Lappeenranta University of Technology
School of Business

MASTERS THESIS

Market integration, return and volatility dynamics; empirical evidence from African stock markets

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ABSTRACT

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Frontier and Emerging economies have implemented policies with the objective of liberalizing their equity markets. Equity market liberalization opens the domestic equity market to foreign investors and as well paves the way for domestic investors to invest in foreign equity securities. Among other things, equity market liberalization results in diversification benefits.

Moreover, equity market liberalization leads to low cost of equity capital resulting from the lower rate of return by investors. Additionally, foreign and local investors share any potential risks. Liberalized equity markets also become liquid considering that there are more investors to trade. Equity market liberalization results in financial integration which explains the movement of two markets. In crisis period, increased volatility and co-movement between two markets may result in what is termed contagion effects.

In Africa, major moves toward financial liberalization generally started in the late 1980s with South Africa as the pioneer. Over the years, researchers have studied the impact of financial liberalization on Africa's economic development with diverse results; some being positive, others negative and still others being mixed. The objective of this study is to establish whether African stock-markets are integrated into the United States (US) and World market. Furthermore, the study helps to see if there are international linkages between the Africa, US and the world markets. A Bivariate- VAR- GARCH- BEKK model is employed in the study.

In the study, the effect of thin trading is removed through series of econometric data purification. This is because thin trading, also known as non-trading or inconsistency of trading, is a main feature of African markets and may trigger inconsistency and biased results. The study confirmed the widely established results that the South Africa and Egypt stock markets are highly integrated with the US and World market. Interestingly, the study adds to knowledge in this research area by establishing the fact that Kenya is very integrated with the US and World markets and that it receives and exports past innovations as well as shocks to and from the US and World market.

Keywords: Financial Liberalization, Integration, Contagion, Spillover, Volatility

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1. INTRODUCTION

Over the past decades, financial liberalization has become the hallmark of most Frontier and Emerging markets. This entails the implementation of a number of financial reforms. Through these reforms, stock markets in Emerging markets were partially or fully opened to foreign investors, coupled with the adoption of internationally recognized accounting standards, enacting of laws to protect investors and timely and systematic release of a company's financials to the general public.

A major reason for such an action as explained by Stulz (1999) and Henry (2000) is that a market that is fully segmented or differentiated from other capital markets tends to be risky and the cost of raising capital is high. This results from the higher required rate of return demanded by investors. This is so because as CAPM shows, the required rate of return is equal to a risk-free rate plus a risk premium. However, the risk premium in this case is equal to the firm's beta times a local market's risk premium. It therefore emphasizes that the local investors alone bear the risks in the segmented market without any foreign investor, hence hindering diversification and increasing considerably the required rate of return and subsequently the cost of equity capital.

Meanwhile, a market that is fully integrated would mean that foreign investors would be ready and available to bear some of the risks in the local market. Local investors, on the other hand, can also diversify their portfolio by investing in foreign markets; and thereby, reaping the benefits of market liberalization through the process of diversification considering that the domestic and foreign risks will offset each other. Liberalization and integration to an extent reduce significantly the required rate of return for domestic investors due to lower risk.

However, despite the positive effects of financial liberalization and market integration, it is feared that crisis in one market can spread to other markets. This is termed as *contagion effect*. Contagion in equity markets defines the assumption that markets move more closely together during periods of crisis (Bekaert et al, 2003). The co-movements (parallel movements) between these markets mean that a slump in, for instance, the US stock market would lead to a slump in the UK

stock market and vice versa. Bekaert et al (2003) mentioned that out of the 17 Emerging markets analyzed using the August 1998 Russian crisis, 9 of them had their five poorest performing months within the crisis period. During the Asian crisis of July 1997 to May 1998, four Asian countries witnessed five worst returns during these months.

In this light, therefore, market integration has garnered more attention in recent literatures. However, the existing literatures broadly examine integration and its subsequent effects from the Emerging markets' perspective. They are mainly focused on main crisis periods such as the 1997 to 1998 Asian crisis (Collins et al, 2003) and the US crisis of 2007 to 2008 (Samarakoon 2011). Evidently, this gives rise to lower span of data. Furthermore, the previous literatures have not looked at the African markets exclusively but considers them as part of either Emerging market or Middle East and North Africa (MENA) group of countries.

