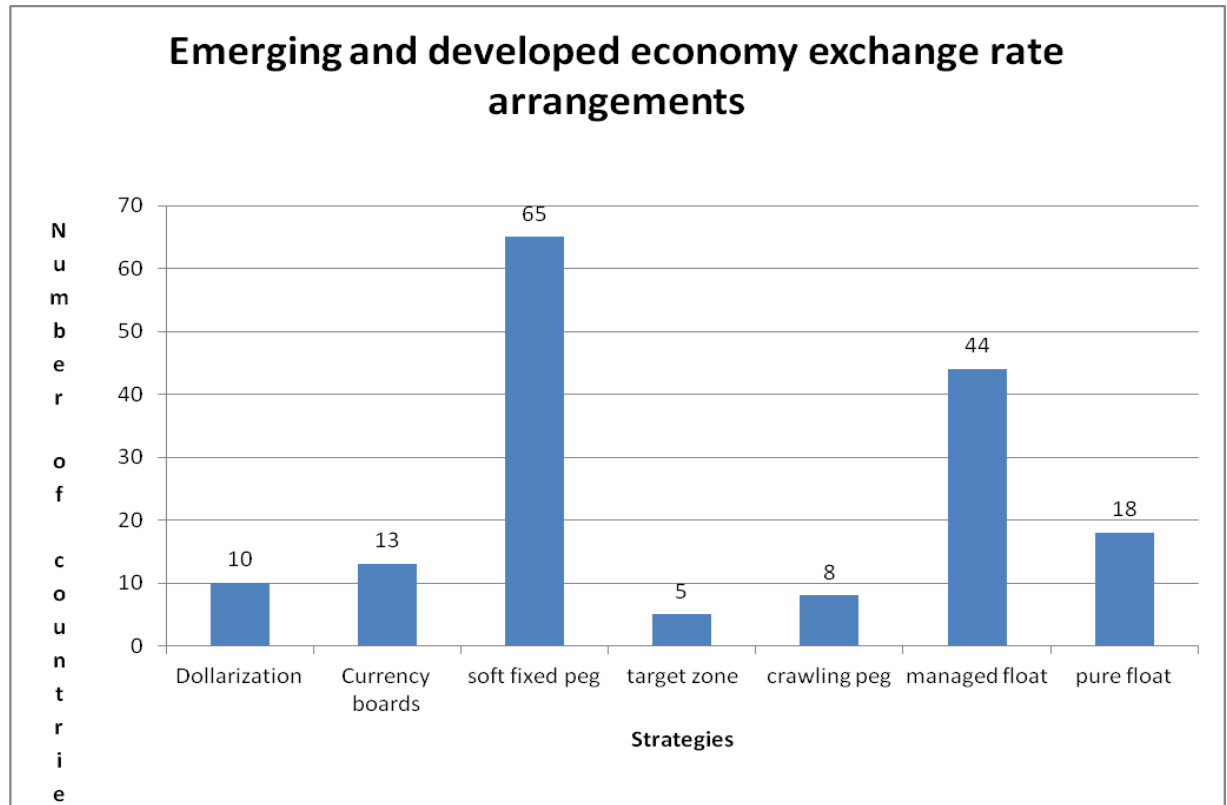
the Central African Economic and Monetary Community currency union (currencies pegged to the Euro), and the East Caribbean Monetary Union which basically pegs to the US dollar (Knoop, 2013).

Having foreign exchange rate reforms although there might exist different opinions towards economic development, to a larger extent can be said to open economies to the outside world. These when effectively done help in trade and other economic opportunities. An IMF working paper (2013) explains that, many African countries towards liberalization opened their foreign exchange markets between 1980 and 1990. From the study, countries such as Ghana, Kenya, Zambia, Mozambique etc., who were involved in this activity benefited through sharp increase in gross domestic product (GDP) per capita, compared to periods when there were strict controls. Such results in these African countries included; increase in annual per capita growth, increase in exports, growth recovery etc. (IMF, 2013).

Another instance in foreign exchange operations in various countries over the years is currency pegging, which has become a common practice worldwide. There are diverse reasons for the choice of a peg but mostly, currency pegs are done in order to gain credibility and also trade relations among countries play a role for selecting a particular peg, where the US dollar, the euro are the major currencies which serve as an anchor for various countries (IMF, 2008). Most of West African countries as noted by the IMF, peg their currencies or quote exchange rates in terms of the US dollar, and whereas, the African union aims to come up with a common currency, suggestions are been made to peg such currency to the euro specifically for reasons relating to trade relations with most EU countries.

According to Eichengreen and Razo-Garcia (2006), a total of 66 emerging and frontier market countries in recent years have either adopted the United States dollar as its currency, peg to the dollar or manage their exchange rate against the dollar, of which such practice is common with most African countries. In the figure below, there is a categorization of countries-both developed and emerging-according to the exchange rate strategy followed, de facto, as at year end 2008. A strong majority of emerging market economies have adopted a soft fixed exchange rate peg that is making the exchange rate fluctuate within a certain desired bracket. From the figure below, it can be seen that there exists a current trend among emerging market

economies, which is mainly focused on intermediate regimes of foreign exchange regimes; such a, managed float and crawling pegs (Knoop, 2013)



**Figure 2 Emerging market exchange rate regimes in 2008**

(Source: Knoop (2013); IMF (2008)).

### 2.1 Egypt

The Egyptian stock exchange (EGX) is known to be the oldest stock market in the Middle East through the emergence of the Alexandria and Cairo stock exchanges which were established in 1883 and 1903 respectively. Presently, the Egyptian stock market is regulated by the Egyptian Financial Supervisory Authority (EFSA). Through its activities, the number of listed firms on the EGX has increased over the years and it's known to trade in stocks, funds and known structured products issued by certain international financial institutions. The EGX has operation mechanism where there are possibilities of intraday and online trading availabilities, which explains how well the stock exchange has developed over the years. It must be noted therefore that, the EGX 30 is the main index which is a free float market cap index and it includes the top 30 companies in Egypt who are included based on their

market capitalization and trade liquidity. In efforts to become a more advanced and efficient stock exchange as those in the developed worlds, the EGX 30 index is traded on several stock exchanges in Europe notably; *“EGX 30 certificates issuance by the Royal Bank of Scotland, EGX 30 EUR X-Part certificates issuance, done by the Deutsche Bank and finally, the EGX 30 open end certificates issuance by Goldman Sachs international”*. As can be seen below, the stock exchange has seen some remarkable performances, for example, the year 2007-2009 (periods before the Arab spring) saw increase in total value and volume trade which was equal to 85.79% of total national GDP in 2007. From the table below, it can be seen that total volume traded in the past three (3) years have declined sharply by approximately 43% between 2010 and 2013. This may be attributed to the ousting of Hosni Mubarak and a series of political unrest, which may have led to capital flight and negatively impacting on the entire economy. Market capitalization as percentage of GDP of the EGX has also declined during the same period of time (ASEA Yearbook, 2014)

However, it is worth mentioning that, EGX has kept its performance steadily over the years. The Egyptian equity market was in 2014 adjudged the best destination for stock market investors in 2014 by producing a return of 30% (Financial Times, 2015). Furthermore, according to the ASEA yearbook of 2014 publication, the stock exchange of Egypt was ranked second by the MSCI indices in 2013 and number one among emerging market peers in two years spanning 2012-2014. According to an African ventures (2013) report, the Egyptian stock exchange was voted the most profitable stock market with returns to investors by recording 49.56% yield-to-date in the year ending 2012. This might be attributed to the European crisis, making room for diversification into emerging markets. Contrary to these, it can be seen from the table below that, the overall performance of the EGX has little to write home about as one may have expected its performance to be maintained over the years. For instance, it can be seen that there has been a reduction in the performance of the EGX, such as consistent fall in the overall total value of trade since 2007 which reflects in the percentage of market capitalization to the overall country GDP, which has fallen to 24% in 2013 compared to 85% in 2007. Overall indicators of the Egyptian stock exchange has proven right the argument that political crisis at a point in time has negative consequences on overall economic development.



**Table 1 Egyptian stock exchange (EGX) -Equity Trading Statistics**

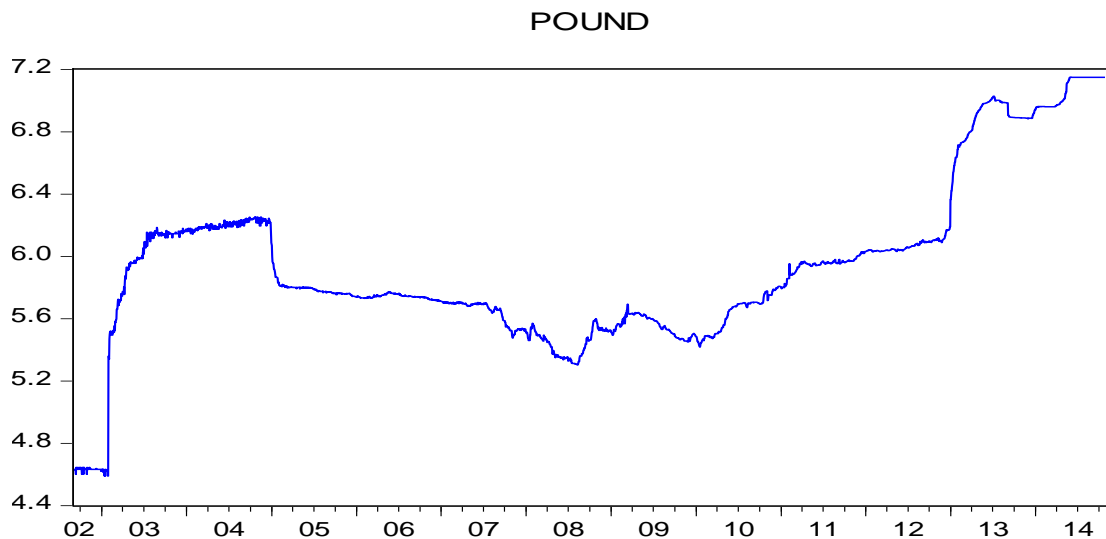
| Indicators                             | 2009   | 2010   | 2011 <sup>^^</sup> | 2012   | 2013  |
|--|--------|--------|--------------------|--------|-------|
| Total value traded \$ billion (USD)    | 81.70  | 55.36  | 24.57              | 23.40  | 23.33 |
| Total volume traded (billion)          | 36.60  | 33.42  | 18.49              | 34.22  | 29.19 |
| Total number of transactions (million) | 14.62  | 10.20  | 5.58               | 6.233  | 4.79  |
| Number of listed companies             | 306    | 212    | 213                | 213    | 212   |
| Number of traded companies             | 289    | 213    | 204                | 220    | 206   |
| Market cap billion \$ (USD)            | 91.08  | 84.10  | 51.68              | 60.09  | 61.51 |
| Market cap as % of GDP                 | 41.40% | 40.46% | 22.73%             | 24%    | 24%   |
| Turnover velocity * (%)                | 49.99% | 42.9%  | 34.0%              | 34.09% | 27%   |

\* Turnover Ratio (%) = value traded of listed stocks/market capitalization, <sup>^^</sup> EGX was closed from 28 January - 22 March after the revolution. Source: ASEA Yearbook, 2014

In the beginning of the 1990's, the Egyptian pound was pegged to the United States Dollar as may have been the case in many African countries and emerging economies. In doing so, it is noted that, the Pound was affected by excessive pressure which led to its depreciation against the major currencies. Such pressures included an all-time 35% depreciation of the pound to the US dollar after the September 2001 terrorist attack. These and other reasons made Egypt adopt a floating exchange rate regime in January 2003 (Jbili and Kramarenko, IMF, 2003).

The Egyptian pound in recent years has faced mixed performances against major currencies, especially the United States Dollar, which is predominantly the case in most African emerging and frontier markets. Dollarization, which is a major problem

in most of these countries continually affect the depreciation of the local currencies against the dollar. Foreign exchange market in Egypt is mainly controlled by the central bank, which has led to lots of black markets demand for dollars in the country over the years. Due to this, the central bank in 2013 introduced the interbank market which was to ease the access to the US dollar (Bloomberg, 2013). As seen from the figure below, with the exception of some normalization between 2005 and 2010, the US Dollar have gained strength against the Pound. This can also be attributed to the excess capital flight out of Egypt during the period of the uprising which destabilized the country a little while. Egyptian Pound to US Dollar (World market rate)



**Figure 3 Egyptian Pound to the US dollar (WMR)**

Source: Thomson Reuters DataStream (2014)

## 2.2 Kenya

The Nairobi securities exchange (NSE) has over the years gone through many reforms to become the most advanced stock exchange in the Eastern region of Africa and one of the most profitable markets in the world (Ventures Africa, 2013). The NSE has evolved to become a full securities service exchange with service dealings in clearing and settlement of equities, debt, derivatives and other associated instruments, which may not exist in some African stock exchanges. It is worth mentioning that, it is one of the few exchanges which have live trading through automated trading services. The NSE-20 index which was launched in 1994 was ranked as the best performing market by the International Finance Corporation after

chalking a total return of 179% with an all-time high of 5030 points since its establishment (Nairobi Stock exchange, 2014).

The index returns of the NSE 20 is mainly based on capital gain/losses of the 20 largest securities listed and are valued based on full market capitalization. In this, most of the active firms come from various industries, with the telecommunication and technology industry topping the list as the most active. In the year 2012, the NSE 20 index continued an upward trend of increase over the years with a growth of 28% and market capitalization rising 46.5% to Shilling 1.27 trillion, equivalent to \$14.53 billion. From the table below which indicates trading statistics in the past 3 years, it can be seen that, the Nairobi securities exchange's volume of trade has continually increased from 2011 to 2013. Market capitalization as percentage of GDP has moved on as 34%, 42% and 56% in 2011, 2012 and 2013 respectively, which indicates an upward trend in performance and returns to investors (ASEA, 2014). Kenya at the moment stands as the gateway to East Africa, with technological advancement and investment opportunities in its tourism industry as well. All these with its peaceful nature may account for a steady growth in the activities of the NSE, where, foreign investors in 2011 accounted for 52% of total value of trades on the market.

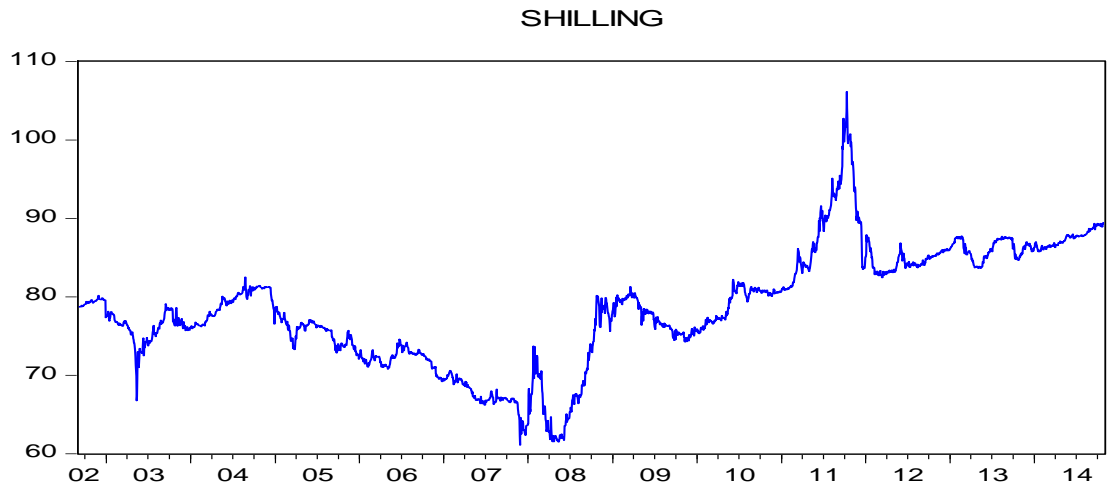
**Table 2 Nairobi stock exchange (NSE 20) – equity trading statistics**

| Indicators                                   | 2011    | 2012     | 2013     |
|--|---------|----------|----------|
| Total value traded \$                        | 917.5 m | 1084.93b | 1811.03b |
| Total volume traded (billion)                | 5.72    | 5.46     | 7.66     |
| Total number of transactions                 | 382,175 | 342,235  | 426,372  |
| Number of listed companies                   | 58      | 60       | 61       |
| Number of traded companies                   | 54      | 56       | 57       |
| Market capitalization (Billions) end of year | 10      | 16       | 22       |
| Market cap as % of GDP                       | 34%     | 42%      | 56%      |
| Turnover velocity % *                        | 9%      | 7%       | 8%       |

\* *Turnover Velocity = (Monthly value traded of listed shares/month-end market cap) x 12 (Annualized)* Source: ASEA Yearbook, 2014

The Kenyan shilling came into force in 1969 which replaced the East African shilling at par and used only by Kenya which is pegged to no currency in the world. Over the years the shilling has had mixed performances against the US dollar and some other major currencies. The foreign exchange market of Kenya became liberalized in the 1990's by moving from an exchange rate regime of crawling peg to official rate and market rate based foreign exchange, thus, adopting a floating exchange rate regime. Through this approach, the Kenyan economy was known to have benefited from the liberalization, consequently led renewed economic stability through foreign confidence in the market (IMF, 2013).

The Kenyan financial market in its dealings is known to make daily transactions between 350 to 500 US Dollars which goes on to reach between 12 to billion US Dollars every month (Central Bank of Kenya, 2014). Over the years, currency depreciation as a result of high levels of imports and dollarization in emerging and frontier markets have continually been a problem, where the Kenyan economy has been of no exception. Such instances have forced and put the central bank under pressure to respond to criticisms of continuous depreciation of the shilling against the US Dollar.



**Figure 4 Kenyan Shilling to the US Dollar (WMR)**

Source: Thomson Reuters DataStream (2014)

In spite of the 2008 global financial crisis, the Kenyan shilling attained its all-time low of 63 shilling to a dollar. This may be as a result of excess demand for the shilling as a result of investors looking for markets which may not have been affected seriously by the crisis. In the case of exchange rates, most African countries follow a particular trend of depreciation against major currencies. These may be as a result of fiscal deficits experienced by these countries through historical importation of goods and services from the advanced economies. However, the Kenyan central bank (2014) in a publication attributed the recent pressure on the shilling to the payment of dividends to corporate investors outside Kenya, which is observed mostly yearly. With the disappearance factors which are seasonal as stated in relation to dividend payment, the central bank mostly expect a normalization of the shilling against the major currencies which will help solve persistent volatility of the currency.

### 2.3 Nigeria

The Nigerian stock exchange (NSE) is among the only three (3) stock exchanges to be members of the World Federation of Exchanges, by receiving its membership vote in 2014 (NSE, 2014). The (NSE) came into force in 1977 after a rebranding of the Lagos stock exchange and launched the All Share Index which is known to be a “*value-weighted market capitalization index*” in 1988. Been regulated by the Securities and Exchange Commission (SEC), deregulation of the capital markets was done to make it more investor-friendly as far back as 1993. In recent years,

coupled with the size of the Nigerian economy, it was able to sign a memorandum of understanding which paved way for it and the Johannesburg stock exchange (JSE) to engage in cross border listing by the two biggest economies in Africa. Over the years, the exchange has contributed to development of the Nigerian financial and capital markets in many ways. Since deregulation of its capital markets, foreign portfolio investments into Nigeria has increased and it's noted to be one of the preferable destinations in the region. In the year 2012, the NSE all share Index closed the year with its highest performance since 2008 with a 35.45% gain. Total trade value in the year end 2013 was impressive and has been same in previous years and volume of trade grew from 89 billion in 2013 to 105 billion in 2013, signifying the potential exhibited by the market. Also, market capitalization for the years 2010, 2011, 2012 and 2013 has been \$53.40, \$43.06, \$57.77 and \$80.69 billion, then again explaining the growth in the market and its opportunities available to investors (ASEA, Yearbook, 2013, 2014).

**Table 3 Nigerian stock exchange (NSE) Equity trading statistics**

| Indicators                      | 2010     | 2011      | 2012    | 2013      |
|---------------------------------|----------|-----------|---------|-----------|
| Total value traded\$ (billions) | 5.29     | 4.18      | 4.23    | 6.53      |
| Total volume traded (billions)  | 93.33    | 89.57     | 89.15   | 106.53    |
| Total number of transactions    | 1,913,00 | 1,230,754 | 937,160 | 1,380,789 |
| Number of listed companies      | 217      | 198       | 194     | 188       |
| Number of traded companies      | 206      | 188       | 172     | 176       |
| Market cap (billions) year end  | 53.40    | 43.06     | 57.77   | 80.69     |
| Market cap as % of GDP          | 24.63%   | 17.43     | 21.80   | N/A       |
| Turnover ratio (%)              | 9.91%    | 9.71%     | 7.32%   | 7.89%     |

\*Turnover Ratio (%) = value traded of listed securities/market capitalization Source: ASEA Yearbook, 2013, 2014

The Nigerian Naira is issued by the central bank of Nigeria which in its activities ensures stability of the Naira over a longer period of time. With its introduction in 1973, the Naira replaced the pound at a rate of 2 Naira equaling 1 pound and it's neither pegged nor any currency pegged to it (Oanda, 2014). Over the years, foreign exchange dynamics in Nigeria has gone through various stages in efforts to make the economy more open. In the 1960's, there was an existence of a fixed exchange rate regime while between 1970's and the mid 1980's brought about a pegged regime. Furthermore, the country in 1986 made the naira to experience various floating regimes when the country adopted a structural adjustment programme (Central Bank of Nigeria).

In the case of exchange rates against the major currencies, various factors play important roles in its determination. One important factor worth noting is what makes Nigeria well known all over the world, oil production, thus how it affects the performance of its currency in the markets. It must therefore be noted that, since majority of foreign exchange is dependent on oil, volatility in the oil industry at a particular time affect foreign exchange supply. Bloomberg (2013) analyze that, falling oil prices around the world forced the central bank to lower its trading range against the US dollar as a result of frequent oil prices. As can be seen from the figure below, the naira performance against the US dollar in the last 3 years has been a constant depreciation hitting a record high of 170 per dollar.

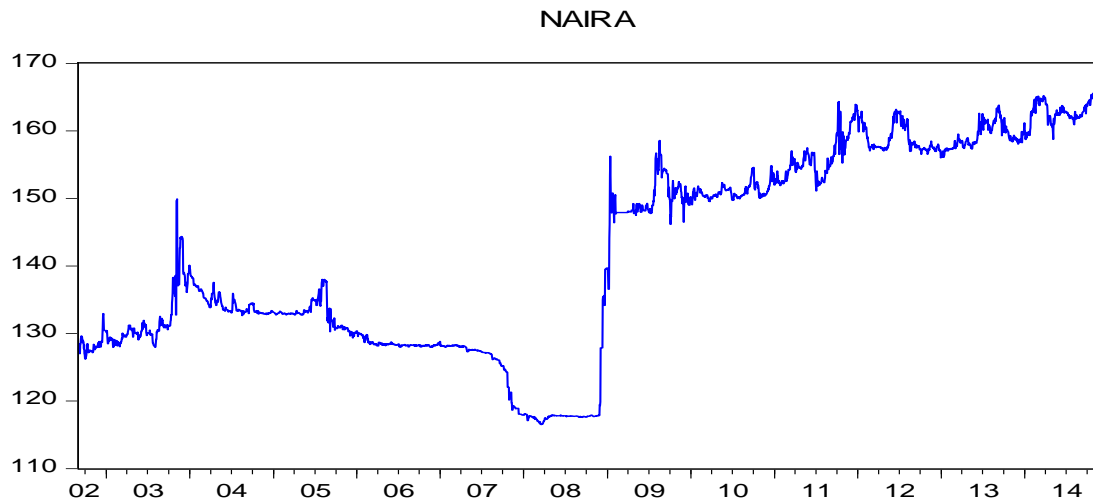


Figure 5 Nigerian Naira to US Dollar (WMR) Source: Thomson Reuters DataStream, 2014

## 2.4 South Africa

The Johannesburg stock exchange (JSE) formed in 1883 has been around as one of the oldest stock exchanges in Africa. It is currently ranked 19<sup>th</sup> largest stock exchange in the world and the biggest in Africa in terms of market capitalization (\$1,007bn at end-2013). The JSE is one of the three only African exchanges to be a member of the World Federation of exchanges by joining as far back as 1963. The JSE index (JSE/FTSE all share index) covers about 99% of the market capitalization and can boast of over 350 companies listed on it at year end 2013. Trading encompasses the equity, bond and derivatives market (Johannesburg stock exchange, 2014). In terms of development, the JSE introduced an automated electronic trading service which replaced the open outcry system way back as 1966. Trade value of the Johannesburg stock exchange over the years has proven its size. For instance, in 2010, trade value increased from \$374.00 billion in 2009 to \$438.08 billion; however trade value in recent years such as 2011, 2012 and 2013 fell as compared to the 2010 value. This may be as a result of recovery from the global financial crisis and the euro zone debt crisis as the South African economy is much linked to these sources. Regardless of these, it can be seen from the table below that, total number of transactions have been increasing over the years, signifying the opportunities and investor confidence possessed in the South African market. It can also be seen that market capitalization between 2009 and 2013 has grown around



89% by hitting \$1103.36 trillion in 2013 as compared to \$981.43 billion in 2010 (ASEA Yearbook, 2012;2013).

**Table 4 Johannesburg stock exchange (JSE) Trading equity statistics**

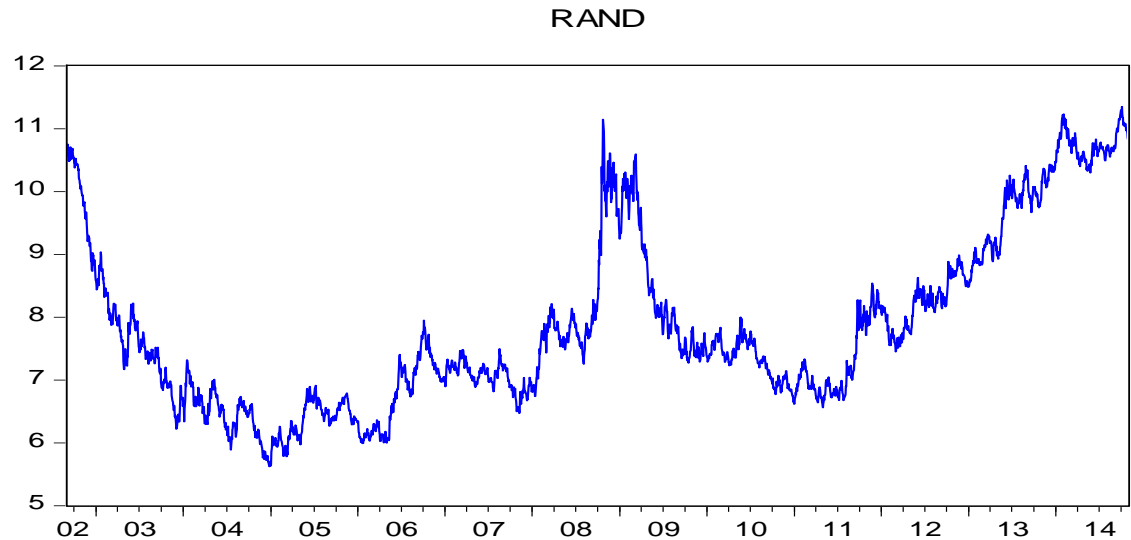
| Indicators                           | 2010       | 2011       | 2012       | 2013       |
|--------------------------------------|------------|------------|------------|------------|
| Total value traded \$ billions (USD) | 438.08     | 402.29     | 408.62     | 413.05     |
| Total volume traded (billions)       | 71.25      | 71.46      | 61.84      | 63.89      |
| Total number of transactions         | 23,758,618 | 26,504,221 | 26,934,622 | 38,964,070 |
| Number of listed companies           | 407        | 406        | 400        | 386        |
| Number of traded companies           | 386        | 385        | 375        | 361        |
| Market cap (billions) (USD)          | 981.43     | 845.58     | 998.34     | 1,102.36   |
| Market cap as % of GDP               | N/A        | 30.91      | N/A        | N/A        |
| Turnover Velocity (%)*               | 43.26%     | 46.25%     | 40.93%     | 55.25%     |

\* *Turnover Ratio (%) = value traded of listed securities/market capitalization* Source: ASEA Yearbook, 2012; 2013

The South African Rand (ZAR) came into effect since 1961 after replacing the pound. The Rand is also accepted as a legal tender in countries such as Swaziland, Namibia and Zimbabwe. Also the Lesotho Loti, the Namibian dollar and the Lilangeni of Swaziland are the main currencies pegged to the Rand (Oanda, 2014). The rand in most cases during the early days was somehow pegged with the US dollar but was delinked from it in 1976 to make it go on independent managed float, but yet still the dollar remains the most traded currency against the Rand (BusinessTech, 2014). Ranging from days of apartheid and recently, the currency has struggled to appreciate among the major currencies. Over the years, the Rand's performance has been a little to be desired of, in a Financial Times (2013) publication; it described the South African Rand as a volatile currency based on its 2013 performance. The South African Rand to the US Dollar ended the years 2009, 2010, 2011 and 2012 at

an exchange rate of 7.476, 6.8254, 8.1701 and 8.3978 respectively, indicating constant depreciation (except for 2010) of the currency against the dollar (ASEA Yearbook, 2013). Due to the free fall of the currency, it is reported to have performed at its worst stage in the year end 2013, where it traded at R10 to 1 USD for the first time since 2008 and this is depicted from the figure below (Wall street journal, 2013).

Since the economy is mostly linked with the advanced economies, the global financial crisis and the euro zone debt crisis and also internal issues such as soaring debt and a series of labor outcry and production cuts in the mining and telecommunications sector and this has generally led to harsh economic conditions, hence affecting the performance of the rand.



**Figure 6 South Africa Rand to the US \$ (WMR)**

Source: Thomson Reuters DataStream, 2014

## 2.5 Tunisia

The Tunis stock exchange, also popularly known as *Bourse de Tunis* was established as a private entity (equally owned by the various brokerage firms in the market) in 1969 and been regulated by the Financial market council of Tunisia. The main index of the stock exchange is the TUNINDEX which is a broad market return index launched in 1997. Again, there are also sector indices were every company listed on the market belongs to each industry they belong to. In addition to these, it has also established the TUNINDEX 20 which has the best performing 20

companies in terms of most liquid shares traded. It is worth noting that, unlike other markets, trading on the Tunis stock exchange is dominated by local investors. Local investors accounted for 93.70% and 87.90% in 2012 and 2013 respectively.

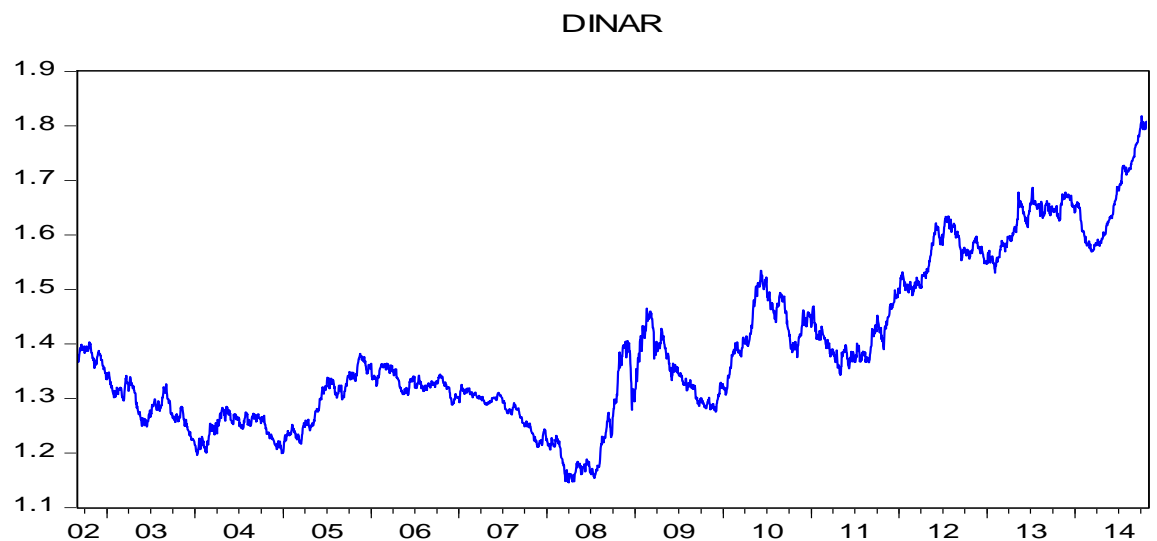
Owing to its fragile socio-political environment in recent years and slow economic growth, the Tunis stock exchange has experienced harsh times with 34 out of its 59 listed companies posting negative returns, arising from consistent decline in share prices in the year end 2012. As represented in the table below, there was a 4.65% decrease in market capitalization in 2012 compared to the 2011 value. The year 2012 however recorded a 24% in value traded compared to 2011 but this didn't last as the closing value of trade in 2013 sharply declined to an estimated value of \$884,953,500.33 from \$1,253,082,047.59 in 2012. However, 2013 recorded an improvement in both the number of traded and listed companies (ASEA Yearbook, 2013; 2014).

**Table 5 Tunis stock exchange – Equity trading statistics**

| Indicators                       | 2010        | 2011        | 2012        | 2013        |
|----------------------------------|-------------|-------------|-------------|-------------|
| Total value traded \$ (billions) | 1.83        | 1.05        | 1.25        | 0.88        |
| Total volume traded              | 271,666,075 | 252,692,067 | 240,522,983 | 238,674,931 |
| Total number of transactions     | 629,488     | 448,872     | 569,403     | 513,099     |
| Number of listed companies       | 56          | 57          | 59          | 71          |
| Number of traded                 | 56          | 57          | 59          | 68          |
| Market capitalization (billions) | 10.63       | 9.64        | 8.89        | 8.56        |
| Market cap as % of GDP*          | 24.11%      | 22.50%      | 19.32%      | 18.20%      |
| Turnover velocity (%)*           | 17.18%      | 10.87%      | 14.10%      | 10.88%      |

\* Estimated value (2013) \* Turnover Velocity = (Monthly Share Value Traded/Month-End Market Capitalization) x 12 (annualized) Source: ASEA Yearbook, 2013; 2014

The Tunisia economy is regarded as one of the fastest and stable economies in Africa and the world in general. Due to its close relations with Europe due to its geographic location, it has reflected in the performance of the Tunisian Dinar over the years. Overall, it can be cited as one of the best performing currencies against major world currencies in Africa. In recent years, socio-political protests have affected the economy in several ways including, reduction in exports and tourism which are two major sources of foreign exchange reserves. It can be seen from the figure below that, the dinar reached an all-time low for the first time of TD1.60:1USD which might be as a consequence of the already mentioned problems. Furthermore, the depreciation of the dinar against the euro (10%) and the US dollar (6.7%) has continued with the year ending 2013 (African Development Bank, 2014). As mentioned earlier, the performance of the euro and the US dollar have significant effect on most currencies around the world, and the dinar is of no exception. At the moment, the Tunisian dinar is pegged to a basket of currencies where the Euro accounts for two-thirds of this peg in the basket. This means that any inconsistencies in the euro zone affects the performance of the dinar against the dollar, and its predicted to depreciate consistently against the US dollar in 2012-2014 as can be seen in the figure below, but it is also predicted to gain and strengthen in 2015-2016 where D1.58 will equate US\$1 by 2016 (KPMG, 2012).



**Figure 7 Tunisian Dinar to the US Dollar (WMR)**

Source: Thomson Reuters DataStream, 2014

In all of this, it is worth highlighting that, intra-African trade is important to touch on in this study. Correlations, spillovers among equity markets may be as a result of these cross border trade investments made by one country in the other. For the purpose of this study, Intra-African trade focus will be highlighted briefly on the countries employed in this study. Trade among these countries are mostly politically or economically motivated, thus each of these African countries belong to one or more regional blocs. Such regional blocs include Economic Community of West African States (ECOWAS), Community of Sahel Saharan States (CENSAD, Common Market for Eastern and Southern Africa (COMESA) etc. According to UNCTAD (2013) report on trade in Africa, it was revealed that intra-African trade between 1995-2011 risen from \$ 45.9 to \$130 billion, while exports among African countries grew an average of 2.6% annually, from 2001 to 2006 and 3.7% from 2007 to 2011. According to the report, imports on the other hand experienced real growth of 9.4% and 4.2% respectively. For the purpose of this study, the table below shows the top five export and import destinations for Egypt, Kenya, Nigeria, South Africa and Tunisia.

**Table 6 Intra-African exports and Imports (Top 5 destinations)**

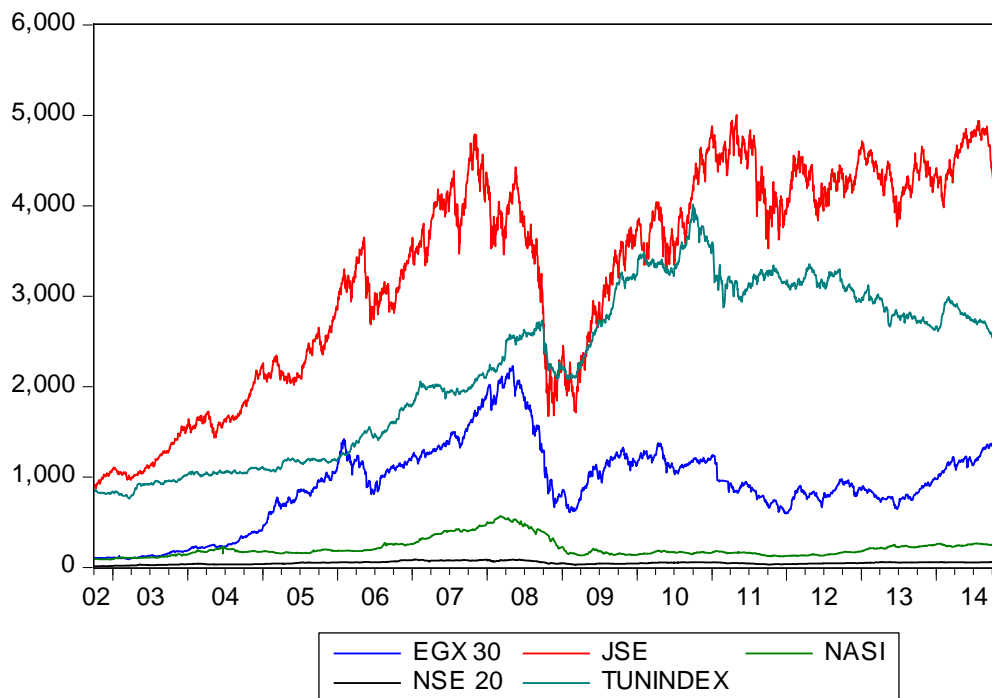
| <b>Country</b> | <b>Exports destinations</b>                           | <b>Import destinations</b>                            |
|----------------|---|---|
| Egypt          | South Africa, Libya, Sudan, Morocco, Egypt            | Algeria, Zambia, Kenya, South Africa, Tunisia.        |
| Kenya          | Uganda, Tanzania, Egypt, DR Congo, Rwanda             | South Africa, Egypt, Uganda, Tanzania, Rwanda         |
| Nigeria        | South Africa, Cote D'Ivoire, Ghana, Cameroon, Senegal | South Africa, Cote D'Ivoire, Algeria, Botswana, Egypt |
| South Africa   | Zimbabwe, Zambia, Mozambique, DR Congo, Angola        | Nigeria, Angola, Mozambique, Zimbabwe, Zambia         |
| Tunisia        | Libya, Algeria, Morocco, Ethiopia, Egypt              | Libya, Algeria, Egypt, Morocco, Cote D'Ivoire         |

Source: UNCTAD, 2013

The existence of most of the intra-regional blocs is a possibility for volatility spillovers in financial securities in respective countries. For example, Egypt, Tunisia, Kenya and Nigeria are all members of COMESA, hence these countries trade among themselves in one way or another. However, trade between South Africa and the focus countries in this study is low since it trades mostly with its Southern African neighbors.

Also, various movements of stock prices within the period of this study is among the respective countries is shown in the figure below.

**Figure 8 Stock price movements in & US**



Source: Thomson Reuters, DataStream (2014)

### **3. LITERATURE REVIEW**

Over the years, volatility issues have emerged to be one of the hot issues in financial and econometric analysis. Forecasting of volatility have over the years been used in different financial series analysis such as risk estimation, portfolio allocation, derivatives pricing etc. which aid in corporations and investors making sound financial decisions. There have been numerous academic papers from experts which have discussed volatility and spillovers of financial variables y using both univariate and multivariate models to solve problems which have had policy implications worldwide.

Generally, volatility modelling has gone beyond earlier models introduced by authors such as Bollerslev, Engle and Wooldridge (1988). Such models which are discussed in subsequent chapters include the Autoregressive Conditional Heteroscedasticity (ARCH), Generalized ARCH (GARCH), Exponential GARCH (EGARCH), VECH, Diagonal VECH (DVECH) and the VAR-GARCH BEKK models.

#### **3.1 Returns, volatility and spillovers between Stock and foreign exchange markets**

Over the last few decades, financial liberalization in most emerging economies spanning across Asia, Latin America, Eastern Europe and Africa has been on a rise. This has led to financial markets which were previously strictly regulated by governments been allowed to operate freely as the case has been in developed markets over a long period of time. In the nutshell, this has given way to foreign portfolio investors, multinationals and fund managers to channel resources to these markets to satisfy their diversification challenges.

In the course of these years, there have been a number of studies done on equity and foreign exchange markets interrelations and how it has helped policy makers, corporations and investors alike in decision making. Some researchers have been done taking into consideration the already developed markets, emerging and frontier markets in Asia, Eastern Europe Africa and Latin America. Some studies performed on volatility spillovers and relationships among equity and currency markets have come up with that have found positive relationships while others have come up with negative and lastly mixed results.

In this section, the study aim to discuss various research papers which have employed different theories, set of data and research geography; both on emerging, developed and African equity and foreign exchange markets. The aim is to look for different outcomes using perspectives reached from studies on linkages among equity and foreign exchange markets and among African equity markets respectively.

### 3.1.1 Previous studies on developed markets

In a bank of Finland discussion paper, Francis, Hasan and Hunter (2002) used a multivariate GARCH framework to discuss the dynamic relationships between certain major currencies and their respective equity markets. The study aimed to examine the conditional auto-correlations between the equity markets and the exchange rates. Empirical evidence from the study showed the existence of a *“bi-directional short-run dependence”* among the two markets. In the U.S, the authors found that past volatility of exchange rates have had a significant effect on the U.S equity markets. Furthermore, further analysis proved that past volatility in the equity markets generally affect the currency market but there is a weakness in volatility transmission from the foreign exchange market. In making decision regarding how the volatility transmission affect each of the markets, the study was on the idea that if currency risks contribute to equity returns in any country then increase in volatility will result in an increase in volatility in the associated market.