This study examines whether African equity markets are fully or partially integrated into the US and the world market after their financial liberalization. Additionally, the study examines whether there exist returns and volatility spillover between African stock markets and the world market and the source of such spillovers, if any at all. Further, the study seeks to understand whether there were any significant pure contagion effects on the stock markets of these Emerging economies. This study also explores the prospects of African markets and their potentials with respect to portfolio diversification.

1.1 Research Questions

1. *Have stock markets in Africa become integrated into world capital markets since their financial liberalization? If yes, what accounts for the level of integration? If no, what account for the level of segmentation?*

2. *Are there international linkages between African, the US and the world stock markets? Does volatility spillover exist between the African, US and the world stock markets? If yes, which market is the source?*

3. *Were there pure contagion effects between African, US and the world market during the 2008 sub-prime crisis?*

4. *Do stock markets in Africa provide the maximum benefits of portfolio diversification?*

1.2 Aims and Objectives

The study aims to capture the performance of African equity markets after implementing drastic measures to liberalize their financial markets. With the advent of high technology, financial liberalization, adoption of international accounting standards, enactment of investor protection laws and laws regarding full financial disclosure, as instances, African stock markets are more than ever exhibiting traits similar to stock markets in the developed economies. The African stock markets are believed to be more integrated with the world market thereby exhibiting similar traits and hence returns, volatility spillovers and contagion. These are some possible financial scenarios that are worth considering. This study therefore, aims at examining whether African stock markets are fully or partially integrated into the world market by analyzing the relationship between them, the World market index and the US market index. Also, the study analyzes the relationship between the African markets and the Emerging Markets' Index as well as the BRIC and Emerging Market Index. Finally, this study investigates whether there were pure contagion effects on the markets under consideration during the financial crisis in 2008 in the US.

1.3 Motivation

Most of the existing researches in finance are focused on the developed markets particularly the US market and the group of 8 countries. Emerging and Frontier markets under which most African markets are classified are partially or entirely ignored. Apparently, this poses a bigger challenge to the financial models designed mostly with the advanced markets in view. Consequently, this underscores the dire need for high quality research on the Emerging African markets by employing these existing models to see how best they describe these markets. It is against this background that this study is undertaken.

Second, emerging economies are the driving force of growth opportunities in the world economy. Considering that growth opportunities in the developed economies are declining at a rapid rate, developing economies present diverse investment opportunities, diversification possibilities, and opportunities for arbitrage profits. Third, these markets are prone to crises which signify the need of high quality research in quantifying their susceptibility. However, the creation of new investment and hedging instruments makes these markets more attractive.

Finally, the results and policy implication of research in these markets have the potential to affect markets and economies far beyond the market under consideration owing to the fact that there is a considerable relationship between finance and the real economy. For instance, a study of the effect of lower cost of capital on the economy can also be examined from the perspective of the increase in the standard of living of individuals in the country in question and how it extends to the neighboring countries.

These reasons serve as the basis for the motivation to conduct this study. The study has the potential to test the existing models with the African market, impact on diversification decision and how examine how these markets performed in the face of the 2008 financial crisis.

1.4 Contribution to Existing Literature

This study contributes to the existing literature in the field of finance research in numerous ways. First, it is worth noting that the African stock markets are predominantly Frontier Emerging markets or at best Emerging markets. In reality, these are the least researched markets in finance literature. It is therefore**,** not surprising that there is little or no literature that comprehensively and exclusively analyzes how African stock-markets are integrated with the world market, US market, Emerging market as well as BRIC indices. For these reasons, the study examines how these markets are integrated into the world market over a fifteen-year period.

Second, insufficient or lack of data has been a major hindrance to research on African stock markets. Most of the literatures on African stock exchanges are

characterized by short span data starting from early 2000s or in most cases 2004. This study however, employs a data of much longer time span starting from 1998 to 2013 summing up to 15 years of daily return data yielding 3910 observations. The suitability of high frequency data in models used to examine volatility is well noted in finance research. To a larger extent, the 3910 observations employed in this study ensure that the right inferences are be made without any bias with respect to data length.