Nieh and Lee (2001) examined the G-7 countries in their study by employing a Vector Error Correction Model (VECM). The long-run relationship between equity and currency markets in the G-7 countries came up with no significant relationship in any of the countries examined. The evidence from the study is in line with the study of Bahmani-Oskooee and Sohrabian (1992) which used the same G-7 countries as focus. Further analysis on the VECM came up with significant short-run relationship among the variables. For example, in Germany, they found that a depreciation in currency drags the stock return and the *“stimulate the markets of UK and Canada”* after one day. Interestingly, stock prices increases in Japan and Italy in a day leads to a depreciation of the currency the following day. Finally, the authors found the U.S market exhibiting no relationship between the equity and foreign exchange market, thus both markets do not affect each other, which is in contrast with the results of Francis et al. (2002). In a similar geographical focus, Yang et al (2004) found



evidence of asymmetric volatility spillovers effect depicting that movements in stock prices have an effect on exchange rate movements in the future. They further found opposite results of changes in exchange rates having a less direct impact on future changes of stock prices.

Moreover, Kanas (2000) in a study of volatility spillovers between equity and currency markets focused on same countries employed by Nieh et al (2001) with the exception of Italy. This may be as a result of the use of the EGARCH model in the study. In his study, the author found evidence of volatility spillovers from stock returns to exchange rates in five countries (U.S, UK, Japan, France and Canada) except for Germany. In the case of Germany, the author documented that the reason for no significant relationship may be as a result of the Bundesbank of Germany's intervention in the currency market which may have affected the volatility of exchange rate changes. However, there was found to be no statistical significance level at 5% for any of the countries on volatility spillovers from exchange rates to stock returns but only Japan and Canada went further to show some significance at the 10% level. By finally employing a correlation coefficient of the EGARCH model, it was found existence of negative significant relationship for all the six countries.

By employing different econometric models other than those discussed earlier, Dark et al. (2008) examined the relationship that exist among the equity and currency markets of Australia and the U.S by using the VAR-BEKK GARCH model. Empirical evidence proved the persistence of volatility spillovers only for the USD/AUD exchange rate to the Australian All Share Index. However, the authors found no volatility spillovers from the Australian all share index to the USD/AUD exchanger rate. Fu and Choi (2011) by applying same multivariate GARCH model examined volatility transmissions and the linkages between the two markets in Japan and the USA. The outcome of the study proved a bi-directional volatility transmission between the Japanese and U.S markets. They also found out that unexpected news announcements contributed to volatility transmission in Japan, thus, fall in stock prices trigger currency market volatility. Furthermore, the study revealed a little evidence of volatility spillovers from the stock markets to the foreign exchange market in Japan, thus there exist a uni-directional relationship in the Japanese foreign exchange market and equity market. Interestingly, results from the U.S market exhibited similar results as in Japan. To sum it up, based on the evidence

from the study, it can be said that volatility in stock markets are significantly affected by exchange rate uncertainties as has been in the case of results from previous studies examined.

Choi, Fang and Fu (2009) examined the same problem by focusing on the New Zealand market by using an EGARCH model. The study found evidence of higher volatility in the foreign exchange leading to lower volatility in stock market owing to the period before the market crash of 1997. In the same period of time, the authors found significant volatility spillovers emanating from the stock market to the New Zealand dollar before the 1997 crash.

### **3.1.2 Previous studies on Emerging and African markets**

In recent years, the major emerging economies (Brazil, China, India and Russia) have by far been able to getting closer and more integrated with the developed markets. It is of emphasis that as the major developed economies in Europe and the U.S are hit by financial crisis and depression, there are possible spillovers onto these major emerging economies as well. For this reason, international portfolio investors have sought after other emerging and frontier markets in Asia, Latin America and Africa to attain better diversification. However, it is worth mentioning that since some of these markets are at the development and infant stages, issues of thin trading and volatility in equity and other financial markets are always on the welcoming front. Since each of these financial markets have linkages, it is important for a better understanding of the behaviors and mitigate against them.

For example, the linkages between equity and currency markets, which is the focus of this study may directly affect decision making of corporations and investors as a result of the fluctuations and high risk associated with these markets (Kuttu, 2012). Academic literature on emerging and African markets on the other hand in relation to interrelation among equity and currency markets have come with mixed results. Phylaktis and Ravazzolo (2005) in their study by employing a cointegration and multivariate Granger causality tests studied the short-run and long-run relationships in certain Pacific Basin countries with data spanning 1980 to 1998. In the study, the authors found the existence of a positive relationship between the stock and foreign exchange, thus, the U.S market have effect on the positive relationship in these countries. This go on to prove that since the U.S markets serves as a channel for the

relationship, it has a greater influence on how these markets behave. Again, a recursive estimation was used to and results indicated that in times of financial crisis, there is an existence of temporary effect on the long-run relationship of the markets. Firstly, there was no long-run relationship between the stock and foreign exchange markets for all the countries except for Hong Kong.

On the other hand, on the relationship between equity and currency markets, Aliyu (2009) in his study of Nigeria by using data covering 2001 to 2008 found a long-run bi-directional relationship between stock and foreign exchange markets after using the Granger two step and Johansen and Juselius cointegration tests. In the same African context, Adjasi, Harvey and Agyapong (2008) applied a univariate EGARCH model to study the Ghanaian market. Evidence showed existence of the currency market having effect of the stock market. As has been the case in some advanced countries previously discussed, the study found that a depreciation in the Ghana cedi affected the stock market volatility in the long-run, depicting a negative relationship while in the short-run it reduces the stock market returns. Similarly, however with mixed results, Adjasi and Beikpe (2006) also found a similar result indicating that a drop in exchange rates results in increase in stock market returns in the long-run for some countries but in the short-run certain countries' stock returns fall when exchange rate goes down.

By applying a bivariate VAR model, Bonga-Bonga (2013) examined the transmission of volatility shocks in the Republic of South Africa market. His findings showed that there is an existence of a positive response in conditional volatility of the foreign exchange volatility to shocks to the equity market of South Africa. On the other hand, response of the equity market to volatility shocks from the currency markets proved otherwise. In the same African context, Kuttu (2012) with a little bit of twist looked at how negative news affect returns and volatility dynamics between the foreign exchange and equity markets of Ghana and Nigeria. By using a negative news sensitivity as a dummy, the author employed a bivariate VAR-EGARCH model in the study. In his findings, the study came up with results that there existed a bi-directional return spillover between the equity and foreign exchange markets of Ghana. He however found a volatility spillover emanating from the equity market to the currency market. Based on the results obtained from Ghana, it can be said that current returns are positively correlated with past returns in both markets. Evidence

from Nigeria showed a unidirectional return spillover from the foreign exchange market to the stock market. Furthermore, taking into account the second moments of the variables, it was found that there exist a uni-directional volatility spillover among the variables in all countries. The study for example found that there existed past innovations from the equity market contributing to volatility in the foreign exchange market of Ghana, while, in Nigeria past innovations that emanate from the foreign exchange market affect volatility in the equity market. In general, the study also found that negative news such as political and ethnic violence, in both countries have a great impact on both the first and second moments of the currency and stock markets.

In a study of six (6) emerging Asian economies, Doong et al. (2005) applied the Granger causality tests to determine the dynamic relationship of stock and exchange rates. Firstly, the study found evidence of no cointegration between stock prices and exchange rates. However there is a bi-directional causality relationship found for Indonesia, South Korea, Malaysia and Thailand although Thailand exhibited a sign of negative relationship with same period change in exchange rates. This is the case where it is said that a fall in a currency is always accompanied by a fall in stock prices.

In similar context, Adjasi et al. (2011) in a bivariate analysis also examined the dynamic relationship that exist in some selected African countries. After a cointegration analysis, it was found that there exist a long run relationship between exchange and stock prices in Tunisia. There were findings of negative effect on stock prices in Tunisia as the Dinar depreciates. By applying an impulse response analysis for Kenya, Ghana, Nigeria and Mauritius, they found that stock returns in these countries reduce when affected by exchange rate shocks, while the opposite was found in the case of South Africa and Egypt which may be described to be much developed markets. Furthermore, the study also found a substantial short-run interactions between exchange rate and stock market returns movements in Ghana, Egypt, Kenya, Mauritius, Nigeria South Africa which also show that there exist no sure way of predicting these markets in the respective countries.

By examining volatility spillovers between stock prices and exchange rates, Kumar (2013) also included the major emerging economies (India, Brazil and South Africa)

popularly known as IBSA countries. The author used a VAR framework and a multivariate GARCH “*with time varying variance-covariance BEKK model is used as a benchmark against the spillover methodology proposed by Diebold and Yilmaz*” to find out the relationships among the markets. Empirical evidences from the multivariate GARCH model showed that in all the three examined countries, there existed a bi-directional relationship between the equity and foreign exchange variables, indicating a full integration of these financial markets in the respective countries. This result is in consistent with the findings of Braha (2009) on his study of Republic of South Africa, Mishra et al. (2007) on India, Morales (2008) for Brazil. Furthermore, both the equity and currency markets of India, Brazil and South Africa exhibited return and volatility spillovers, where the stock markets in each country was known to be a major player as compared to the foreign exchange market both in first and second moment interactions and volatility spillovers.

Mishra, Swain and Malharta (2007) in a study of the Indian market found the existence of a bi-directional volatility spillovers between the foreign exchange and equity markets (except for S&P CNX NIFTY and S&P CNX 500) of India. There was also evidence of a long-run relationship between the two variables, thus exhibiting information flow and integration of the markets. On the other hand, Jiranyakal (2012) used a cointegration test, non-causality test and two-step approach with a bivariate GARCH model and Granger causality tests for the Thai market first found no long-run relationship between stock prices and exchange rates. Further tests also showed evidence of positive “*unidirectional causality*” from the stock markets to the foreign exchange returns, thus associated exchange rate risks cause stock prices to fall. Finally, the author found evidence of a bi-directional relationship between stock market risks and risks associated with the currency market however in different directions.

In their investigation with focus on emerging Eastern European markets including Hungary, Poland and the Czech Republic and the Russian market, Fedorova and Saleem (2009) focused on volatility transmissions in the equity and currency markets of these countries. The study by using weekly returns from the respective countries estimated a bivariate GARCH-BEKK model to find evidence of an integration of the other three countries integration with the Russian economy in all aspects of the

variables included in the study. They also came up with an evidence of a unidirectional relationship of volatility spillovers from the currency markets to the equity markets in respective countries, where the volatility source were from the foreign exchange market.

Wu (2005) also focused on how regional economies in Asia interact by studying how the equity and foreign exchange markets interact during and aftermath of the 1997 Asian crisis. To be able to find evidence for the interrelations, the author used a bivariate EGARCH and EGARCH-X models for the study. It was found that, there exist a two-way relationship between the equity and currency markets especially during the recovery periods of the Asian financial crisis. On the other hand, the study went further to compare volatility transmissions during and after the crisis. It was found that, spillover effects had increased during the recovery period of the crisis which shows an increase in momentum of transmission after the crisis period. The results obtained here showed that during the crisis, many of the countries in Asia were heavily affected. The author document that countries such as Indonesia, Japan, Thailand and the Philippines were heavily affected due to their vulnerability and full exposure to the crisis.

A study which focused on Latin America was conducted by Diamandis and Drakos (2010). They investigated the relationship among four (4) Latin American countries namely Argentina, Brazil, Chile and Mexico while using the U.S market as comparison. The dynamic relationship among stock and foreign exchange markets were examined by using a cointegration approach. They found evidence of a positive correlation between stock and foreign exchange markets in all countries and as expected they are all caused as a result of linkages with the U.S market. Muhammad and Rasheed (2002) in their study of two Asian countries Pakistan and India found no long-run and short-run relationship between stock prices and exchange rates. In the same study, the authors found a short-run relationship between exchange and stock prices in Bangladesh and India. This result go on to explains the extent to which there are no relationship in stock prices and exchange rates, taking into consideration their short run momentum, at least for this study.

In a much broader context, Andreou, Matsi and Savvides (2013) in a University of Cyprus working paper, examined twelve emerging markets by applying a quarto-

variate VAR GARCH model to know the extent to which exchange rates and stock markets are related in each of the countries studied. With a BEKK representation, the authors went further to test for spillovers as in volatility among the stock and currency markets and additionally incorporates spillovers from regional and global context. Empirical evidence showed a bi-directional causality in variance between the equity and foreign exchange markets for all the countries studied except for Colombia. Also, the study found that global equity markets, especially those in the already advance markets contributes significantly to volatility spillovers in the emerging economies. Furthermore, the study looked into whether or not the Asian crisis and a particular exchange rate regime contribute to volatility spillovers between the stock and currency markets. It was found that there was a bi-directional volatility transmission or causality between the variables during the period of the crisis. In addition, it was also found that a country adopting a more flexible exchange rate regime has a higher tendency of volatility spillovers between the stock and foreign exchange market.

In conclusion, to make reading simpler and easy navigation, the interrelations between stock and currency markets discussed by various researchers in both developed and emerging and African markets are summarized below in a tabular form.

Table 7 Tabulated Previous Studies

| <b>Previous studies on developed markets</b> |                              |                        |  |
|--|------------------------------|------------------------|--|
| Year   | Researcher(s)                | Model(s)               | Findings   |
| 2002   | Francis, Hasan and Hunter    | multivariate framework | Past volatility of exchange rates have Significant effect on the US market and vice versa  |
| 2001   | Nieh and Lee                 | VECM                   | No significant relationship in the G-7 countries equity and currency markets.  |
| 2000   | Kanas                        | Bivariate EGARCH       | Evidence of volatility spillovers from stock returns to exchange rate changes in 5 countries except Germany; No statistical significance level at 5% for any of the countries on volatility spillovers from exchange rates to stock but only Japan and Canada show some significance at the 10% level. |
| 2008   | Dark, Raghavan, and Kampelli | VAR-GARCH BEKK         | Evidence of volatility spillover only from USD/AUD to the Australian All share index; significant spillovers between the USD/AUD and the AOI (direction unknown),  |
| 2011   | Fu, Holmes and Choi          | VAR-GARCH BEKK         | Evidence of transmission from stock to foreign exchange market in Japan (uni-directional transmission); Volatility in stock markets  |



Table 8 Tabulated previous studies (1.1)

| Previous studies on emerging and African markets |                         |  |  |
|--|-------------------------|--|--|
| Year   | Researcher(s)           | Model  | Findings   |
|  |                         |  | are significantly affected by exchange rate uncertainties.   |
| 2009   | Choi, Fang and Fu       | EGARCH   | Higher volatility in equity market owing to the period before the market crash of 1997; significant volatility spillover from stock to th NZ before and after the market crash dollar. |
| 2004   | Yang and Doong          | EGARCH   | Evidence of asymmetric volatility spillover effect; Stock prices affect exchange rate changes in the future, and the opposite is true for foreign exchange market.                     |
| 2005   | Phylaktis and Ravazzolo | cointegration and<br>Multivariate Granger<br>Causality tests | A positive relationship between stock and Foreign exchange markets in the US market serve as channel; No long-run relationship after employing a recursive estimation.                 |
| 2009   | Rahman and Uddin        | Granger causality  | No cointegration among the variables in all countries; No easy predictability of the   |

**Table 9 Tabulated previous studies (1.2)****Previous studies in emerging and African markets**

| Year | Researcher(s) | Model  | Findings   |
|------|---------------|--|--|
|      |               | Test/ Johansen   | the markets of India, Pakistan and Bangladesh.   |
| 2013 | Bonga-Bonga   | Bivariate VAR  | A positive response in conditional volatility of Foreign Exchange to volatility shocks to the equity markets of South Africa, vice versa for equity to currencies market.  |
| 2012 | Kuttu         | VAR-EGARCH   | Existence of a bi-directional return spillover between the equity and foreign exchange markets of Ghana; Evidence of volatility spillover emanating from the equity market to the currency market; Evidence from Nigeria showed a uni-directional return spillover from the foreign exchange market to the stock market. |
| 2009 | Aliyu         | Granger two step<br>Johansen and<br>Juselius cointegration | Evidence of long-run bi-directional relationship between stock returns and exchange rates.   |

**Table 10 Tabulated previous studies (1.3)**

| <b>Previous studies on emerging and African markets</b> |                             |   |  |
|---|-----------------------------|---|--|
| <b>Year</b>   | <b>Researcher(s)</b>        | <b>Model</b>  | <b>Findings</b>  |
| 2008  | Adjasi, Harvey and Agyapong | univariate EGARCH   | Depreciation in the Ghana cedi affects stock Market volatility in the long run.  |
| 2002  | Jiranyakal                  | cointegration tests<br>Non-causality tests and<br>Two-step approach with<br>Bivariate GARCH | Evidence of no long-run relationship for Thailand between stock prices and exchange but other models proves otherwise; causal relationship tests shows a bi-Directional relationship among the two markets   |
| 2005  | Doong, Yang and Wang        | Granger causality test  | Weak support for cointegration between stock And currency prices in all countries; a bi-directional causality found only in Thailand, Korea, Indonesia and Malaysia; fall in currencies drag stock prices in same direction.   |
| 2011  | Adjasi, Beikpe and Osei     | cointegration and impulse Analysis tests  | Positive and significant relationship between Exchange rates and stock prices found in Tunisia and fall in the Tunisian Dinar affects stock prices negatively; Exchange rate shocks also affect stock returns in Ghana, Kenya, Nigeria and Mauritius while opposite remained For Egypt and South Africa; Short-run |

**Table 11 Tabulated previous studies(1.4)**

| <b>Previous studies on emerging and African markets</b> |                      |                      |   |
|---|----------------------|----------------------|---|
| <b>Year</b>   | <b>Researcher(s)</b> | <b>Model</b>         | <b>Findings</b>   |
|   |                      |                      | interactions between Stock returns and exchange rates in all countries except Tunisia.  |
| 2002  | Muhammad and Rasheed | cointegration tests  | Evidence of no relationship in stock prices and exchange rates in the short-run for Pakistan-India and Bangladesh- India.   |
| 2010  | Diamandis and Drakos | cointegration tests  | Information flow from the USA is strong in contributing to a positive correlation between stock returns and exchange rates in Argentina Mexico, Brazil and Chile.                 |
| 2009  | Fedorova and Saleem  | bivariate GARCH-BEKK | A one way direction of Volatility spillovers from Currencies Equity markets in all studied countries; strong integration of the Eastern European markets with the Russian market. |

### **3.2 Returns, volatility and spillovers among equity markets**

Over the years, equity market dependencies have become necessary and important for corporations and portfolio investors all over the world. Due to contagion effects, it can be said that, volatility effects in one stock market can be felt in another stock market in a different country. For example, countries that belong to the same regional or economic bloc share such spillovers to a larger extent. It must be said that, such dependencies have become real over the years, dating back to the 2008 financial crisis which spread across all over the world with the U.S as the source is a perfect example in this case. In this regard, understanding how stock markets interact will in a long way help policy makers, decision makers and international investors in their activities.

Financial liberalization, unlike some decades ago has seen tremendous rise and almost every country in the world at the moment is opened to foreign investors and foreign trade. This has enabled a more correlation of international financial markets, hence equity markets, and a better understanding of them helps in decision making for governments, investors and financial institutions. One significant factor to know is that, generally, the developed equity markets drive the happenings in other equity markets, especially those of developing and emerging markets. As documented by Alkulaib, Najand and Mashayekh (2009), most financial markets all over the world were affected as a result of the 1987 financial markets crash in the US, the East Asia crisis of the mid 1997's affected most developing economies and same can be said in respect of the crisis in Thailand of 1997 which mainly resulted in contagion effects on most South Asian countries such as Indonesia, Malaysia, Korea and Philippines.

Unlike the developed equity markets, emerging and many African counterparts are characterized by high volatility as a result of thin trading at many times (Kuttu, 2012). Over the years, new equity markets have emerged with up to date trading mechanisms and have served as a good purpose for portfolio diversification all over the world. Most of these markets with relaxed laws are in Asia, Africa, Eastern Europe and the Middle East. Although most of these emerging market stock markets are known to be highly volatile, it must be said that they have become important and serve as a simultaneous destinations for diversification in periods when the developed markets are hit by crisis.

For instance, the Egyptian stock market was named to be the best destination for equity investors in the year 2014 when it recorded a total return in excess of 30% for investors (Financial Times, 2015). A growing number of studies have focused on the extent of relationship among equity markets mostly on developed economies, some on emerging and African markets using different econometric models.

In this section, the level at which equity markets are interrelated or intergraded as discussed by many authors will be discussed, spanning across studies in developed and emerging and African markets.

### **3.2.1 Previous studies on developed markets**

The volatility and spillover effects in equity markets in the international context has attracted the attention of many researchers over the years. Lee (2013) in his study, used a bivariate Weibull conditional autoregressive range to investigate the persistence of volatility spillovers in a regional and global context. Empirical results proved that, the stock markets of US, Japan, China, Hong Kong and Taiwan have a “*conditional autoregressive range relationship*”. Also the study found an effect of the US and the Japanese market volatility spillovers greatly impacting on the stock markets of Taiwan.

Booth, Martikainen and Tse (1997) in their study of the Scandinavian equity markets, employed an EGARCH model to study how the dynamics of volatility spillovers play along in these countries. In their results, it was found that each of the four Scandinavian market’s returns and volatilities are dependent on their past values. Also, in reaction to good and bad news and how it affects stock market volatilities, Finland, Sweden and Norway exhibited greater responses to bad news, thus a retreat in the stock markets and vice versa. With reference to long lasting cultural and economic ties, the markets of Finland and Sweden particularly exhibit volatility spillovers to each other. On the other hand, taking into account all the four countries, the authors found a weak integration among the countries.

In a study of volatility spillovers from the US, European, Japanese and South East Asian markets, Caporale, Pittis and Spagnolo (2006) employed the GARCH-BEKK model in their analysis by using indices spanning from 1986 to 2000. Evidence from the study shows a volatility spillovers in all cases owing to a bi-directional relationships in the second moments. However, the study found a unidirectional link

during crisis period and more importantly, the countries that got affected by the crisis become unresponsive to any financial development.