Third, thin-trading which is defined as non-synchronous trading or non-trading is a common characteristic of Emerging and Frontier equity markets. Alternatively, thin-trading may be defined as the non-trading of shares or inconsistency of trading. It is established that thin-trading may potentially lead to serial correlation in the returns series. This may result in biasness of the result and hence any inferences made will be inaccurate and misleading Miller et al (1994); Appiah-Kusi et al (2003); Mlambo et al (2005). Most literatures on Africa Stock markets do not take into account thin-trading and hence resulting in biased results. In this study however, in the spirit of Miller et al (1994); Appiah-Kusi et al (2003); and Mlambo et al (2005), thin-trading is removed from the data through systematic econometric processes.

1.5 Scope and Limitation

This study covers the key stock markets in Africa and their integration into the world market. It is worth noting that there are Emerging markets and Frontier Emerging markets. These markets pose a lot of challenges with regard to availability of data resulting from non-availability of data in the databases, incomplete, and short span data. Also, a few literatures have actually explored integration and contagion from the Emerging markets' perspective but those purely from African markets perspective are almost non-existent. These include Bekaert et al (1995), De Santis et al (1997), Tai (2007), Bekaert et al (2003a) and Bekaert et al (2003b) and a few others.

1.6 Structure of the study

The study is arranged as follows: the first chapter introduces the study and contains the objectives, motivations, limitations and contribution of the study. Next section, chapter two presents the overview of the various stock markets and details the year of establishment of the various stock exchanges, transformation over the years and recent developments. Chapter three is the literature review section. It recaps what the existing literatures say about international linkages, and contagion as well as the supporting theories. This is followed by the methodology which is chapter four. This section specifies the models employed in the study. Chapter five presents the data collection method, sources and the manipulation of data to fit the analysis. Proceeding is the chapter six which is the empirical results and analysis section and it presents the findings of the study. More so, it takes into account the implications of the results and how it can be applied in real-life, and the impact of these financial scenarios on the real economy. Finally, the conclusion summarizes the whole study in a nutshell and provides also recommendations for further studies.

2. OVERVIEW OF STOCK MARKET ACTIVITY IN AFRICA

Collectively, the stock market activity in Africa can be analyzed based on the reports of African Securities Exchanges Association (ASEA). ASEA is a non-profit company limited by guarantee which was founded on the 13th of November 1993 in Kenya. ASEA aims to foster cooperation and exchange of information between the various stock exchanges in Africa. ASEA can boast of 20 exchanges in 27 African countries.

According to the United Nations Development Program (UNDP) handbook on Africa Equity Markets, Africa can boast of one of the largest stock markets in the world which mostly is attributable to the huge market capitalization of the Johannesburg Stock Exchange (JSE), South Africa. However, the majority of African equity markets are described as Frontier markets which is noted to be relatively small with respect to capitalization and liquidity levels hence these markets usually receive little or no attention from the Global Emerging Markets (GEM) portfolio funds. In addition, the African markets are characterized by poor information dissemination channels, lack of electronic trading systems, partial or no implementation of financial policies, political instability and among other problems.

However, beginning from the year 1990, most African countries have implemented sound financial policies that aim to open these markets to international investors. Moreover, the privatization of state-owned companies sparked a major revolution of liberalization on the continent. To a larger extent these policy implementations have attracted foreign firms to the African market whiles at the same time, serve as a tool to manage the debt of the government. A typical example is Kenya and Ghana where these governments have been able to issue longer-term instruments which facilitate better management of local debt (UNDP, 2003).

On the other hand, these relatively smaller African markets have proven to be resistant to the recent global financial crisis that hugely impacted on the share values around the world. The main reason for this resilience is the little or lack of correlation between these small markets and the developed markets. These

frontier-African markets thereby offer maximum benefits of portfolio diversification. It is therefore, appropriately summed up in the UNDP (2003) handbook as: "*African capital markets represent the final frontier of global capital*".