Taking into consideration volatility spillovers from matured markets to emerging equity markets, a European Central Bank (ECB) working paper of 2009, the authors used a tri-variate GARCH-BEKK model to study how in times of turbulence in matured markets affect volatility spillovers in emerging economies. By including 41 emerging markets, the authors found that volatility in matured markets have a consequence on the conditional variance of many of the emerging markets studied but the parameters of spillovers change during turbulent periods. The changes in spillovers parameters in emerging markets go on to show that spillovers from the matured markets are only present during crisis periods in those markets. On the other hand, the authors found evidence of a higher conditional variance in emerging markets in non-turbulent periods. Although there is an evidence of spillovers from the matured markets to the emerging economies, the study found them to be incomplete.

In a similar context, a study of return and volatility spillovers from developed European markets to five emerging economies were carried out by Shih and Wang (2009). The study employed a multi-factor model with time varying loading model. The data set was mainly from 1996 to 2006 by using MSCI world and MSCI Europe indices together with national indices of Poland, Czech Republic, Hungary, Russia and Turkey. Results from the study showed a significant volatility spillover effects for the emerging European countries coming from the world and European developed markets, whereas the intensity of the volatility is stronger from the developed European markets as compared to the world indices but mean spillover effects from the world supersedes that of the developed Europe.

Certain researches, most often rely on the US market, which is advanced enough to study how it affects other markets. By using a daily price indices of the Tehran stock exchange (TEPIX) and S&P 500 for the period 2008 to 2014, Gholami (2015) employed a multivariate GARCH framework to study volatility spillovers between the US and the Iranian equity markets. The results of the study showed a return spillover in stock markets returns in both countries. Also, it is found that shocks emanating

from negative news have a significant effect on both markets whiles past period volatility have an effect on current periods.

As already mentioned, the elimination of trade laws, the existence of regional blocs and free trade among countries (examples been the European Union, NAFTA etc.) have greatly affected the interdependencies in equity markets around the world. Baele (2005) in his study of volatility spillovers in western European equity markets used a regime-switching model to find that regime switches are economically and statistically significant. He found that both the US and EU exhibited an increase in shock spillover intensity during the periods between 1980's and the 1990's. The EU however exhibited a higher shock spillover intensity. This is as a result of equity market development over the years, low inflation figures and trade integration. Finally, in periods of high world market volatility, the study found that the US market served as a contagion source to some of the European equity markets.

Kanas (1998) also investigated with a European evidence on how stock market volatility spillovers pay along. In the study, the author applied the EGARCH model to capture potential asymmetric effects innovation on volatility. The study focused on the three largest equity markets in Europe; (London, Frankfurt and Paris). Evidence from the study proves a bi-directional volatility spillover between the London and Paris stock exchanges and Paris and Frankfurt stock exchanges during the period 1984 to 1993. However there was a unidirectional spillovers from London to Frankfurt. In the case of asymmetric spillovers, the study found that all the markets responded greatly to bad news than when there is a good news. Furthermore, owing to financial market crashes during the period of study, the author found that the number of spillovers during after crash periods is greater than the spillovers of the pre-crash periods and the former has a greater intensity. This results also is in line with the results of Koutmos and Booth (1995) on their study of volatility spillovers during the post-crash periods in New York, London and Tokyo stock markets.



### 3.2.2 Previous studies on emerging and African markets

Major emerging and African equity markets as have already mentioned, have in recent years played a major role in serving as a diversification destination for investors in periods when the developed markets are hit with crisis or become saturated. The markets have therefore helped in arriving at important investment strategies. By using an EGARCH model Appiah-Kusi and Pescetto (1998) studied the dynamics of volatility spillovers by focusing on emerging African equity markets. Supporting evidence showed that many of the African equity markets are highly volatile, which has been the regular perception, however investors who take the chance in investing these stocks are highly rewarded with returns. This notion goes with the basic portfolio theory of whether higher risks imply higher returns. Also, the study found an asymmetric volatility spillovers and that most of the spillover effects exists among countries which belong to the same economic bloc. Contrary to this study, Humavindu and Floros (2006) used daily closing indices of the Namibian stock exchange and Johannesburg stock exchange with a sample covering 1999 to 2003 to study how these two markets are integrated and its volatility dynamics. By performing volatility modellings and cointegration tests, the authors found evidence of very low correlation and no linear correlation among the markets. The study also found no volatility effects after conducting volatility modellings while the Namibian stock exchange is known to be a risk diversification destination in the Southern Africa region.

In a much broader scope on the integration and volatility spillovers among African stock markets, Saleem, Collan, Ahmed and Gyasi (2014) studied the extent to which the African countries studied (Kenya, Mauritius, Egypt, Morocco, South Africa, Tunisia and Zambia) are integrated with the US, world, BRIC countries and emerging market indices. The study made use of the bivariate VAR-GARCH-BEKK model with data set spanning a 15 year duration from 1998 to 2013. Among the countries studies, the Egyptian and especially South African equity markets which are known to be the oldest and most advanced equity markets in Africa came up with an integration with the world and US markets, which the authors see not to be a surprise. However, the Kenyan stock market also exhibited same direction which is a proof of how the Nairobi Stock Exchange (NSE) and the entire Kenyan economy is becoming attractive for foreign investors. Furthermore, he study found a low correlation among the African markets with the rest of the world, at least when a

comparison is made with the developed markets. This therefore go on to prove that many of these markets are still 'young' and still in development stages. However, it was also revealed that the African markets shared a stronger correlation with the developed markets during the crisis period of 2008. For this evidence, the assertion of these African markets serving as a diversification avenue during crisis periods in developed markets do not hold, hence seeing a drop in investments same as the case may be for developed markets.

In recent times, there has been a wind of change in investment destination and this cannot be said without a mention of the four (4) major emerging economies which come together as the BRIC (Brazil, Russia, India and China). According to a Bloomberg (2015) publication, the world's economic order in terms of largest economy by GDP in 2030 will have all these countries overtaking most of the countries in the list at the moment. This is of no surprise that these markets have been growing at a faster pace in recent times. These growth has shown that the BRIC stock markets have been a preferable destination for investors all over the world. The BRIC equity markets have had linkages due to their similarities and characteristics. Dasgupta (2014) examined the dynamic integration and linkages between the Indian stock markets with its BRIC counterparts. To be able to determine the short-run and long-run relationships among the stock markets, the author employed the Johansen and Juselius and Engle and Granger cointegration tests on the data. Empirical evidence suggest the existence of a cointegration of a long-run and short-run bi-directional relationship between the stock markets of India and Brazil. Again the results showed a causation from the Chinese market to the Brazil, which finally has a causal effect on the stock market of Russia. The Indian economy which in a World Bank report recently overtook Japan as the world's third largest economy in terms of purchasing power parity (PPP) was known from the study that, its stock market has had a stronger impact on the stock markets of Brazil and Russia. Gilenko and Fedorova (2014) also used the same BRIC context to apply a BEKK-GARCH in mean model to study the internal and external spillover effects of these countries during and after crisis periods. Firstly, they found that during the pre-crisis period, there existed a low but highly significant correlations among the markets. In terms of mean-to-mean spillovers, the study found that there existed a spillover which goes from Brazil to Russia and the Chinese stock markets and thus,

volatility spillovers are highly present among the markets. However, after the crisis period, it was found that volatility-to-volatility spillovers entirely disappear but correlations among the stock markets remain much stronger.

Aside the BRICS which has gained popularity over the years, there has been several coining of names for certain emerging markets around the world. Becoming popular among them now is the countries of Colombia, Indonesia, Vietnam, Egypt, Turkey and South Africa (CIVETS). These frontier emerging economies provide a wide range of opportunities for investors due to the fact that they possess dynamic economies and growing populations that are generally young. Korkmaz, Cevik and Erdal (2012) in their study of these new bloc of countries employed a causality-in-mean and causality-in-variance models to identify return and volatility spillovers among these countries. It was found that contemporaneous spillovers among the CIVETS countries are generally low but may move together with a matter of time. Also there was a feedback effect that existed between Indonesia and Egypt after performing the causality-in-mean tests while the only feedback relationship found after conducting the variance-in-mean tests were found to exist among only South Africa and Vietnam. In comparing the CIVETS group of countries to the BRICS, it can be said that these are new countries and the level of correlation and integration in stock markets will remain low for a very long time. This is a good case for investors to look at the stability, spillovers and linkages and strength in making decisions concerning portfolio investments.

Alkulaib, Najand and Mashayekh (2009) also studied a group of countries in the Middle East and North Africa (MENA) region on the dynamic linkages among the equity markets and how well this is helping to attract equity investors around the world. These countries in some decades ago were known to have stricter rules in place towards foreign investors have recently reformed and growth in these regions can be said of same in other emerging economies. By conducting tests on lead/lag relationships, the authors found that there was no market causality or volatility spillovers among the North African countries. On the other hand countries such as Oman, Jordan, Qatar, Turkey, Saudi Arabia, Kuwait, Lebanon, UAE, and Jordan exhibit a level of linkages among the stock markets. The results prove a bi-directional relationship between the stock markets of Turkey and Lebanon. Taking into account the countries in the Gulf Cooperation Council which consists of Qatar,

Oman, Bahrain, UAE, Saudi Arabia and Kuwait, the study found that these stock markets show more interaction and correlation, where the market of UAE leads, as compared with what happens between the other countries. In another instance, Rao (2008) in his investigation of volatility persistence in certain Middle East emerging economies found that equity markets of the countries studied exhibited own and cross spillover innovations and volatility spillovers over time. Innovation spillovers were mostly found to be spilled from UAE and Saudi Arabia to the other markets constantly. It is important to note from the study that, the countries studied mainly derive volatility persistence within the domestic market, which can be said to be a good case for international diversification, due to the fact that these markets are rarely pushed by happenings in the developed world.

By using the stock market data of India and twelve (12) other Asian countries, Mukherjee and Mishra (2010) study into the integration and volatility spillovers among these stock markets. The study actually focuses on trading periods and non-trading hours to determine the return and volatility spillovers, hence, to know how the transmission of information is carried out during trading periods and when trade closes for the day. The study uses a GARCH (1, 1) model with data within a time period from 1997 to 2008. Evidence from the study showed that there is a bi-directional intraday return spillover between India and most of the Asian countries studied. Also, there exist a significant information flow to India from four countries namely; Singapore, Korea Thailand and Hong Kong. Again it was found that India predominantly influences the stock markets of Pakistan and Sri Lanka. In the case of information transmission, it was found that overnight information transmission rarely exists when compared to intraday information flow and information flow during the day goes without delay.

In his study of four African equity markets, Kuttu (2012) applied a multivariate VAR-EGARCH analysis to study the dynamics of return and volatility spillovers in Ghana, Kenya, Nigeria and South Africa. From his results, it was evident that there existed a bi-directional relationship between the equity markets of Ghana and Kenya and Nigeria and South Africa. It was also found that South Africa is dominant in shipping past return innovations in the first moments of trading to Kenya and Nigeria which proves that both countries are affected by changes and actions in the South African equity market. Again, the results in the second moments shows that Nigeria

dominates the other countries. There is a uni-directional volatility spillover to the Kenyan and South African stock markets. Overall, the results from the study showed a weak integration among the equity markets, however Ghana and Nigeria showed a significant integration in the stock markets.

Jayasuriya (2011) also examined the interlinkages between the Chinese stock markets and its emerging market neighbors. The author utilized a vector autoregressive (VAR) model. Impulse response and vector decomposition of VAR in the study. Data from the study comprised of monthly stock market return data of China, Thailand, Indonesia and Philippines from the period 1993 to 2008. It was found that, the stock market of China had a dominant role over the years on the return behavior of the other markets. This is a proof that shocks emanating from China are greatly felt in the other markets. Finally, it was found that the markets are not interrelated but there is a level of relationship between China and the other markets when foreign investor return are accounted for.

Ncube and Mingiri (2015) also studied Africa's largest stock market, that is South Africa and how it is integrated with other African markets. They used monthly data for the period 2000-2008 and also applied a Johansen and Julius cointegration techniques to determine the long-run relationship between the stock markets. Although the study see the African stock markets are improving, the authors also make note of a segmentation of the various equity markets, which concur with other previous studies. The results of whether or not world market activities affect the African equity markets also proved positive, however there exist portfolio diversification opportunities for investors. Piesse and Hearn (2005) also go further on the integration of African stock markets by employing the EGARCH model to study countries in the Sub Saharan African region. The results showed that the price indices of the Sub Saharan African stock markets exhibit volatility but are transmitted differently through the markets. However, it was found that both Nigeria and South Africa's equity market ship spillovers to other local markets. Adjasi and Beikpe (2006) also looked at one big market (South Africa) and a smaller market (Ghana) to determine the causal linkages among their stock markets by using a cointegration and error correction models. They came up with results that there exists a long-run relationship among African stock markets and there is existence of causality running mainly from the large markets to the smaller ones. This is the case where the South

African market was known to have a dominating effect on the Ghanaian stock market.

#### 4. DATA

In the study, data for a period of 12 years starting 1<sup>st</sup> October 2002 to 31 October 2014 is used by generating 3154 daily observations for both stock and the foreign exchange data from all the countries used in the study. Daily price data was gathered from DataStream on the variables; Egypt stock exchange (EGX 30), the Egyptian Pound, Nairobi Stock Exchange (NSE 20), Kenyan Shilling, the Nigeria All Share Index, Nigerian Naira, Johannesburg Stock Exchange (JSE All Share Index), the South African Rand, Tunisian Stock Index (TUNINDEX) and the Tunisian Dinar. Furthermore, the daily price data were converted into simple percentage returns using the formula;  $Ret = ((P_t - P_{t-1})/P_{t-1}) * 100$ .

##### 4.1 Descriptive Statistics

The descriptive statistics of the data applied in the study are explained in details in this section while it is presented in the table 8 below. Taking into account the fifth assumption of the classical linear regression model, there is a prediction which assumes that the disturbances of the data must be normally distributed, thus, the need to look into the skewness and kurtosis behaviors of the data.

Statistically, a normally distributed data is known to be not skewed and also must have a kurtosis of 3. From the table below, it can be seen that all the variables from the respective countries exhibit excess kurtosis which means they have fat tails, while there is the existence of skewness in some of the series. From the table below, it can be seen that all the series exhibit a distribution of leptokurtic (kurtosis greater than 3) in them which is an indication that more of the variance is due to infrequent deviations. It must be emphasized that the direction (positive or negative) of a skewed data explains the direction in which returns may be expected from the series. When there is negative skewness, a market is known to have a downtrend and when it is positive, there is an uptrend. The Egyptian Pound, Johannesburg all share index, the South African Rand, Kenyan shilling, Nairobi stock exchange, Nigerian all share Index and the Nigerian Naira are all skewed to the right or are positive which is an indication of positive shocks coming from the respective countries. The positivity of the skewness also explains that investors in these markets are likely to expect positive returns compared to their counterparts with negative skewness. It must be emphasized that, the non-normality of the distribution

of the data calls for a non-linear model as a suitable one for analyzing the study, hence, the use of the Bivariate VAR-GARCH-BEKK model.

In most cases, when it comes to volatility related studies the standard deviation is often used as a measure of how risky the asset under consideration may be. From the percentage returns, the Johannesburg all share index came up with the highest standard deviation of 179.58% which means it is the most volatile among all the series. It is closely followed by the Egyptian stock exchange (EGX30) with 172.85%. The higher volatility may be as already mentioned political turmoil that rocked the country in 2011, rendering it unstable for some time in the last few years. Also, the NSE20 the South African Rand and Nigeria All share index followed with medium volatility of 117.05%, 107.05% and 103.95% respectively, with the remaining series reporting the lowest standard deviations less than 100% where the Egyptian pound is the less risky with 18.13%. Although South Africa counts as the second biggest economy in Africa in terms of GDP, it can be said that both the South African Rand and the JSE all share index have over the years exhibited higher volatility, owing to structural and other economic fatalities in recent years and its close association with biggest world markets which has recently suffered turmoil.

In order to confirm the usability of the data for further analysis in the study, additional tests are made to identify whether or not the data applied in the study contain unit root and is stationery. This is done using the Augmented Dickey Fuller (ADF) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) respectively. The ADF is known to have a null hypothesis of the presence of unit root, while the alternative hypothesis is that there is no unit root. In the ADF test, the negative number under t-statistic is looked at and the more negative it is, the stronger the rejection of the null hypothesis. From the results in the table below, all the variables are statistically significant at 1% level indicating that the null hypothesis is rejected. Stationarity of the series is however determined with the aid of the KPSS test. The null hypothesis is that there is stationarity of the data. From the test results, there was insignificance of probability at 1% significance level, which means the null hypothesis is accepted which makes the data valid for further analysis.

Furthermore, based on the selected model for the study, there is the need to make further tests to check for the ARCH tests. In doing so, firstly, the Lagrange multiplier



test which is made to assess ARCH effects in the series is conducted for autoregressive conditional heteroskedasticity on residuals. The obtained *Obs\*R-squared* which are large enough are also accompanied by significant *Prob Chi-square* at 1% significance level. This is an indication that the data has ARCH effects and confirms the model selection for the study. Also, the heteroskedasticity test is carried on the residuals at selected lags (15). The Ljung-Box Q-test which is used here is a way to test for autocorrelation using joint multiple lags. From the table below, the  $LB_{15}$  signifies Ljung-Box Q-statistics for residual serial correlation up to the 15th order. The results indicate that there is autocorrelation in the returns for the selected variables and as already confirmed, there is the existence of ARCH effects

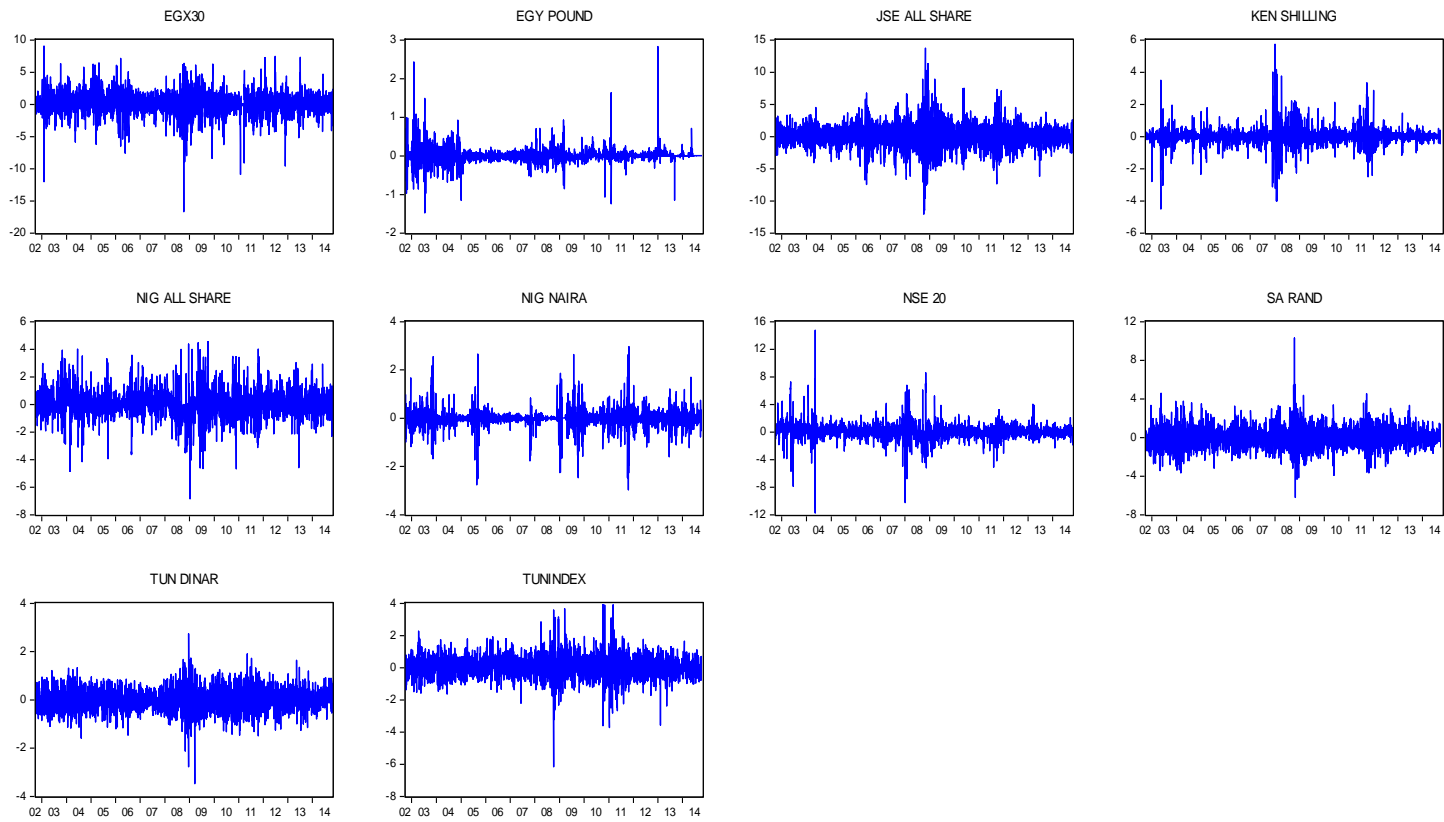
#### **4.2 Additional analysis**

A first look at the graphical presentation of the various series came up with questions regarding the Egyptian pound, the Nigerian all share indexes and the Nigerian Naira. They all came up with abnormal higher spikes indicating higher returns which seemed abnormal, implying the existence of some outliers in the data which were mainly in 2002, 2003. This was corrected by calculating for the average price and later replaced in the sections the outliers were found. After this activity the graphical presentation became normal.