2.1 Recent Performance of African Stock Markets

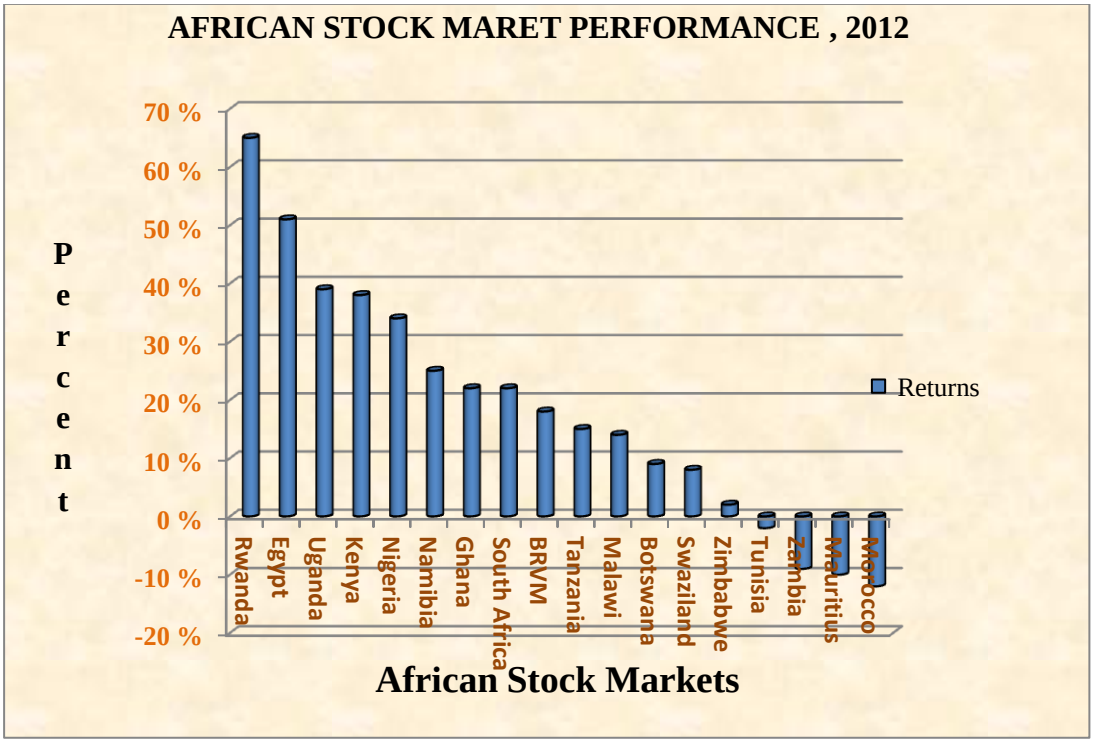


Fig 1: African Stock Market Performance, 2012 (ASEA Yearbook, 2013)

The figure above depicts the performance of stock markets in African as at December, 31st, 2012. The African markets unlike stock markets in the developed world was more positive and recorded very impressive returns. Rwanda ended the year on top with a massive 65% yearend growth. Egypt followed with 50% yearend growth signaling a rebound from the political uprisings that struck the country a year or two earlier. Uganda, Kenya, Nigeria, Namibia, Ghana and Zimbabwe recorded positive growth and this gives a good testimony that there is still more room for investment on the African stock markets. It is however, without negative gains as it can be seen from Tunisia, Zambia, Mauritius and Morocco. Investor-confidence in these markets dropped quite drastically during the 2012 financial year. For countries like Tunisia and Morocco, it may be

attributed to the Arab spring. However, for Zambia and Mauritius, probably economic reasons might have triggered the drop in confidence by investors (ASEA Yearbook 2012). That notwithstanding, a comparison of African stock markets to their international counterparts still put the African markets on a higher pedestal as illustrated below.

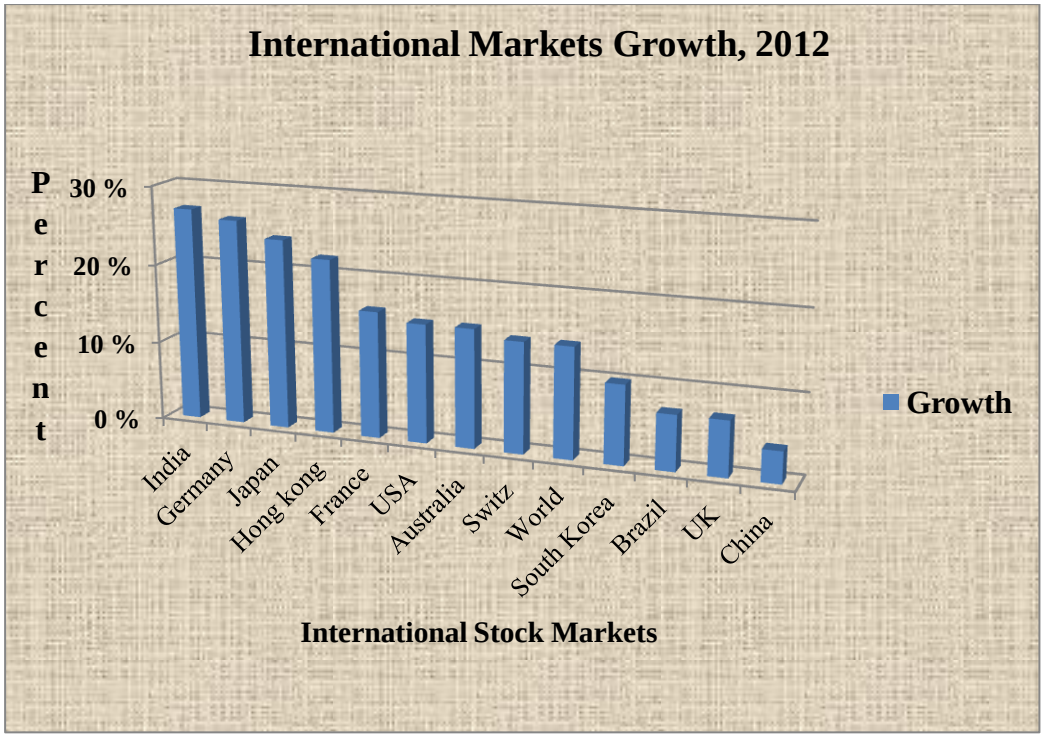


Fig 2: International stock market performance (ASEA Yearbook 2013)

The figure above presents the performance of some international stock markets during the 2012 financial year. India recorded the highest growth of 27% which is very meager compared to the 65% growth of the stock market in Rwanda, Egypt, Nigeria, Uganda and Kenya (ASEA Yearbook 2012). Arguably, one may look at the growth with respect to the size of the market for instance the market capitalization and the number of trading. However, the purpose of this analysis is to establish the growth potential or prospects of these Emerging and Frontier Emerging markets as compared to the developed markets.

As can be seen from the figure above, most of the advanced economies such as the USA, Germany, Japan, and France have limited opportunities for growth. United Kingdom as shown recorded a growth of less than 10% (ASEA Yearbook 2012). This might be attributable to the European sovereign debt crisis that has

crippled economies like Greece, Portugal, Ireland, Spain, Italy and a host of other European countries. African stock markets therefore, from this comparison will provide reasonable benefits for diversification considering that the markets are still growing and there is a need for more innovative instruments.

2.2 South Africa

The stock exchange of South Africa was founded on 8th of November 1887. Called the Johannesburg Stock Exchange (JSE), the stock exchange of South Africa is noted to be the largest exchange in the continent of Africa as well as comparatively at par with exchanges in the developed world with respect to the level of technology and innovativeness. Ranked as the 17th largest equity exchange in the world, JSE has a total market capitalization of some R3.2 trillion, 400 listed companies and a market liquidity of 36%. JSE is deemed to be larger than 9 stock exchanges in the developed world. JSE is one of the world's busiest and biggest stock exchange centers and was voted the number one stock exchange in terms of regulation by the World Federation of Exchange (WFE) for 2010. JSE lists shares on two separate markets, the Mainboard and AltX (ASEA Yearbook 2012).

JSE over 2011 and 2012, as depicted below shows signs of poor performance with a reduction in the number of listed companies from 450 to 406 and significant fall in market capitalization from 1 trillion to 856 billion.

Table 1: South Africa Trading Equity Statistics (Currency USD)

Indicators	2008	2009	2010	2011	2012
Total Value Traded (Billion USD)	*394.56*	*374.01*	*438.09*	*402.30*	*408.63*
Total Volume Traded (Billion)	*83.78*	*82.86*	*71.25*	*71.46*	*61.84*
Total Number of Transactions (Million)	*17.40*	*20.95*	*23.76*	*26.50*	*26.93*
Number of Listed Companies	*425*	*410*	*407*	*406*	*400*
Number of Traded Companies	*404*	*390*	*386*	*385*	*375*
Market Capitalization (Billion USD)	*549.2*	*793.07*	*981.44*	*845.58*	*998.34*
Market Cap as % of GDP	*NA*	*NA*	*NA*	*30.91*	*NA*
Turnover Ratio (%)	*71.84*	*46.25*	*43.26*	*46.25*	*40.93*