**Table 12 Descriptive Statistics**

|                  | EGX30      | EGYPOUND   | JSEALLSHARE | SARAND     | KENSHILLING | NSE20     | NIGNAIRA   | NIGALLSHARE | TUNINDEX  | TUNDINAR  |
|------------------|------------|------------|-------------|------------|-------------|-----------|------------|-------------|-----------|-----------|
| Mean %           | 9.58       | 1.42       | 0.53        | 5.38       | 0.72        | 6.73      | 3.88       | 0.99        | 3.84      | 0.97      |
| Median%          | 5.03       | 0.00       | 0.00        | 3.76       | -1.35       | 13.04     | 0.00       | 0.00        | 3.20      | 0.00      |
| Maximum%         | 20.61      | 16.78      | 5.72        | 14.74      | 10.30       | 13.80     | 46.40      | 12.73       | 3.91      | 2.73      |
| Minimum%         | -16.71     | -1.50      | -4.51       | -11.75     | -6.19       | -12.06    | -32.70     | -7.42       | -6.20     | -3.50     |
| Std. Dev.%       | 172.85     | 18.13      | 179.58      | 107.00     | 52.14       | 117.05    | 35.49      | 103.95      | 68.63     | 44.67     |
| Skewness         | -0.27      | 35.35      | 0.46        | 0.41       | 0.51        | -0.80     | 6.11       | 5.72        | -0.13     | -0.10     |
| Kurtosis         | 15.02      | 1685.83    | 21.96       | 24.60      | 7.57        | 8.75      | 378.43     | 175.00      | 8.67      | 5.83      |
| Jarque-Bera      | 19019.78** | 3.73E+08** | 47377.72**  | 61396.99** | 2884.53**   | 4349.91** | 18542091** | 3903929**   | 4230.87** | 1053.10** |
| Probability      | 0.00       | 0.00       | 0.00        | 0.00       | 0.00        | 0.00      | 0.00       | 0.00        | 0.00      | 0.00      |
| ADF (T-Stat)     | -23.84**   | -17.01**   | -19.12**    | -18.61**   | - 18.00**   | -18.51**  | -19.86**   | -19.04**    | -17.64*   | -17.78**  |
| KPSS (LM Stat)   | 0.10       | 0.02       | 0.20        | 0.04       | 0.02        | 0.10      | 0.10       | 0.10        | 0.22      | 0.03      |
| ARCH (LM Test)   | 240.22**   | 115.49**   | 830.41**    | 434.60**   | 584.72**    | 454.78**  | 560.20**   | 359.10**    | 540.42**  | 210.21**  |
| LB <sub>15</sub> | 35.34**    | 172.50**   | 35.41**     | 17.73**    | 59.84**     | 24.13**   | 60.40**    | 35.51**     | 22.83**   | 19.50**   |
| Sum              | 302.03     | 44.91      | 16.64       | 169.75     | 22.69       | 212.15    | 122.44     | 31.09       | 120.98    | 30.59     |
| Sum Sq. Dev.     | 9841.60    | 384.63     | 857.04      | 4319.69    | 3609.87     | 10168.14  | 6961.33    | 799.60      | 1485.23   | 629.10    |
| Observations     | 3154       | 3154       | 3154        | 3154       | 3154        | 3154      | 3154       | 3154        | 3154      | 3154      |

(\*\*\*) explains statistically significant at 1%. KPSS (Kwiatkowski–Phillips–Schmidt–Shin) is a test for stationary process. KPSS Lagrange Multiplier is seen to be not significant and hence the null hypothesis of stationary cannot be rejected. Standard Deviation and the mean were annualized. ARCH (LM) is the Lagrange multiplier test for ARCH up to lag 15, LB15 is Ljung-Box Q-statistic using 15 lags and ADF is the Augmented Dickey Fuller for unit root test.



**Figure 9 Graphical Presentation of series**

### 4.3 Volatility Clustering

Volatility clustering explains the tendency at which volatility in markets appear in bunches. Under volatility clustering, it is noted that large returns of either signs (-,+ ) lead to large and small returns of either signs to follow with small returns at a period of time. A possible explanation for this behavior is that information arrival which leads to changes in asset prices are not evenly spaced but arrive in bunches.

The price at which a stock sells at a particular time, for example, reflects or is the result of available information that flows within the market, whether positive or negative and these information in volatility clustering is known to arrive in bunches rather than been evenly spaced. The figure above depicts that the series used in the study show some sort of volatility clustering a point in time during the years under consideration. The returns can be seen to fluctuate around the constant but exhibit volatility clustering, that is, large changes in returns cluster together and small changes in returns also cluster together. This means that the series can be said to exhibit conditional heteroscedasticity.

One significant timeline worthy of mention is the 2008 sub-prime crisis. African markets had their own share of the crisis, since they may be one way or another be related to other global indices. It can therefore be seen that all the series exhibit some spikes during this period of time. Also, the Egyptian stock and foreign exchange markets responded with some negative spikes in the stock market during 2011, the year of the revolution which led to the ousting of Hosni Mubarak from office. This may have been as a result of low foreign direct investment in the wake of the political unrest. However due to a low correlation of the Egyptian stock and currency with the other African countries, the effect of the revolution wasn't felt in the other series has also shown in the correlation analysis below.

### 4.4 Correlations

To be able to identify the degree of linear association among the variables, which is a way to prove that there is a linear relationship between them and movements in the variables are to some extent related given by the correlation coefficient. It can be seen from the table below that the Egyptian Pound seem very much segmented from

all the other variables, depicting very low correlation with the other variables in the study, same as the Nigerian Naira.

Although some correlations exist among the markets, there seem not to be higher correlation among them, indicating the possibly that these various African markets are independent of each other to a larger extent. One would have predicted a higher correlation between Tunisia and Egypt (both in the MENA region) but the results confirm otherwise.

Table 13 Correlations

|                      | <i>EGX30</i> | <i>EGY POUND</i> | <i>JSE ALL SHARE</i> | <i>SA RAND</i> | <i>NSE 20</i> | <i>KEN SHILLING</i> | <i>NIG ALL SHARE</i> | <i>NIG NAIRA</i> | <i>TUNINDEX</i> | <i>TUN DINAR</i> |
|----------------------|--------------|------------------|----------------------|----------------|---------------|---------------------|----------------------|------------------|-----------------|------------------|
| <i>EGX30</i>         | 1            |                  |                      |                |               |                     |                      |                  |                 |                  |
| <i>EGY POUND</i>     | <b>-0.20</b> | 1                |                      |                |               |                     |                      |                  |                 |                  |
| <i>JSEALL SHARE</i>  | <b>0.20</b>  | -0.05            | 1                    |                |               |                     |                      |                  |                 |                  |
| <i>SA RAND</i>       | <b>-0.13</b> | 0.04             | <b>-0.80</b>         | 1              |               |                     |                      |                  |                 |                  |
| <i>NSE 20</i>        | <b>0.10</b>  | -0.06            | <b>0.11</b>          | <b>-0.10</b>   | 1             |                     |                      |                  |                 |                  |
| <i>KEN SHILLING</i>  | -0.07        | 0.04             | <b>-0.15</b>         | <b>0.13</b>    | <b>-0.57</b>  | 1                   |                      |                  |                 |                  |
| <i>NIG.ALL SHARE</i> | 0.06         | -0.03            | 0.02                 | -0.02          | 0.03          | -0.02               | 1                    |                  |                 |                  |
| <i>NIG NAIRA</i>     | 0.02         | 0.02             | -0.01                | 0.03           | -0.03         | 0.03                | <b>-0.33</b>         | 1                |                 |                  |
| <i>TUNINDEX</i>      | 0.08         | -0.01            | <b>0.33</b>          | <b>-0.33</b>   | 0.07          | -0.08               | 0.01                 | -0.02            | 1               |                  |
| <i>TUN DINAR</i>     | -0.06        | 0.05             | <b>-0.43</b>         | <b>0.46</b>    | -0.08         | <b>0.11</b>         | -0.01                | 0.05             | <b>-0.63</b>    | 1                |

Numbers in bold represent statistically significance at 10% level.

## **5. METHODOLOGY**

### **5.1 Autoregressive Conditional Heteroscedastic (ARCH) models**

In modelling financial time series data, it is well known that most econometric models are unable to capture the required features due to the fact that they have characteristics of exhibiting large values and usually not normally distributed and the variance of the errors not been constant thus known to be heteroscedastic. The ARCH model pioneered by Engle (1982) is mostly preferred in studies related to volatility clustering. The model assumes that large shocks in data series tend to be followed by another large shocks within a period of time.

With reference to Engle (1982), the ARCH model assumes conditional variance and also depends on certain key elements of information set in an autoregressive manner. He further describe that, the Arch model is able to distinguish between conditional and unconditional variances, thus, making the conditional variance able to change over a period of time.

### **5.2 Generalized ARCH (GARCH) Model**

The ARCH model in its use exhibited certain problems which made financial time series modelling become more cumbersome and unreliable. This was due to the problem that the ARCH model in use makes it difficult determining the appropriate number of lags and the violation of the non-negativity constraint ( variance cannot be negative) which meant that the estimated parameters were anyway supposed to be negative. The ARCH model also assumes that positive and negative shocks have the same effects on volatility which is not the case due to the fact that prices of financial assets at all times respond differently to shocks (Tsay, 2005).

A natural extension of the ARCH model, which helped to get around these shortcomings was the result of GARCH which was proposed independently by Bollerslev (1986). The GARCH model however, allowed the conditional variance to depend on its own previous lags which wasn't the case in ARCH (Brooks, 2008). Generally, a GARCH (1, 1) model is known to be sufficient enough to capture volatility clustering in a series of data and it's less likely to breach non-negative constraints.

### 5.3 Multivariate GARCH (MGARCH) Models

Since the introduction of the ARCH model by Engle (1982), modelling of volatility in financial time series has grown over the years, leading to different extensions to the original model. It is important to note that, MGARCH models aid in forecasting and estimating correlations and covariances that exist among the set of variables used into the study. MGARCH models specifically helps in the estimation and forecasting of covariances and correlations and are time varying in nature (Brooks, 2008). For the purpose of this study, the principal focus is on modelling the co-movements, risks between markets, shock transmission and correlation and among stock and foreign exchange markets, it is imperative to consider the MGARCH models. As already stated, unlike their univariate counterparts, the MGARCH models are able to specify how conditional covariance move over time due to the fact that the variance covariance of the error term ( $\epsilon_t$ ) allows the dependence of information set.

The general multivariate GARCH model was first specified by Bollerslev, Engle and Wooldridge (1988) in the form as:

$$y_t = \mu_t + \epsilon_t, \quad (1)$$

$$\epsilon_t | \phi_{t-1} \sim N(0, H_t),$$

Where  $\mu_t$  represents the  $N \times 1$  vector of conditional expectation of  $y_t$  at period  $t$ ,  $\epsilon_t$  represents the  $N \times 1$  vector of shocks at time  $t$ .  $\phi_{t-1}$  presents all available information at time  $t-1$ .

Over the years, there have been several multivariate GARCH models which have been proposed by mainly the pioneering authors. The models include the VEC, the Diagonal VEC and the BEKK models.

#### 5.3.1 The VEC Model

First of extension to the MGARCH model was the VEC which assumes that the conditional variances and covariances depends on lagged values of all the variances and covariances and also on the lags of the squares of both error terms and its cross products. The model in its simplest explanation can be said that, the components in



the variance-covariance of ( $H_t$ ) represents a linear function of lagged squared error, returns as well as innovation. The model is specified as below:

$$VECH(H_t) = C + \sum_{i=1}^p A_i VECH(\Xi_{t-i} \Xi_{t-i}') + \sum_{j=1}^p B_j VECH(H_{t-j}) \quad (2)$$

Where  $H_t$  denotes a 2x2 conditional variance covariance,  $\Xi_t$  represents a 2x1 innovation vector at a time  $t$ ,  $C$  represents the parameter vector while  $A$  and  $B$  denotes a 3x3 parameter matrices and  $VECH(\cdot)$  serves as an operator that adds up the columns in the lower triangular section of the matrix as a vector (Brooks, 2008: 432)

The usual VECH model has 21 parameters which is estimated. However this is known to be complicated in interpretation, leading to the introduction of a restriction on the conditional variance covariance by Bollerslev et al (1988). This resulted in the  $C$  having 3 elements and  $A$  and  $B$  having 9 elements each as presented in equation (3) below

$$\begin{bmatrix} h_{11t} & h_{12t} \\ h_{21t} & h_{22t} \end{bmatrix}, \Xi_t = \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}, C = \begin{bmatrix} c_{11} \\ c_{21} \\ c_{31} \end{bmatrix},$$

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}, B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \quad (3)$$

$$VECH(H_t) = \begin{bmatrix} h_{11t} \\ h_{21t} \\ h_{12t} \end{bmatrix}$$

### 5.3.2 The Diagonal VECH Model

With the availability of 21 parameters on the VECH model which seem to make it cumbersome, further restrictions on the number of estimated parameters necessitated the proposal of the diagonal VECH model by Bollerslev et al. (1988). The diagonal VECH model therefore economizes on the estimated parameters. This

was of the purpose to make it simple to apply the already proposed VEC model, therefore by doing so, the authors suggested that; components in the variance-covariance matrix ( $H_{ijt}$ ) only depend on their own lags, while the previous values of the error term ( $\varepsilon_{it}\varepsilon_{jt}$ ) also depend on their previous lags, whereas A and B become diagonal (Brooks, 2008:434).

The diagonal VEC model is known to carry a variance-covariance matrix which is supposed to be “*positive semi definitive*” in the sense that a variance must always be positive, thus the covariance between two series take the same position. This is echoed by Engle and Kroner (1995) that, the diagonal VEC model possesses an “*all positive definitive diagonal representations and nearly all positive definitive representations*” which isn’t the case for the first proposed model. However, this may be a disadvantage of the model as there may not be assurances that the variance covariance will be positive semi-definite (Brooks, 2008). The diagonal VEC model is written as follows:

$$h_{ijt} = \omega_{ij} + A_{ij}\varepsilon_{it-1}\varepsilon_{jt-1} + \beta_{ij}h_{ijt-1} \quad (4)$$

where  $\omega_{ij}$ ,  $A_{ij}$  and  $\beta_{ij}$  are the estimated parameters.  $h_{ijt}$  (variance-covariance matrix) is supposed to positive semi-definite.

### 5.3.3 Bivariate VAR-GARCH BEKK model

The bivariate VAR-GARCH-BEKK model has in recent times been used in studies to identify how financial market variables are related to each other. In the context of African markets, it was realized that this model has not yet been implemented yet, thus the need to employ this into this study. The VAR-GARCH-BEKK model as specified will be used to analyze co-movements in the conditional variance and covariance of the series used in the study.

By estimating the mean equation, the first order Vector Autoregressive (VAR (1)) is used to help arrive at the conditional mean returns of all the variables that are been paired. The model is therefore written as follows:

$$y_{1t} = \beta_{10} + \beta_{11}y_{1t-1} + \alpha_{11}y_{2t-1} + u_{1t} \quad (5)$$

$$y_{2t} = \beta_{20} + \beta_{21}y_{2t-1} + \alpha_{21}y_{1t-1} + u_{2t}$$

The vector  $u_t$  which is the error term captures innovations that may be available in each of the markets. However, the spillovers (own and cross markets) of the variables are captured by the estimates of the  $\beta$  coefficient which represents the vector autoregressive parameters.

Furthermore, the bivariate GARCH (1, 1) BEKK is defined as follows:

$$H_t = C_0 C_0' + A_{11} \varepsilon_{t-1} \varepsilon_{t-1}' A_{11}' + G_{11} H_{t-1} G_{11}' \quad (6)$$

Where  $C_0$  represents the upper triangular matrix which is at the same time a constant of the equation, while  $A_{11}$  and  $G_{11}$  which measures the ARCH (own shocks) and GARCH effects are the unrestricted ( $n \times n$ ) parameters. It must be emphasized that both contribute to capturing the degree of innovation ( $i$  to market  $j$ ) in the market and conditional volatility availability between the markets respectively.

## 6. EMPIRICAL RESULTS

This section is solely dedicated to presenting the outcome of the study, thereby, focusing on the extent to which the results answers the research questions proposed for the study. In this study, the focus has been to identify the volatility dynamics (linkages) among equity and foreign exchange markets, and to know which market is the source. The study also aim to know the interrelations in the equity markets of the countries under the study. For the benefit of policy makers, portfolio investors and corporations in general, it is also important for the study to identify the possibility of volatility in financial markets can be used to mitigate the escalation of possible crisis. Finally, we aim to know whether or not African equity and currency markets still possess potential for foreign portfolio diversification.

With the aid of DataStream, daily price data of equity indices and foreign exchange were obtained and converted into percentage returns, while 3154 observations are obtained. A total of five (5) countries namely; Egypt, Kenya, Nigeria, South Africa and Tunisia are used in the study. Further analysis such as stationarity, presence of ARCH effects, autocorrelation were performed to establish the usability of the data for analysis towards the objective of the study.

Further analysis paved way for the use of a bivariate GARCH-BEKK model for further analysis that satisfies the research objectives. In doing so, results of various pairs that are presented in this section mainly are on the interrelation between stock and exchange rates in the respective countries. Again, various analysis are preformed among selected pairings of equity markets of the countries under the study. The pairings of the equity and exchange rates together with the equity markets yielded 15 pairings as shown below;

1. *Egypt: Stock-Exchange, Egypt-Tunisia, Egypt-Kenya, Egypt-Nigeria.*
2. *Nigeria: Stock-Exchange, Nigeria-South Africa, Nigeria-Tunisia, Nigeria-Kenya*
3. *South Africa: Stock-Exchange, South Africa-Tunisia, South Africa-Egypt, South Africa-Kenya*
4. *Kenya: Stock-Exchange, Kenya-Tunisia*
5. *Tunisia: Stock-Exchange*

For easier understanding of the results presented, the results are presented on country basis as shown above through the pairings made and are presented in the tables below. In the results as presented in the table below, fifteen (15) parameters are presented as obtained from running the analysis. The results below were obtained through employing a bivariate VAR (1) model to arrive at the mean return spillovers while shock transmissions and volatility spillovers depends on GARCH (1, 1)-BEKK estimations. The first four parameters in the table present the matrix  $\beta$  in the mean equation. It captures the linkages between the markets with respect to mean returns. In this regard, the returns between the stock and foreign exchange market and among the various equity markets in Africa. Furthermore, as presented in the tables below, the parameters  $\beta_{ii}$  and  $\beta_{jj}$  have different meanings signifying own market returns spillovers while the off diagonal parameters  $\beta_{ij}$  and  $\beta_{ji}$  represents the returns spillovers when two markets are paired. Also, the matrices  $\gamma$  and  $\delta$  as shown in the tables defines the time-varying variance-covariance effect. These matrices capture the volatility dynamics in various markets and between the pair of markets under consideration. The diagonal estimates in matrix  $\gamma$  shows the own ARCH effect within the specific market whereas the diagonal estimates in matrix  $\delta$  captures the own GARCH effect. However, the various off diagonal estimates shows pairwise shock transmissions and volatility spillovers between the stock and foreign exchange market and among the various equity markets paired against each other.

## **6.1 Mean Return Dependencies**

To be able to explain the return spillovers of the empirical results, focus will be turned onto own return and cross return spillover that exists among the various pairings made for the study. The main focus will be to explain how the various markets depend on their own past returns and the spillovers among the cross markets.

### **6.1.1 Own Return Spillover**

From the results below, it is can be seen that Egypt, Nigeria, Kenya and Tunisia have high significance among all the pairings while South Africa on the other hand came up with an insignificance results for all the pairings under the parameter  $\beta_{ii}$ . From the results, the leading diagonals of our variables shows that all variables in the respective countries depend on their past returns. This means that the returns of

the equity and foreign exchange markets in Egypt, Kenya, Nigeria and Tunisia are affected by relative shocks in the market while the opposite is true for South Africa.

### **6.1.2 Cross Return Spillover**

Taking into consideration the pairing of the stock and foreign exchange and the various stock markets of the respective countries, the off-diagonal parameters  $\beta_{ij}$  and  $\beta_{ji}$  are used to explain how return spillover exists across markets and countries. Looking at the relationship between the EGX 30 and the Egyptian Pound exchange rate, it can be seen that the stock market is influenced by changes in the foreign exchange market by 42%, thus a uni-directional relationship. This is an indication to show that the stock and the foreign exchange markets in Egypt are highly linked in terms of return spillover, where the stock market receives the spillover from the currency market. Also, on the relationship among the equity markets, Egypt is seen to be influenced by past innovations in Tunisia (9%) and Kenya by 8%. The Egyptian stock market can be described to have a weak linkage with the various African markets. It can be seen that there are no return dependencies between Egypt, South Africa and Nigeria.

The Nigerian All share index, on the other hand, receives return spillover of 54% from the foreign exchange market, which is an indication of a high integration among the two markets. However, pairing of the Nigerian stock market with the other stock markets as shown in the table below comes with no influence in terms of returns spillover which shows the level of segmentation of Nigeria from the other African stock markets in terms of returns.

South Africa which now ranks as the second biggest economy in Africa also boasts of the most advanced financial market and biggest stock exchange in terms of market capitalization. As seen from table 16, the returns in South Africa are not dependent on changes in any of the countries studied. It may be interesting to notice that South Africa receives a little or no past innovations from all the countries (1-2% each from Tunisia and nothing at all from Egypt and Kenya). The South African market, just like most of the developed African equity markets can be said to be closely integrated with the world and major emerging markets as reported by Saleem et al (2014) in their study. However, the JSE as a dominant force in Africa, exports returns to Kenya and Egypt, 3% and 13% respectively. It can also be seen that the

linkage between the equity and currency market in South Africa is very weak, where the foreign exchange exports a meagre return of 2% to the stock market.