Turnover Ratio (%)* =Value of traded listed securities / market capitalization.
Source: ASEA Yearbook 2013

2.3 Tunisia

Founded in 1969 as public institution, the Tunisia stock exchange underwent massive transformation in the early 1990s and wholly became a private company in the year 1995. Since then, other changes such as the implementation and Electronic Trading System, the launch of a market index, TUNINDEX, sector indices, separate indices for small and medium sized companies to a larger extent facilitates efficient trading on the market as well as transparency in the pricing of assets or securities. In the year 2007, the Tunisian exchange market migrated to a trading system known as the NSC Trading System (NSC V900). This market has received its fair share of crisis in the form of the political uprisings in the Arab world. The Tunis stock exchange had to suspend stock market quotation for twice within a period of 15 business days during the uprisings so as to calm the nerves of investors. The effects of the uprisings can be seen from the reduction in the market capitalization, the fall in turnover ratio in 2011 as well as the fall in market capitalization as a percentage of GDP. More so, the fluctuations in the value traded on listed securities over the three year period testify to the volatile nature of the market resulting mainly from the Arab uprisings (ASEA Yearbook 2012).

Table 2: Tunisia Trading Equity Statistics (Currency USD)

Indicators	**2009**	**2010**	**2011**	**2012**
Total Value Traded (Billion USD)	*1.30*	*1.83*	*1.05*	*1.25*
Total Volume Traded (Million)	*189*	*272*	*253*	*241*
Total Number of Transactions	*394,137*	*629,488*	*448,872*	*569,403*
Number of Listed Companies	*52*	*56*	*57*	*59*
Number of Traded Companies	*52*	*56*	*57*	*59*
Market Capitalization (Billion USD)	*9.28*	*10.63*	*9.64*	*8.89*
Market Capitalization as % of GDP	*22.90 %*	*24.11 %*	*22.50 %*	*19.32 %*
Turnover Ratio (%)*	*14.02 %*	*17.18 %*	*10.87 %*	*14.10 %*

Turnover Ratio (%)* =Value of traded listed securities / market capitalization.
Source: ASEA Yearbook 2013

2.4 Egypt

The Egyptian Exchange dates back to 1883 with the establishment of the Alexandria Bourse and Cairo Stock Exchange in 1903 with 97 listed companies and a market capitalization of L.E 29 million, which rose to 228 listed companies

in 1907 and a market capitalization of L.E 91 million. These two were merged in the 1940s and 1950s and performed magnificently to be ranked fifth among the world exchanges.

The Egyptian exchange continues to be one of the most attractive markets in the Middle East and Africa region according to Standard and Poor. The market recorded Price to Earnings ratio of 10.47 as compared to the regional PE of 15.86. More so, the market recorded a high dividend yield of 10.40%. The average dividend yield for the region is 3.58% as at December 2011. Furthermore, the influx of new companies to the market signifies the confidence in the Egyptian market. The year 2011 for instance witnessed the listing of 9 new companies. Performance wise, the Egyptian market has been very resilient as compared to other major exchanges around the world. Despite the turmoil in the financial markets, coupled with the uprising in Egypt about 79% of the companies listed on the Egyptian market realized profits whiles 79% of the listed companies made significant profits during the first half of the financial year.

As shown below, the market capitalization in the 2011 declined almost 50% from 84 billion to 48 billion but rose appreciably to 60 billion in 2012. This can be attributable to the Arab spring that might have given rise to capital flight by foreign investors (ASEA Yearbook 2012).

Table 3: Egypt Trading Equity Statistics (Currency USD)

Indicators	**2008**	**2009**	**2010**	**2011**	**2012**
Total Value Traded (Billion USD)	*96.06*	*81.71*	*55.36*	*24.57*	*23.40*
Total Volume Traded (Billion)	*25.56*	*36.60*	*33.43*	*18.49*	*34.22*
Total Number of Transactions (Million)	*13.46*	*14.63*	*10.20*	*5.59*	*6.23*
Number of Listed Companies	*373*	*306*	*212*	*213*	*235*
Number of Traded Companies	*322*	*289*	*213*	*204*	*220*
Market Capitalization (Billion USD)	*86*	*91*	*84*	*52*	*60*
Market Cap as % of GDP (%)	*45.45*	*41.40*	*40.46*	*22.73*	*NA*
Turnover Ratio (%)*	*70.3***	*49.9***	*42.9*	*34*	*34.09*