Spanning across two different regional blocs in Africa, it can be seen from the results that there exists a bi-directional relationship between Kenya and Tunisia. Kenya receives past innovations of 12% from Tunisia and exports 9% of returns to the other side. Taking into account the two countries stock market and currency markets relationship respectively, the results show that stock markets in both countries are highly influenced by the currency market by receiving past innovations of returns; 33% and 28% respectively.

In summary, it can be said that, return spillovers are mostly uni-directional among the foreign exchange and equity markets, where the stock market receives this spillover from the other side. With the exception of a bi-directional relationship between Kenya and Tunisia, all the return spillovers seem to be a one way affair which shows a level of segmentation among these countries when it comes to influencing each other with returns.

## **6.2 Shock and Volatility Spillover (ARCH and GARCH)**

The parameters  $\gamma$  and  $\delta$  presented in tables 14 to 18 explains the time varying variance covariance effect of the model used in the study. Therefore, these matrices capture the volatility dynamics that exists within the equity and currency markets and among the respective stock markets pairings employed in the study. The leading diagonal estimates in the matrix  $\gamma$  explains the shock or ARCH effects within the specific market and those of the matrix  $\delta$  explains or captures the volatility or GARCH effect. On the other hand, the off-diagonal estimate parameters of the same matrices represents the cross market shock transmission and volatility spillovers.

From the results, it can be seen that all the parameters representing the own shock and volatility spillover are statistically significant. The currency markets of the various countries and their corresponding stock markets can be seen to be influenced by their own past shocks and volatility spillover having an impact on the conditional variance of Egypt, Kenya, Nigeria, South Africa and Tunisia.

### 6.2.1 Cross Shock and Volatility Spillover

Shock transmission across markets are represented by the off-diagonal parameters  $\gamma_{ij}$  and  $\gamma_{ji}$  which revealed transmissions between the pairings made from the table below. The Egyptian Pound can be seen to be very predominant in shock spillover by transmitting 67% of shocks to the EGX 30, however the reciprocal from the stock markets is a little 1%. From table 10 below, both Nigeria and Tunisia are the main markets which respond to changes in Egypt in terms of shock transmission from Egypt. The EGX 30 transmits shocks of 10 and 5% respectively to Tunisia and Nigeria and receives only 2% from Tunisia.

The relationship between the Nigerian All share Index and the Naira exchange rate seem to be very weak, thus are not affected so much in terms of shocks. It can be seen that both markets display a bi-directional relationship, hence, with a weak transmission of 2% shock transmission. On the other hand, the results indicates that South Africa seem to be the only market that plays a major role in terms of shock transmissions, thus, the Nigerian stock exchange receiving 7% shocks from the JSE while it receives a little of 2% shocks from Tunisia and Kenya.

In terms of the interaction between the JSE and the South African Rand, there was found to be a bi-directional relationship among the two variable. Both markets exhibit this relationship by transporting 3% of shocks to each side. With regards to the pairings made, there is an evidence from our results that the JSE receives shocks of 9% from the EGX 30 and 1% each to Tunisia and Kenya. On the other hand, the JSE displays a bi-directional relationship with Tunisia by exporting 7% to the Tunisian stock exchange while Egypt receives just 25% from South Africa.

Finally, a uni-directional relationship exists between the stock and foreign exchange markets in Tunisia and Kenya. It can be seen that the Tunisian stock exchange and Nairobi stock exchange all transmit shocks of 30% and 8% each to the currency market.

From the analysis above, it can be said that the equity market in all the countries studied serve as a source of shock transmission to the currency market. The foreign exchange markets in Africa respond mostly and are affected by changes in the stock market. In some instances, it can be said that, when stock prices are affected by exchange rate shock, the tendency of stock prices falling may be high. However the



results depict the opposite of this assumption, here mostly the shocks are from the stock market to the foreign exchange market. Furthermore, there seem to be a situation where all the countries stock exchanges are segmented from other countries in terms of shock transmissions as obtained from the empirical evidences.

The parameter  $\delta$  explains the volatility spillover of the study, thus the cross market volatility spillover are explained from the off-diagonal parameters  $\delta_{ij}$  and  $\delta_{ji}$ .

From the results presented, there is a bi-directional relationship between Egypt and Tunisia. Most importantly, these two countries belong to the same regional bloc and the relationship in terms of spillover may be considered for certain similarities in the countries. The EGX 30 transmits a higher volatility of 12% to Tunisia while it receives just 1% of it from the other side. On the other hand, Egypt receives no volatility spillover from Kenya and Nigeria but exports 7% to the latter.

There exist a bi-directional relationship between Nigeria and Tunisia while the NASI on one hand receives volatility spillover from the Johannesburg stock exchange. The results also came up with no relationship between Kenya and Nigeria in terms of spilling volatility to each market.

South Africa receives no spillover from Tunisia but exports some spillover to Tunisia while it receives spillover from Egypt and exports none to the other way round. Spillover between South Africa and Kenya is very weak or can be said to be no existing relationship among the two markets in terms of cross market volatility spillover. The results below also show a uni-directional relationship between Kenya and Tunisia, where Kenya receives no spillover but ships spillover to Tunisia.

With regards to volatility spillover between the stock and foreign exchange market in respective countries, the results shows a weak relationship in all countries except for Tunisia. The Tunisian Dinar and the stock market interact resulting in the stock market export spillover of 11% to the foreign exchange market negatively.

### **6.3 Linkages, Stock and foreign Exchange Return and volatility spillover**

The results above contributes to the formed research questions for which the study has been conducted on. Firstly, the study aim to look at the extent to which the equity and foreign exchange markets are linked with a focus on the research question "*Are there any existence of linkages (return and volatility spillover) between*

*foreign exchange and the stock market of the respective countries? If yes, which market is the source?"* In respect to returns spillovers, all the equity markets, with the exception of the Johannesburg stock exchange show a dependence on own past returns. The equity markets were observed to receive return spillover from the currency markets showing a uni-directional relationship. With reference to these results, one can attribute this to recent liberalizations in financial markets in Africa which has brought about foreign investor participation. However, such investors are "smart" and are responsive to risks that may be associated with such young African markets, thus leading to capital outflows during crisis periods, leading to excessive volatility transmissions from the equity to currency markets.

Generally, one can attribute the relationship between the foreign exchange and stock markets in the respective countries studied to be uni-directional and dominated by the foreign exchange market exporting such spillovers to the other side, which was evident in Egypt, Kenya, Nigeria and South Africa.

Volatility spillover effects among the two markets came up with volatility persistence to be very limited which shows a relatively low or no integration among the two markets. As seen from table 14 below, only the EGX 30 and the Egyptian Pound came up with a 26% volatility spillover which is seen to be exported to the foreign exchange market from the equity market. In the various countries studied, the results is an indication of a weaker relationship among the two markets studied, depicting a weaker integration, thus each market do not affect the other so much, except for Egypt where spillover exported to the currency market is high.

More importantly, emphasis must be placed on the fact that own volatility spillover coefficients from the stock markets are higher than compared to those from the foreign exchange market. This shows that any changes that occur in the equity markets of the respective countries are more considerable than external shocks.

#### **6.4 Linkages, Equity markets returns and volatility spillover**

A look at the results showed some existence but weak level of integration among the various African equity markets with respect to mean return dependencies. Returns of are affected by past innovations from Tunisia while South Africa on one hand exports past innovations to Egypt. Both Kenya and Tunisia export return innovations of 8% and 9% respectively to Egypt. Overall results is an indication of low linkages

and also uni-directional among the markets. The Nigeria equity market can be seen to be much segmented since it neither receives nor export return stimuli to any of the African countries.

The weaker integration with regards to the return dependencies also can be attributed to the fact that, recently countries such as South Africa, Egypt and Kenya are becoming more linked with the world, emerging and US Indices, as documented by Saleem (2014). These market dynamics can be said to be more linked to foreign investor participation thus, controlling the movements in trade, which leaves the linkages from one country to the other independent but rather goes in direction with the markets outside Africa.

Volatility transmission among the various equity markets revealed that Egypt exports spillover to Tunisia which is a neighboring country in the Middle East and North Africa (MENA) region. Again, Egypt exports spillover to Nigeria but receives nothing in return from the two countries. The results exhibit a bi-directional relationship between Nigeria and South Africa. The South African stock exchange receives volatility spillover Tunisia and exports spillover to Egypt. It can be said here that it is only Egypt which has a dominance in terms of volatility stimuli. Interestingly, the Nairobi stock exchange proved to be more segmented of all the markets by receiving or exporting no spillover to any country.

Own volatility spillover coefficients from the stock markets are higher than the cross-market coefficients. This shows that any changes that occur in the equity markets of Egypt, Kenya, Nigeria, South Africa and Tunisia are more considerable than external shocks.

Although there are some level of relationship between the various equity markets studied, general observation shows a uni-directional relationship, where the spillover are mostly from one market to the other only. The earlier assertion of these markets gradually becoming linked to the world markets can also be true in the sense of volatility spillovers. In the spirit of dominance and size, the study would have expected at least the South African equity market to have dominated information flow to the other markets and would receive relatively weaker influence from the other markets. However, the results above proved otherwise, thus the effect mostly are one way and not dominated by one equity market.

### **6.5 Regional bloc linkages (Equity markets)**

In recent times, there have been studies that have focused on linkages among equity markets of countries within same geographical and economic blocs. From the study, the transmission of returns and volatility spillover cannot entirely be supported but there exist some linkages. Just like any economic union around the world, majority of these unions are set up with a dream to achieve a greater economic integration. For example, Tunisia, Kenya, Nigeria and Egypt belong to the Community of Sahel Saharan States (CENSAD) while Egypt and Kenya are members of the Common Market for Eastern and Southern Africa (COMESA). Nevertheless, there seem to be no linkages in terms of returns and volatility transmission between Kenya and Egypt in their stock markets. As has been mentioned in the literature, this results is in contrast with findings from the study of Aggrawal and Kyaw (2005) and other studies who found that there are linkages in the equity markets of countries which belong to the North American Free Trade Agreement (NAFTA) bloc.

On the other hand, there are some linkages found among the equity markets of some countries. For example, the Egyptian equity market was found to export volatility to Tunisia while it receives return shocks from Tunisia. Kenya is also affected by returns transmission from Tunisia while it ships returns transmission to Tunisia, depicting a bi-directional relationship between the two countries. Tunisia on the other hand is only affected by Nigeria with volatility spillover, which go on to tell that all the countries which belong to the Community of Sahel Saharan States. These results satisfy various studies which have found some linkages among countries which belong to the same economic unions.

Finally, in Africa there seem to be the existence of various economic communities, depending on geographical location. With regards to this, the study found cross regional linkages among the countries. The Johannesburg stock exchange exports returns spillover to Egypt and receives volatility shocks from the EGX 30. Nigeria receives volatility spillover to South Africa and no reciprocal from the other side. Again Nigeria is affected by volatility spillover from Egypt while the former affects Tunisia with volatility stimuli.

## 6.6 Diversification Benefits

The next research question the study seek to answer is "*can fund managers and potential investors benefit from portfolio diversifications in emerging and frontier markets in Africa?*". The most important thing to note is that, having a well-diversified portfolio by investors is a remedy to reduce risks in the long run. Empirical evidence obtained so far indicates that, although there are some level of return dependencies, shocks and volatility spillovers among the African markets, there is still an evidence of young and segmented markets. This means that, at this point, the benefits that may arise from these markets cannot be underestimated in any way when investment focus is channeled across African equity markets. In this regard, investors can reap benefits from diversifying into the various markets at the same time since information flow from one market to the other may be slow, thus having a little impact on the other.

However, it is also important to know that, the level of integration between these African markets, for example South Africa with the world indices poses a low benefit for diversification. This in effect suggests that, those markets that are known to be young and still growing, offer diversification benefits to portfolio investors and yield lower risks, thus bring about diversification benefits in the long run.

Table 14 EGYPT, GARCH 1.1 results

EGYPT  
VAR(1)-GARCH (1,1) BEKK  
estimates

| Parameters            | STOCK-<br>EXCHANGE |           |        | EGYPT-<br>KENYA |           |        | EGYPT-TUNISIA |           |        | EGYPT-NIGERIA |           |        |
|-----------------------|--------------------|-----------|--------|-----------------|-----------|--------|---------------|-----------|--------|---------------|-----------|--------|
|                       | Coeff              | Std Error | Signif | Coeff           | Std Error | Signif | Coeff         | Std Error | Signif | Coeff         | Std Error | Signif |
| <i>B<sub>ii</sub></i> | 0.18               | 0.02      | 0.00   | 0.16            | 0.02      | 0.00   | 0.16          | 0.02      | 0.00   | 0.15          | 0.02      | 0.00   |
| <i>B<sub>ij</sub></i> | 0.42               | 0.18      | 0.02   | 0.08            | 0.02      | 0.00   | 0.09          | 0.04      | 0.02   | -0.02         | 0.02      | 0.34   |
| <i>B<sub>ji</sub></i> | 0.00               | 0.00      | 0.01   | 0.02            | 0.01      | 0.04   | 0.00          | 0.01      | 0.41   | 0.01          | 0.01      | 0.12   |
| <i>B<sub>jj</sub></i> | -0.21              | 0.02      | 0.00   | 0.30            | 0.02      | 0.00   | 0.13          | 0.02      | 0.00   | 0.33          | 0.03      | 0.00   |
| <i>ω<sub>ii</sub></i> | 0.30               | 0.04      | 0.00   | 0.36            | 0.03      | 0.00   | 0.37          | 0.03      | 0.00   | 0.30          | 0.03      | 0.00   |
| <i>ω<sub>ij</sub></i> | 0.02               | 0.00      | 0.00   | 0.02            | 0.02      | 0.25   | -0.12         | 0.02      | 0.00   | -0.09         | 0.04      | 0.01   |
| <i>ω<sub>jj</sub></i> | 0.00               | 0.01      | 1.00   | -0.09           | 0.01      | 0.00   | 0.16          | 0.02      | 0.00   | 0.27          | 0.02      | 0.00   |
| <i>γ<sub>ii</sub></i> | 0.25               | 0.02      | 0.00   | 0.29            | 0.02      | 0.00   | 0.31          | 0.02      | 0.00   | 0.27          | 0.02      | 0.00   |
| <i>γ<sub>ij</sub></i> | 0.01               | 0.00      | 0.00   | 0.01            | 0.01      | 0.16   | -0.02         | 0.01      | 0.00   | 0.00          | 0.01      | 0.70   |
| <i>γ<sub>ji</sub></i> | -0.67              | 0.15      | 0.00   | -0.03           | 0.01      | 0.01   | -0.10         | 0.04      | 0.00   | -0.05         | 0.03      | 0.07   |
| <i>γ<sub>jj</sub></i> | 0.45               | 0.02      | 0.00   | 0.28            | 0.01      | 0.00   | 0.34          | 0.02      | 0.00   | 0.40          | 0.02      | 0.00   |
| <i>δ<sub>ii</sub></i> | 0.95               | 0.01      | 0.00   | 0.93            | 0.01      | 0.00   | 0.92          | 0.01      | 0.00   | 0.95          | 0.01      | 0.00   |
| <i>δ<sub>ij</sub></i> | -0.01              | 0.00      | 0.00   | -0.01           | 0.00      | 0.16   | 0.01          | 0.00      | 0.01   | 0.00          | 0.00      | 0.93   |
| <i>δ<sub>ji</sub></i> | 0.26               | 0.06      | 0.00   | 0.01            | 0.00      | 0.12   | 0.13          | 0.03      | 0.00   | 0.07          | 0.02      | 0.00   |
| <i>δ<sub>jj</sub></i> | 0.91               | 0.01      | 0.00   | 0.96            | 0.00      | 0.00   | 0.89          | 0.01      | 0.00   | 0.87          | 0.01      | 0.00   |

Table 15 NIGERIA GARCH 1.1 Results

NIGERIA  
VAR(1)-GARCH (1,1) BEKK  
estimates

| Parameters                   | STOCK-<br>EXCHANGE |           |        | NIGERIA-SOUTH<br>AFRICA |           |        | NIGERIA-TUNISIA |           |        | NIGERIA-KENYA |           |        |
|------------------------------|--------------------|-----------|--------|-------------------------|-----------|--------|-----------------|-----------|--------|---------------|-----------|--------|
|                              | Coeff              | Std Error | Signif | Coeff                   | Std Error | Signif | Coeff           | Std Error | Signif | Coeff         | Std Error | Signif |
| <b><i>B<sub>ii</sub></i></b> | 0.38               | 0.02      | 0.00   | 0.33                    | 0.02      | 0.00   | 0.33            | 0.02      | 0.00   | 0.34          | 0.02      | 0.00   |
| <b><i>B<sub>ij</sub></i></b> | 0.54               | 0.05      | 0.00   | 0.03                    | 0.01      | 0.00   | 0.02            | 0.02      | 0.32   | -0.01         | 0.01      | 0.32   |
| <b><i>B<sub>ji</sub></i></b> | 0.00               | 0.00      | 0.94   | -0.06                   | 0.03      | 0.02   | -0.02           | 0.01      | 0.08   | 0.02          | 0.01      | 0.22   |
| <b><i>B<sub>jj</sub></i></b> | -0.09              | 0.02      | 0.00   | 0.00                    | 0.02      | 0.91   | 0.13            | 0.02      | 0.01   | 0.29          | 0.02      | 0.00   |
| <b><i>ω<sub>ii</sub></i></b> | 0.23               | 0.02      | 0.00   | 0.29                    | 0.02      | 0.00   | 0.28            | 0.02      | 0.00   | 0.26          | 0.02      | 0.00   |
| <b><i>ω<sub>ij</sub></i></b> | 0.01               | 0.00      | 0.00   | -0.05                   | 0.03      | 0.04   | -0.02           | 0.02      | 0.17   | 0.00          | 0.02      | 0.87   |
| <b><i>ω<sub>jj</sub></i></b> | 0.03               | 0.00      | 0.00   | 0.11                    | 0.03      | 0.00   | 0.07            | 0.01      | 0.00   | 0.09          | 0.01      | 0.00   |
| <b><i>γ<sub>ii</sub></i></b> | 0.36               | 0.02      | 0.00   | 0.41                    | 0.02      | 0.00   | 0.40            | 0.02      | 0.00   | 0.36          | 0.02      | 0.00   |
| <b><i>γ<sub>ij</sub></i></b> | 0.01               | 0.00      | 0.00   | -0.07                   | 0.03      | 0.01   | -0.01           | 0.01      | 0.32   | 0.02          | 0.02      | 0.20   |
| <b><i>γ<sub>ji</sub></i></b> | -0.02              | 0.05      | 0.71   | 0.00                    | 0.01      | 1.00   | -0.01           | 0.02      | 0.68   | 0.02          | 0.01      | 0.01   |
| <b><i>γ<sub>jj</sub></i></b> | 0.42               | 0.02      | 0.00   | 0.22                    | 0.01      | 0.00   | 0.20            | 0.02      | 0.00   | 0.27          | 0.01      | 0.00   |
| <b><i>δ<sub>ii</sub></i></b> | 0.90               | 0.01      | 0.00   | 0.86                    | 0.01      | 0.00   | 0.87            | 0.01      | 0.00   | 0.89          | 0.01      | 0.00   |
| <b><i>δ<sub>ij</sub></i></b> | -0.01              | 0.00      | 0.00   | 0.05                    | 0.02      | 0.00   | 0.01            | 0.01      | 0.23   | 0.00          | 0.01      | 0.69   |
| <b><i>δ<sub>ji</sub></i></b> | -0.04              | 0.02      | 0.06   | 0.00                    | 0.00      | 0.96   | 0.01            | 0.01      | 0.34   | 0.00          | 0.00      | 0.29   |
| <b><i>δ<sub>jj</sub></i></b> | 0.92               | 0.00      | 0.00   | 0.97                    | 0.00      | 0.00   | 0.97            | 0.00      | 0.00   | 0.96          | 0.00      | 0.00   |