Turnover Ratio (%)* =Value of traded listed securities / market capitalization.
Source: ASEA Yearbook 2013

2.5 Morocco

Affectionately called the Casablanca stock exchange (CSE), the Moroccan market was founded in the year 1929. To improve efficiency and transparency on the market, such transformations as, the introduction of an electronic trading system was effected in 1997. Also, the trade settlement period was shortened from T+5 to T+3 in May 2001. Further, the floating-weighted capitalization method for calculating indices was adopted in December 2004. More so, a new clearing system was introduced in 2002, whiles new listing requirements were implemented in 2005. CSE competes with Egypt for the second place in Africa in terms of market capitalization. It was second in Africa in 2011 but currently sits at third after South Africa and Egypt.

As depicted in the table below, the Morocco market has been declining in terms of market capitalization over the years 2010 to 2012 even though the number of companies has increased over the same period. The turnover ratios are also in decline over the three year period.

Table 4: Morocco (Casablanca) Trading Equity Statistics (Currency USD)

Indicators	**2009**	**2010**	**2011**	**2012**
Total Value Traded (Billion USD)	*7.05*	*9.78*	*5.98*	*5.83*
Total Volume Traded (Million)	*211.57*	*263.56*	*189.51*	*204*
Total Number of Transactions	*285,252*	*329,877*	*218,823*	*156,768*
Number of Listed Companies	*76*	*74*	*76*	*77*
Number of Traded Companies	*77*	*78*	*77*	*77*
Market Capitalization (Billion)	*64.74*	*69.29*	*60.19*	*52.8*
Market Cap as % of GDP	*71.22 %*	*76.30 %*	*60.62 %*	*53.04 %*
Turnover Ratio (%)*	*10.88 %*	*14.11 %*	*9.94 %*	*9.03 %*

Turnover Ratio (%)* =Value of traded listed securities / market capitalization.
Source: ASEA Yearbook 2013

2.6 Kenya

Nairobi stock exchange (NSE) was established in the year 1951 and has undergone many transformations from pre-independence era to its current position. Noticeable among these changes are the registration of the company as an association of stockbrokers in 1954, the formation of a regulatory body in 1989

charged with the task of boosting the growth of the capital market, registration as a company in 1991, and the introduction of the computerized delivery and settlement system (DASS) in 1994. In 2004, the NSE was face-lifted to full automation with respect to clearing and settlement.

In the year 2011, both the NSE's 20 Share Index and NASI declined by 5.8 and 7.7 percent respectively. Market capitalization decreased significantly in the year 2011 but rose again in 2012. However, turnover ratios was still very impressive as shown in the table below. The market capitalization re-bounded in 2012 after a fall in 2011. The number of listed companies also increased from 58 to 60 in the year 2012.

Table 5: Kenya (NSE) Trading Equity Statistics (Currency USD)

Indicators	2007	2008	2010	2011	2012
Total Value Traded(Billion USD)	*1.42*	*1.25*	*1.37*	*0.92*	*1.08*
Total Volume Traded (Billion)	*1.94*	*5.86*	*7.55*	*5.72*	*5.46*
Total Number of Transactions	*973,548*	*890,542*	*721,367*	*382,175*	*342,235*
Number of listed companies	*54*	*56*	*55*	*58*	*60*
Number of traded companies	*50*	*51*	*50*	*54*	*56*
Market Capitalization (Billion)	*13.61*	*10.98*	*14.48*	*10.34*	*15.9*
Market Cap as % of GDP	*49.34*	*31.81*	*48.29 %*	*34.48 %*	*42.05*
Turnover Ratio (%)*	*10.41*	*11.42*	*9.45*	*8.87*	*6.82*

Turnover Ratio (%)* =Value of traded listed securities / market capitalization
Source: ASEA Yearbook 2013

2.7 Mauritius

Established in 1989, the Stock Exchange of Mauritius (SEM) is a private limited company that tasks itself with maintaining an efficient and regulated securities market in Mauritius. Currently, SEM is one of the well-recognized stock exchanges in Africa and a member of the World Federation of Exchanges (WFE). The Mauritius stock market initiated market liberalization in 1994, by opening its doors to the international or foreign investors. International investors thereby needed no approval to trade shares. In addition, foreign investors benefited from such incentives without restrictions on remittance of revenue as well as tax-free dividends and capital gains.