Table 16 SOUTH AFRICA GARCH 1.1 Results

SOUTH AFRICA  
VAR(1)-GARCH (1,1) BEKK  
estimates

| Parameters                   | STOCK-<br>EXCHANGE |           |        | SOUTH AFRICA-<br>TUNISIA |           |        | SOUTH AFRICA-<br>KENYA |           |        | SOUTH AFRICA-<br>EGYPT |           |        |
|------------------------------|--------------------|-----------|--------|--------------------------|-----------|--------|------------------------|-----------|--------|------------------------|-----------|--------|
|                              | Coeff              | Std Error | Signif | Coeff                    | Std Error | Signif | Coeff                  | Std Error | Signif | Coeff                  | Std Error | Signif |
| <b><i>B<sub>ii</sub></i></b> | 0.01               | 0.02      | 0.51   | 0.01                     | 0.02      | 0.60   | 0.00                   | 0.02      | 0.97   | 0.01                   | 0.02      | 0.70   |
| <b><i>B<sub>ij</sub></i></b> | 0.01               | 0.03      | 0.75   | 0.01                     | 0.04      | 0.69   | 0.00                   | 0.02      | 0.95   | 0.00                   | 0.01      | 0.92   |
| <b><i>B<sub>ji</sub></i></b> | 0.02               | 0.01      | 0.22   | -0.01                    | 0.01      | 0.06   | 0.03                   | 0.01      | 0.00   | 0.13                   | 0.02      | 0.00   |
| <b><i>B<sub>jj</sub></i></b> | -0.01              | 0.01      | 0.56   | 0.14                     | 0.02      | 0.00   | 0.30                   | 0.02      | 0.00   | 0.15                   | 0.02      | 0.00   |
| <b><i>ω<sub>ii</sub></i></b> | 0.18               | 0.02      | 0.00   | 0.15                     | 0.02      | 0.00   | 0.17                   | 0.02      | 0.00   | 0.14                   | 0.02      | 0.00   |
| <b><i>ω<sub>ij</sub></i></b> | -0.09              | 0.01      | 0.00   | -0.06                    | 0.03      | 0.06   | 0.03                   | 0.02      | 0.10   | -0.01                  | 0.07      | 0.87   |
| <b><i>ω<sub>jj</sub></i></b> | 0.05               | 0.01      | 0.00   | 0.15                     | 0.02      | 0.00   | 0.09                   | 0.01      | 0.00   | 0.40                   | 0.04      | 0.00   |
| <b><i>γ<sub>ii</sub></i></b> | 0.29               | 0.02      | 0.00   | 0.25                     | 0.01      | 0.00   | 0.24                   | 0.01      | 0.00   | 0.22                   | 0.01      | 0.00   |
| <b><i>γ<sub>ij</sub></i></b> | -0.03              | 0.01      | 0.01   | -0.01                    | 0.01      | 0.37   | 0.02                   | 0.01      | 0.01   | -0.08                  | 0.03      | 0.00   |
| <b><i>γ<sub>ji</sub></i></b> | 0.03               | 0.03      | 0.28   | -0.06                    | 0.04      | 0.08   | -0.01                  | 0.01      | 0.68   | 0.02                   | 0.01      | 0.18   |
| <b><i>γ<sub>jj</sub></i></b> | 0.20               | 0.02      | 0.00   | 0.32                     | 0.03      | 0.00   | 0.28                   | 0.01      | 0.00   | 0.33                   | 0.02      | 0.00   |
| <b><i>δ<sub>ii</sub></i></b> | 0.95               | 0.01      | 0.00   | 0.96                     | 0.00      | 0.00   | 0.97                   | 0.00      | 0.00   | 0.97                   | 0.00      | 0.00   |
| <b><i>δ<sub>ij</sub></i></b> | 0.01               | 0.00      | 0.00   | 0.01                     | 0.00      | 0.09   | -0.01                  | 0.00      | 0.00   | 0.02                   | 0.01      | 0.00   |
| <b><i>δ<sub>ji</sub></i></b> | -0.01              | 0.01      | 0.14   | 0.05                     | 0.02      | 0.01   | 0.00                   | 0.00      | 0.32   | -0.01                  | 0.01      | 0.50   |
| <b><i>δ<sub>jj</sub></i></b> | 0.98               | 0.00      | 0.00   | 0.91                     | 0.02      | 0.00   | 0.96                   | 0.00      | 0.00   | 0.91                   | 0.01      | 0.00   |



Table 17 KENYA GARCH 1.1 Results

KENYA  
VAR(1)-GARCH (1,1) BEKK  
estimates

| Parameters            | STOCK-<br>EXCHANGE |           |        | KENYA-TUNISIA |           |        |
|-----------------------|--------------------|-----------|--------|---------------|-----------|--------|
|                       | Coeff              | Std Error | Signif | Coeff         | Std Error | Signif |
| <i>B<sub>ii</sub></i> | 0.35               | 0.02      | 0.00   | 0.00          | 0.01      | 0.75   |
| <i>B<sub>ij</sub></i> | 0.33               | 0.04      | 0.00   | 0.12          | 0.02      | 0.00   |
| <i>B<sub>ji</sub></i> | 0.00               | 0.01      | 0.60   | 0.09          | 0.01      | 0.00   |
| <i>B<sub>jj</sub></i> | 0.00               | 0.02      | 0.03   | -0.04         | 0.03      | 0.22   |
| <i>ω<sub>ii</sub></i> | 0.11               | 0.01      | 0.00   | 0.09          | 0.01      | 0.00   |
| <i>ω<sub>ij</sub></i> | -0.02              | 0.01      | 0.01   | -0.04         | 0.03      | 0.22   |
| <i>ω<sub>jj</sub></i> | 0.07               | 0.00      | 0.00   | 0.16          | 0.02      | 0.00   |
| <i>γ<sub>ii</sub></i> | 0.32               | 0.02      | 0.00   | 0.27          | 0.01      | 0.00   |
| <i>γ<sub>ij</sub></i> | 0.01               | 0.00      | 0.08   | -0.01         | 0.01      | 0.08   |
| <i>γ<sub>ji</sub></i> | 0.08               | 0.03      | 0.02   | -0.01         | 0.02      | 0.53   |
| <i>γ<sub>jj</sub></i> | 0.38               | 0.02      | 0.00   | 0.30          | 0.02      | 0.00   |
| <i>δ<sub>ii</sub></i> | 0.94               | 0.01      | 0.00   | 0.96          | 0.00      | 0.00   |
| <i>δ<sub>ij</sub></i> | 0.00               | 0.00      | 0.13   | 0.00          | 0.00      | 0.27   |
| <i>δ<sub>ji</sub></i> | -0.04              | 0.01      | 0.00   | 0.01          | 0.01      | 0.19   |
| <i>δ<sub>jj</sub></i> | 0.92               | 0.01      | 0.00   | 0.92          | 0.02      | 0.00   |

Table 18 TUNISIA GARCH 1.1 Results

TUNISIA  
VAR(1)-GARCH (1,1) BEKK  
estimates

| Parameters        | STOCK-<br>EXCHANGE |           |        |
|-------------------|--------------------|-----------|--------|
|                   | Coeff              | Std Error | Signif |
| <b><i>Bii</i></b> | 0.26               | 0.02      | 0.00   |
| <b><i>Bij</i></b> | 0.28               | 0.03      | 0.00   |
| <b><i>Bji</i></b> | -0.01              | 0.01      | 0.29   |
| <b><i>Bjj</i></b> | -0.05              | 0.02      | 0.01   |
| <b><i>ωii</i></b> | -0.13              | 0.01      | 0.00   |
| <b><i>ωij</i></b> | 0.00               | 0.01      | 0.62   |
| <b><i>ωjj</i></b> | 0.02               | 0.00      | 0.00   |
| <b><i>γii</i></b> | 0.42               | 0.02      | 0.00   |
| <b><i>γij</i></b> | -0.01              | 0.01      | 0.49   |
| <b><i>γji</i></b> | 0.30               | 0.03      | 0.00   |
| <b><i>γjj</i></b> | 0.14               | 0.01      | 0.00   |
| <b><i>δii</i></b> | 0.88               | 0.01      | 0.00   |
| <b><i>δij</i></b> | 0.00               | 0.00      | 0.66   |
| <b><i>δji</i></b> | -0.11              | 0.01      | 0.00   |
| <b><i>δjj</i></b> | 0.99               | 0.00      | 0.00   |

## 7. CONCLUSIONS

The dynamics of return and volatility transmission between the equity and foreign exchange markets and also among the equity markets of Egypt, Kenya, Nigeria, South Africa and Tunisia have been examined extensively. By applying a VAR-GARCH-BEKK model to 3154 observations on data obtained from all respective countries, the study has been able to establish some own market and cross market dynamics between the equity and currency market in each country and cross market return and volatility transmissions in the equity markets.

In all of the countries studied, the results obtained did not show a reciprocal return spillover between the stock and the foreign exchange market. However, it was found that the stock markets in Egypt, Kenya, Nigeria and South Africa were on the receiving end of return spillover from the currency market.

Furthermore, results have proven the level of segmentation among the stock and foreign exchange markets in transmitting volatility spillover, hence indicating a low integration among them. With the exception of Egypt, which came up with spillover stimuli among the foreign exchange and stock markets in the country, all the other countries studied showed a weaker or not integration in terms of volatility spillover. In terms of external shocks, a conclusion can be made from the fact that, own market volatility spillover in the equity markets are highly significant and this changes in the equity markets proved to be more considerable than any external shocks.

With regards to the equity market interrelations, the study came up with evidence showing a weaker relationship among the various African stock markets with reference to mean return dependencies. Nevertheless, it was found that there exist some form of unidirectional return transmission. For instance, we found the Egyptian stock market been the highest beneficiary in terms of return spillover. The EGX 30 seem to be affected by return spillover from South Africa, Kenya and Tunisia. Again the Nigerian All share Index is seen to be the most segmented among the countries studied in terms of return stimuli. The Egyptian stock market which has been one of the preferred destinations in emerging and frontier countries, seem to be in linkage with almost all the countries studied although it seem to be at the receiving end. With regards to the other markets, these market dynamics can be said to be more linked to foreign investor participation thus, controlling the movements in trade, which

leaves the linkages from one country to the other independent but rather goes in direction with the markets outside Africa, mostly countries like Egypt, Kenya and South Africa becoming much linked to the US, emerging market indices.

The results came up volatility persistence among the markets. However, overall evidence from the findings showed a relatively low integration among the various equity markets. Egypt, which received some significant amount of return spillover earlier, had some effect on Tunisia and Nigeria by shipping volatility spillover to these countries. Nigeria on one hand also receives volatility spillover from South Africa.

As has already been mentioned in terms of return spillover among the countries, Egypt, again showed dominance in terms of volatility stimuli with the other countries. Interestingly, the Nairobi Stock Exchange proved to be more segmented of all the markets by receiving or exporting no spillover to any country.

By employing the same model as in this study, suggestion for further research can be focused on including other macroeconomic variables such as inflation, unemployment, consumer price index, industrial production etc. to study how they go in hand with the dynamics of spillover of the equity and foreign exchange markets. The study can focus on how these variable changes can affect return and volatility spillover in the equity markets. Also, with similar length of data, a sub sample can be made by studying how recent financial crisis has also affected the volatility dynamics in the major countries studied. This to an extent, help to know how well the interrelation among the markets and countries can be relied on by portfolio investors.

### **7.1 Contribution of the study**

Foreign exchange and equity market return and volatility have received numerous studies over the years. The relatively low level of integration among the foreign exchange and stock markets and among the various African equity markets have been covered extensively by various studies. This study, which hasn't been so different from the already discussed literature, came up with results that may have been expected. A look at depreciation in currencies, which is a regular phenomenon in most African countries, affect stock market prices. Results of the study have mostly indicated the transfer of returns and volatility to the equity markets from the currencies market. Although serious depreciation of currencies affect stock prices in

the short run, various studies examined also indicated its positive effect in rising stock prices in the future. Investors who are likely to diversify into these growing African markets are likely to reap results of this diversification by trading wisely in these equity markets.

Interestingly, one would have expected the South African markets to have played a dominance role in transmitting return and volatility spillover. The study came up with a result showing the dominance of Egypt. In South Africa, the results also showed some high level of segmentation in return and volatility spillover of the foreign exchange and stock market, indicating a low effect from each market.

The level of segmentation of the various African markets, can be used by foreign portfolio investors as a means to diversify investments, without been affected by information flow from other markets. However, the rate at which investors can predict these African markets is very less and this satisfies the market efficiency theory. Volatility wise, Egypt seemed to be the dominance market in volatility transmission. Investors can use this market as a way to enter the African market and later on diverse into other parts of the continent. However, in spite of these benefits mentioned, the level at which the South African stock exchange seem to be much segmented from the African markets need a mention. The South African equity market as has already been mentioned in this study and from previous studies exhibit a level of integration with the world and emerging market indices. For this reason, any instability and shocks in the already unstable European, Chinese market and other world indices can be easily felt within the equity market. Thus, it can be said that the JSE offers less diversification benefits for investors whose major aim is to diversify into the various African stock markets, but the benefit of diversification cannot be entirely ruled out.

Furthermore, the contribution of the study to policy formulation can be directed to policy makers looking into restructuring macroeconomic variables, of which the foreign exchange market is included. In doing so to stabilize the economy and attract foreign investments. Investors, generally, take into account the performance of the currencies market to determine their investment allocations and forecasting stock market volatility. Again, for corporate entities, dealing with volatility dynamics of the currencies market is important. In doing so the rate of volatility of the currencies

market affect firms that import internationally, thus, the need to enter into hedging strategies, which eventually may be costly for the firms but that's the only way to lock in prices.

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**APPENDICES****Appendix 1: ARCH Effects Test Results****EGYPT****EGX30**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 17.25373 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 240.2188 | Prob. Chi-Square(15) | 0.0000 |

**EGYPTIAN POUND**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 7.952765 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 115.4900 | Prob. Chi-Square(15) | 0.0000 |

**SOUTH AFRICA****SARAND**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 33.45745 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 434.5756 | Prob. Chi-Square(15) | 0.0000 |

**JSE ALLSHARE**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 74.89842 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 830.4059 | Prob. Chi-Square(15) | 0.0000 |

**NIGERIA****NIGERIA ALLSHARE**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 26.89228 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 359.0586 | Prob. Chi-Square(15) | 0.0000 |

**NIGERIA NAIRA**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 45.22668 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 560.1567 | Prob. Chi-Square(15) | 0.0000 |

**TUNISIA****TUNINDEX**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 43.30124 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 540.4160 | Prob. Chi-Square(15) | 0.0000 |

**Tunisia Dinar**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 14.94339 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 210.2073 | Prob. Chi-Square(15) | 0.0000 |

**KENYA****NSE20**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 35.27695 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 454.7839 | Prob. Chi-Square(15) | 0.0000 |

**KENYAN SHILLING**

Heteroskedasticity Test: ARCH

|               |          |                      |        |
|---------------|----------|----------------------|--------|
| F-statistic   | 47.66449 | Prob. F(15,3122)     | 0.0000 |
| Obs*R-squared | 584.7242 | Prob. Chi-Square(15) | 0.0000 |

**Appendix 2: Augmented Dickey Fuller Test Results**

Null Hypothesis: D(EGX30) has a unit root

Exogenous: Constant

Lag Length: 28 (Automatic - based on AIC, maxlag=28)

|  | t-Statistic | Prob.* |
|--|-------------|--------|
| Augmented Dickey-Fuller test statistic | -17.78615   | 0.0000 |
| Test critical values:                  |             |        |
| 1% level                               | -3.432254   |        |
| 5% level                               | -2.862267   |        |
| 10% level                              | -2.567201   |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(EGX30,2)

Method: Least Squares

Date: 08/12/15 Time: 18:31

Sample (adjusted): 11/12/2002 10/31/2014

Included observations: 3124 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| R-squared          | 0.798415    | Mean dependent var    |             | -0.000125 |
| Adjusted R-squared | 0.796526    | S.D. dependent var    |             | 3.835353  |
| S.E. of regression | 1.730055    | Akaike info criterion |             | 3.943740  |
| Sum squared resid  | 9260.623    | Schwarz criterion     |             | 4.001809  |
| Log likelihood     | -6130.122   | Hannan-Quinn criter.  |             | 3.964584  |
| F-statistic        | 422.5651    | Durbin-Watson stat    |             | 1.999886  |



Prob(F-statistic) 0.000000

Null Hypothesis: D(EGY\_POUND) has a unit root  
 Exogenous: Constant  
 Lag Length: 28 (Automatic - based on AIC, maxlag=28)

|  | t-Statistic | Prob.* |
|--|-------------|--------|
| Augmented Dickey-Fuller test statistic | -17.00502   | 0.0000 |
| Test critical values:                  |             |        |
| 1% level                               | -3.432254   |        |
| 5% level                               | -2.862267   |        |
| 10% level                              | -2.567201   |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(EGY\_POUND,2)  
 Method: Least Squares  
 Date: 08/12/15 Time: 18:36  
 Sample (adjusted): 11/12/2002 10/31/2014  
 Included observations: 3124 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| R-squared          | 0.864891    | Mean dependent var    |             | 8.75E-05  |
| Adjusted R-squared | 0.863624    | S.D. dependent var    |             | 0.469683  |
| S.E. of regression | 0.173449    | Akaike info criterion |             | -0.656304 |
| Sum squared resid  | 93.08214    | Schwarz criterion     |             | -0.598235 |
| Log likelihood     | 1055.147    | Hannan-Quinn criter.  |             | -0.635460 |
| F-statistic        | 682.9653    | Durbin-Watson stat    |             | 1.999282  |
| Prob(F-statistic)  | 0.000000    |                       |             |           |

Null Hypothesis: D(JSE\_ALL\_SHARE) has a unit root  
 Exogenous: Constant  
 Lag Length: 28 (Automatic - based on AIC, maxlag=28)

|  | t-Statistic | Prob.* |
|--|-------------|--------|
| Augmented Dickey-Fuller test statistic | -19.11817   | 0.0000 |
| Test critical values:                  |             |        |
| 1% level                               | -3.432254   |        |
| 5% level                               | -2.862267   |        |
| 10% level                              | -2.567201   |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(JSE\_ALL\_SHARE,2)  
 Method: Least Squares

Date: 08/12/15 Time: 18:37  
 Sample (adjusted): 11/12/2002 10/31/2014  
 Included observations: 3124 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| R-squared          | 0.826539    | Mean dependent var    |             | 0.000561 |
| Adjusted R-squared | 0.824913    | S.D. dependent var    |             | 4.337441 |
| S.E. of regression | 1.814931    | Akaike info criterion |             | 4.039529 |
| Sum squared resid  | 10191.56    | Schwarz criterion     |             | 4.097597 |
| Log likelihood     | -6279.744   | Hannan-Quinn criter.  |             | 4.060373 |
| F-statistic        | 508.3754    | Durbin-Watson stat    |             | 2.002914 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Null Hypothesis: D(SA\_RANDOM) has a unit root  
 Exogenous: Constant  
 Lag Length: 28 (Automatic - based on AIC, maxlag=28)

|  | t-Statistic | Prob.* |
|--|-------------|--------|
| Augmented Dickey-Fuller test statistic | -18.28760   | 0.0000 |
| Test critical values:                  |             |        |
| 1% level                               | -3.432254   |        |
| 5% level                               | -2.862267   |        |
| 10% level                              | -2.567201   |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(SA\_RANDOM,2)  
 Method: Least Squares  
 Date: 08/12/15 Time: 18:38  
 Sample (adjusted): 11/12/2002 10/31/2014  
 Included observations: 3124 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| R-squared          | 0.826539    | Mean dependent var    |             | 0.000561 |
| Adjusted R-squared | 0.824913    | S.D. dependent var    |             | 4.337441 |
| S.E. of regression | 1.814931    | Akaike info criterion |             | 4.039529 |
| Sum squared resid  | 10191.56    | Schwarz criterion     |             | 4.097597 |
| Log likelihood     | -6279.744   | Hannan-Quinn criter.  |             | 4.060373 |
| F-statistic        | 508.3754    | Durbin-Watson stat    |             | 2.002914 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Null Hypothesis: D(SA\_RANDOM) has a unit root  
 Exogenous: Constant  
 Lag Length: 28 (Automatic - based on AIC, maxlag=28)

t-Statistic Prob.\*

|  |           |           |        |
|--|-----------|-----------|--------|
| Augmented Dickey-Fuller test statistic |           | -18.28760 | 0.0000 |
| Test critical values:                  | 1% level  | -3.432254 |        |
|  | 5% level  | -2.862267 |        |
|  | 10% level | -2.567201 |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(SA\_RANDOM,2)  
 Method: Least Squares  
 Date: 08/12/15 Time: 18:38  
 Sample (adjusted): 11/12/2002 10/31/2014  
 Included observations: 3124 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| R-squared          | 0.811181    | Mean dependent var    |             | 8.69E-05 |
| Adjusted R-squared | 0.809535    | S.D. dependent var    |             | 1.185558 |
| S.E. of regression | 0.517404    | Akaike info criterion |             | 1.528932 |
| Sum squared resid  | 829.3569    | Schwarz criterion     |             | 1.583101 |
| Log likelihood     | -2361.721   | Hannan-Quinn criter.  |             | 1.548376 |
| F-statistic        | 492.9345    | Durbin-Watson stat    |             | 2.000776 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Null Hypothesis: D(NSE\_20) has a unit root  
 Exogenous: Constant  
 Lag Length: 28 (Automatic - based on AIC, maxlag=28)

|  |           | t-Statistic | Prob.* |
|--|-----------|-------------|--------|
| Augmented Dickey-Fuller test statistic |           | -18.50513   | 0.0000 |
| Test critical values:                  | 1% level  | -3.432254   |        |
|  | 5% level  | -2.862267   |        |
|  | 10% level | -2.567201   |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(NSE\_20,2)  
 Method: Least Squares  
 Date: 08/12/15 Time: 18:40  
 Sample (adjusted): 11/12/2002 10/31/2014

Included observations: 3124 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| R-squared          | 0.764763    | Mean dependent var    |             | -0.000433 |
| Adjusted R-squared | 0.762559    | S.D. dependent var    |             | 2.322502  |
| S.E. of regression | 1.131708    | Akaike info criterion |             | 3.094890  |
| Sum squared resid  | 3962.680    | Schwarz criterion     |             | 3.152958  |
| Log likelihood     | -4804.218   | Hannan-Quinn criter.  |             | 3.115734  |
| F-statistic        | 346.8523    | Durbin-Watson stat    |             | 2.004560  |
| Prob(F-statistic)  | 0.000000    |                       |             |           |

Null Hypothesis: D(NIG\_ALL\_SHARE) has a unit root

Exogenous: Constant

Lag Length: 26 (Automatic - based on AIC, maxlag=28)

|  | t-Statistic | Prob.* |
|--|-------------|--------|
| Augmented Dickey-Fuller test statistic | -18.63437   | 0.0000 |
| Test critical values:                  |             |        |
| 1% level                               | -3.432253   |        |
| 5% level                               | -2.862266   |        |
| 10% level                              | -2.567201   |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(NIG\_ALL\_SHARE,2)

Method: Least Squares

Date: 08/12/15 Time: 18:41

Sample (adjusted): 11/08/2002 10/31/2014

Included observations: 3126 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| R-squared          | 0.740475    | Mean dependent var    |             | -0.000606 |
| Adjusted R-squared | 0.738213    | S.D. dependent var    |             | 1.898878  |
| S.E. of regression | 0.971563    | Akaike info criterion |             | 2.789095  |
| Sum squared resid  | 2924.309    | Schwarz criterion     |             | 2.843264  |
| Log likelihood     | -4331.356   | Hannan-Quinn criter.  |             | 2.808539  |
| F-statistic        | 327.3777    | Durbin-Watson stat    |             | 1.999393  |
| Prob(F-statistic)  | 0.000000    |                       |             |           |

Null Hypothesis: D(NIG\_NAIRA) has a unit root

Exogenous: Constant

Lag Length: 26 (Automatic - based on AIC, maxlag=28)

|  | t-Statistic | Prob.* |
|--|-------------|--------|
|  |             |        |

|  |           |           |        |
|--|-----------|-----------|--------|
| Augmented Dickey-Fuller test statistic |           | -19.86022 | 0.0000 |
| Test critical values:                  | 1% level  | -3.432253 |        |
|  | 5% level  | -2.862266 |        |
|  | 10% level | -2.567201 |        |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(NIG\_NAIRA,2)  
 Method: Least Squares  
 Date: 08/12/15 Time: 18:42  
 Sample (adjusted): 11/08/2002 10/31/2014  
 Included observations: 3126 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| R-squared          | 0.848129    | Mean dependent var    |             | 0.000116 |
| Adjusted R-squared | 0.846805    | S.D. dependent var    |             | 0.906309 |
| S.E. of regression | 0.354730    | Akaike info criterion |             | 0.774000 |
| Sum squared resid  | 389.8327    | Schwarz criterion     |             | 0.828168 |
| Log likelihood     | -1181.761   | Hannan-Quinn criter.  |             | 0.793443 |
| F-statistic        | 640.7716    | Durbin-Watson stat    |             | 2.001813 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

Null Hypothesis: D(TUN\_DINAR) has a unit root  
 Exogenous: Constant  
 Lag Length: 28 (Automatic - based on AIC, maxlag=28)

|  | t-Statistic | Prob.*    |
|--|-------------|-----------|
| Augmented Dickey-Fuller test statistic | -17.78169   | 0.0000    |
| Test critical values:                  | 1% level    | -3.432254 |
|  | 5% level    | -2.862267 |
|  | 10% level   | -2.567201 |

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(TUN\_DINAR,2)  
 Method: Least Squares  
 Date: 08/12/15 Time: 18:43  
 Sample (adjusted): 11/12/2002 10/31/2014  
 Included observations: 3124 after adjustments

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| R-squared          | 0.833176    | Mean dependent var    |             | -0.000305 |
| Adjusted R-squared | 0.831613    | S.D. dependent var    |             | 1.106706  |
| S.E. of regression | 0.454137    | Akaike info criterion |             | 1.268721  |
| Sum squared resid  | 638.1080    | Schwarz criterion     |             | 1.326790  |
| Log likelihood     | -1951.743   | Hannan-Quinn criter.  |             | 1.289565  |

|                   |          |                    |          |
|-------------------|----------|--------------------|----------|
| F-statistic       | 532.8453 | Durbin-Watson stat | 2.003441 |
| Prob(F-statistic) | 0.000000 |                    |          |

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Null Hypothesis: D(TUNINDEX) has a unit root  
 Exogenous: Constant  
 Lag Length: 28 (Automatic - based on AIC, maxlag=28)

---

|  | t-Statistic | Prob.* |
|--|-------------|--------|
| Augmented Dickey-Fuller test statistic | -17.63960   | 0.0000 |
| Test critical values:                  |             |        |
| 1% level                               | -3.432254   |        |
| 5% level                               | -2.862267   |        |
| 10% level                              | -2.567201   |        |

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\*MacKinnon (1996) one-sided p-values.

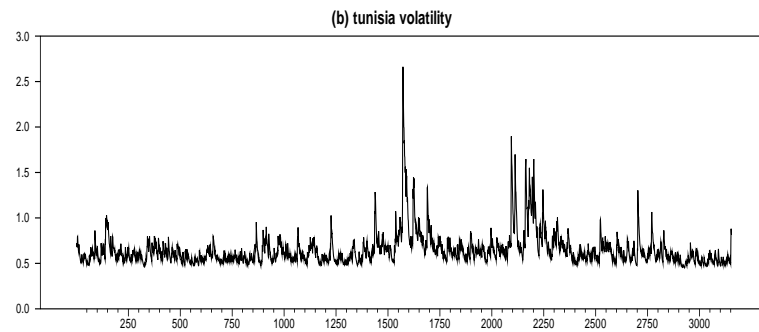
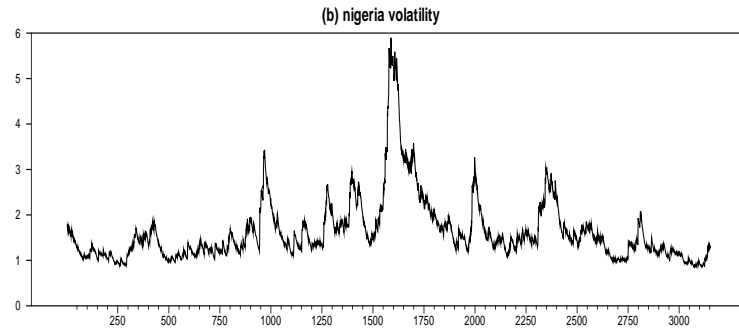
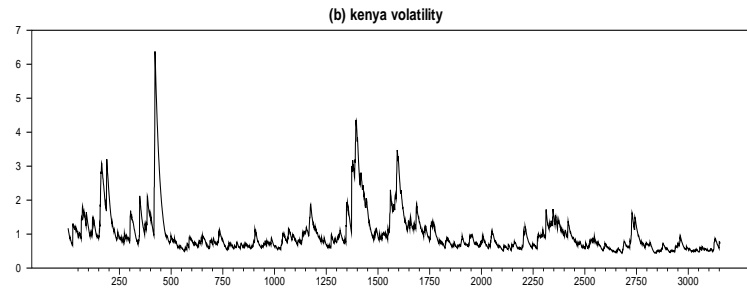
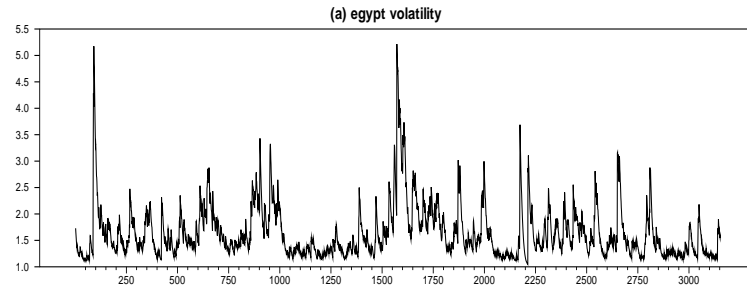
Augmented Dickey-Fuller Test Equation  
 Dependent Variable: D(TUNINDEX,2)  
 Method: Least Squares  
 Date: 08/12/15 Time: 18:44  
 Sample (adjusted): 11/12/2002 10/31/2014  
 Included observations: 3124 after adjustments

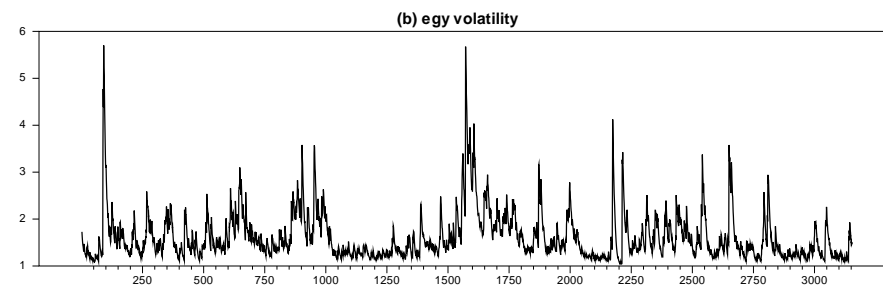
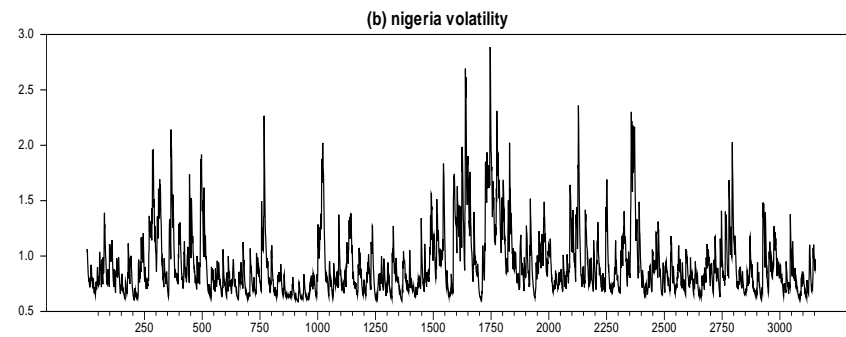
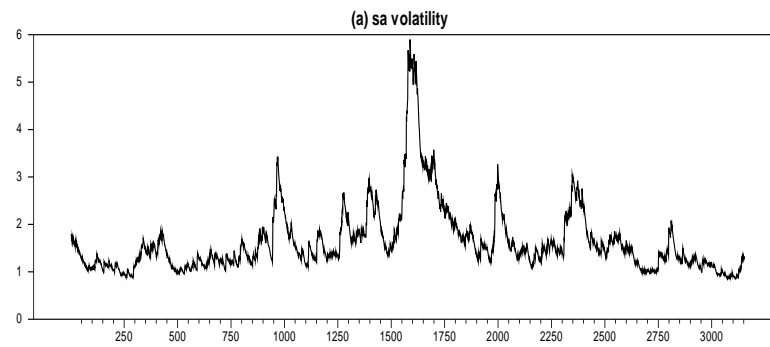
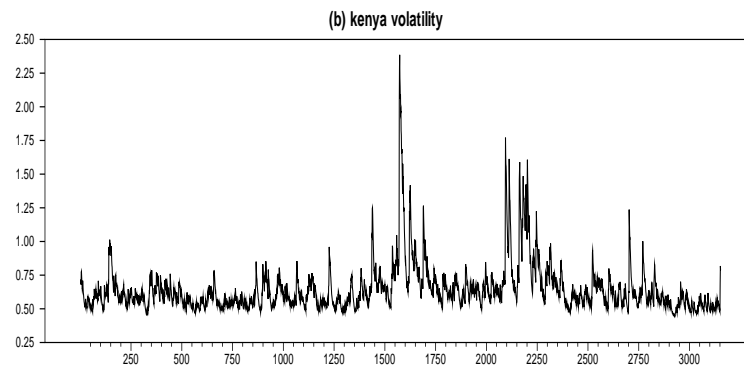
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| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| R-squared          | 0.803862    | Mean dependent var    |             | 0.000286 |
| Adjusted R-squared | 0.802024    | S.D. dependent var    |             | 1.542548 |
| S.E. of regression | 0.686349    | Akaike info criterion |             | 2.094695 |
| Sum squared resid  | 1457.505    | Schwarz criterion     |             | 2.152763 |
| Log likelihood     | -3241.914   | Hannan-Quinn criter.  |             | 2.115539 |
| F-statistic        | 437.2634    | Durbin-Watson stat    |             | 2.007665 |
| Prob(F-statistic)  | 0.000000    |                       |             |          |

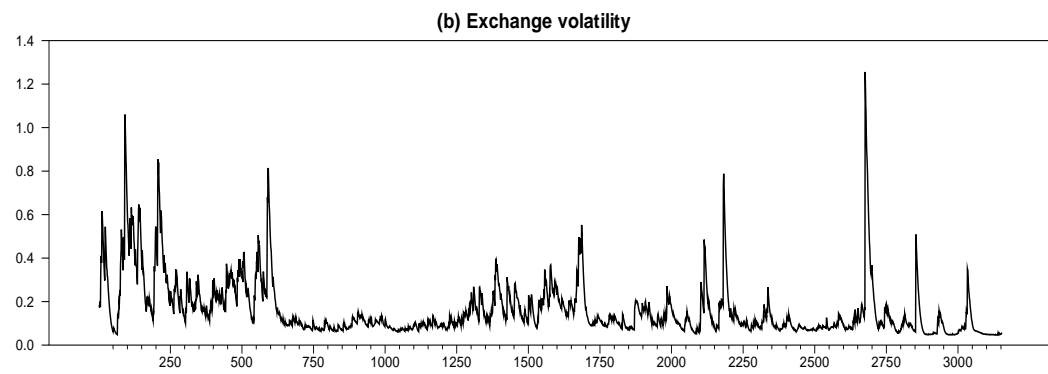
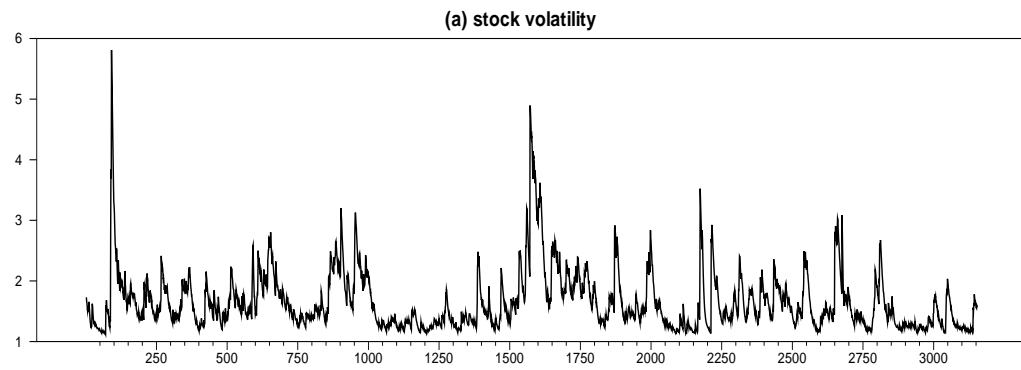
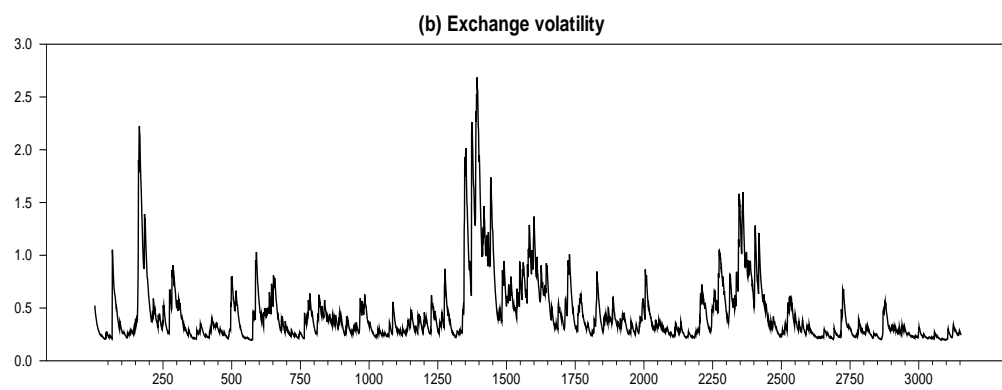
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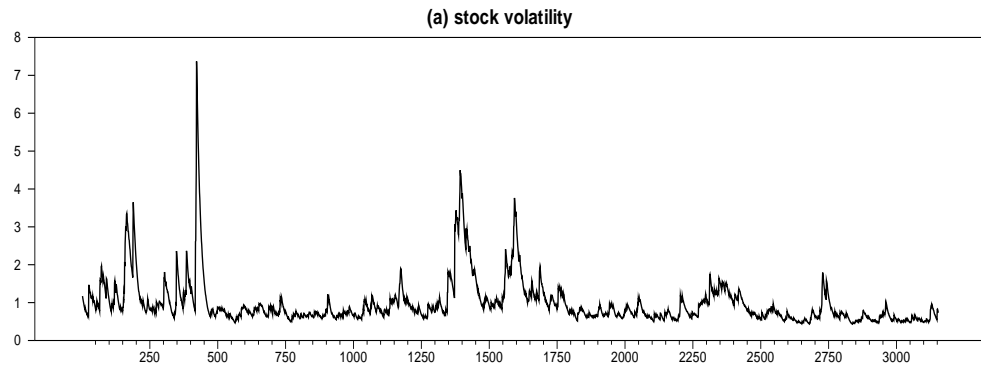
### Appendix 3 Volatility of series



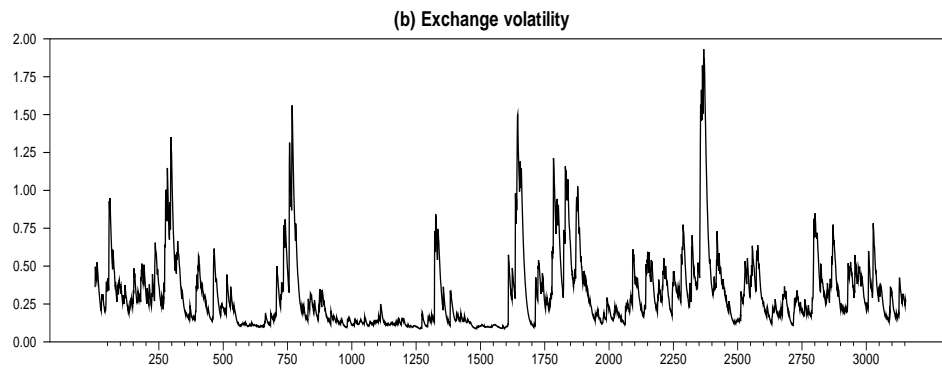
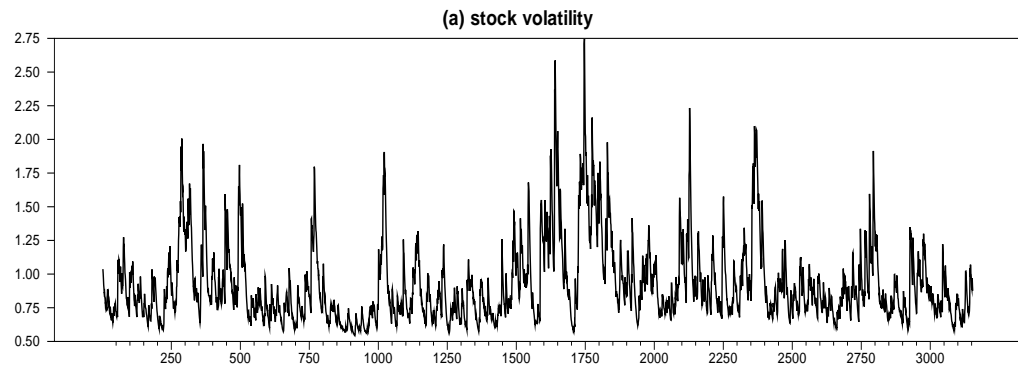


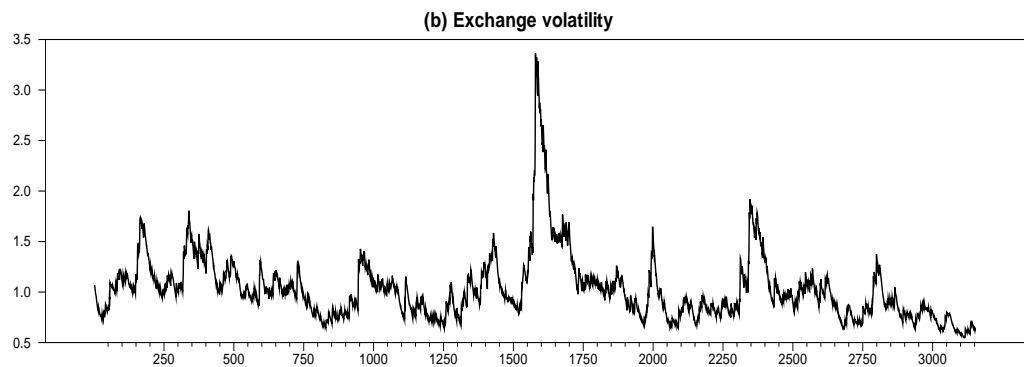
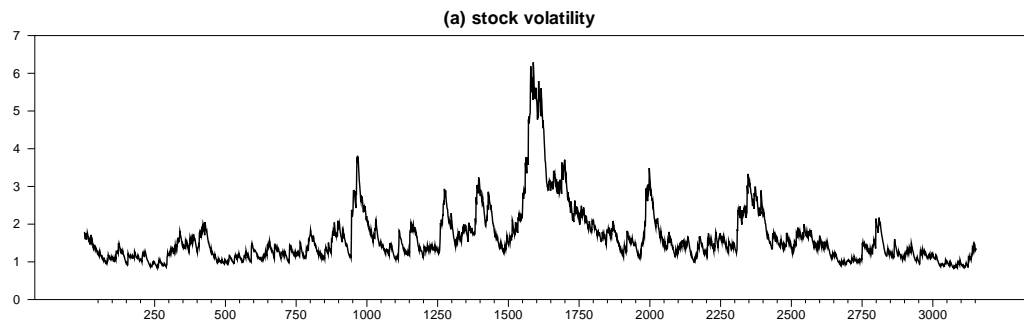


**EGYPT****KENYA**



**NIGERIA**



**SOUTH AFRICA****TUNISIA**