Over the years, SEM has introduced a number of reforms to boost the performance of the market among which include the implementation of the Central Depository System (CDS) in 1997. The market has been frequented with the problem of trading pattern and the introduction of the automated trading system signifies an end to this problem. Further, SEM the Development & Enterprise Market (DEM) index introduced in 2006 was designed with Small and Medium-sized Enterprises and startup companies in mind. The objective is to ensure that these companies thrive by pooling funds from the market.

With respect to performance, as shown in the table below, over the years, 2009 to 2011, the market capitalization has improved significantly. The turnover ratio rose from 5.9% to 7.28% in 2011 even though the listed companies reduced to 87 from 89 over the same period.

Table 6: Mauritius Trading Equity Statistics (Currency USD)

Indicators	2007	2008	2010	2011	2012
Total Value Traded (Million USD)	*445.96*	*437.42*	*439.69*	*559.14*	*352.83*
Total Volume Traded (Million)	*300.80*	*318.68*	*483.57*	*347.39*	*304.50*
Total Number of Transactions	*74,367*	*71,148*	*77,764*	*68,653*	*63,404*
Number of listed companies	*91*	*93*	*87*	*87*	*88*
Number of traded companies	*91*	*89*	*87*	*87*	*88*
Market Cap (Billion USD)	*7.77*	*4.53*	*7.46*	*7.68*	*7.1*
Market Cap as % of GDP	*96.5*	*56*	*80.63*	*70.9*	*63.66*
Turnover Ratio (%)*	*5.74*	*9.66*	*5.9*	*7.28*	*4.97*

Turnover Ratio (%)* =Value of traded listed securities / market capitalization.
Source: ASEA Yearbook 2013

2.8 Zambia

The Lusaka Stock Exchange (LuSE) started in 1994 as a private limited liability company. LuSE is noted to be a pivotal institution in the economic reform, financial sector reforms, privatization and liberalization that earmarked the 1990s in Zambia. Investor-protection was one key issue addressed in the securities act enacted in 1993. The main index on the Lusaka stock exchange is the LuSE All Share Index with a base date of January 1997 and a base value of 100 points. LuSE offers such securities as ordinary shares, preference shares, government and corporate bonds and depository receipts.

The market capitalization of LuSE signals the great strides that the market is making over the years. As shown in the table below, the market capitalization rose from a little over six (6) billion to nine (9) billion over the 2011 and 2012 financial year. The number of listed companies also increased from 20 to 21.

Table 7: Zambia (LUSE) Trading Equity Statistics (Currency USD)

Indicators	**2007**	**2008**	**2010**	**2011**	**2012**
Total Value Traded (Million USD)	*72.36*	*167.84*	*43.78*	*195.71*	*149.10*
Total Volume Traded (Million)	*2800.27*	*1585.77*	*875.01*	*1419.66*	*1148.27*
Total Number of Transactions	*6199.0*	*8384.00*	*6619.0*	*NA*	*7117.0*
Number of listed comopanies	*17.00*	*19.00*	*20.00*	*20.00*	*21.00*
Number of traded companies	*17.00*	*20.00*	*20.00*	*20.00*	*21.00*
Market Capitalization (Billion USD)	*4.83*	*4.11*	*5.27*	*6.30*	*9.41*
Market Cap as % of GDP	*54.64*	*40.04*	*0.39*	*0.48*	*0.64*
Turnover Ratio (%)*	*1.55*	*0.66*	*0.01*	*0.03*	*0.02*

Turnover Ratio (%)* =Value of traded listed securities / market capitalization.

Source: ASEAN Yearbook 2013

3. LITERATURE REVIEW

3.1 Financial liberalization

In Africa, the time leading up to the 1980s were characterized by strict government interventions in the financial sector of the economy. Limits on bank interest rates, inflow and outflow of funds, policies and regulations in this sector were the sole responsibility of the government. However, after the 1980s, the theoretical and practical benefits of financial liberalization appealed to these governments. Consequently, a wave of financial revolution such as: enactment of laws to protect investors, opening the financial markets to foreign investors, and the adoption of a free-float method of interest rate calculation swept across these developing markets.

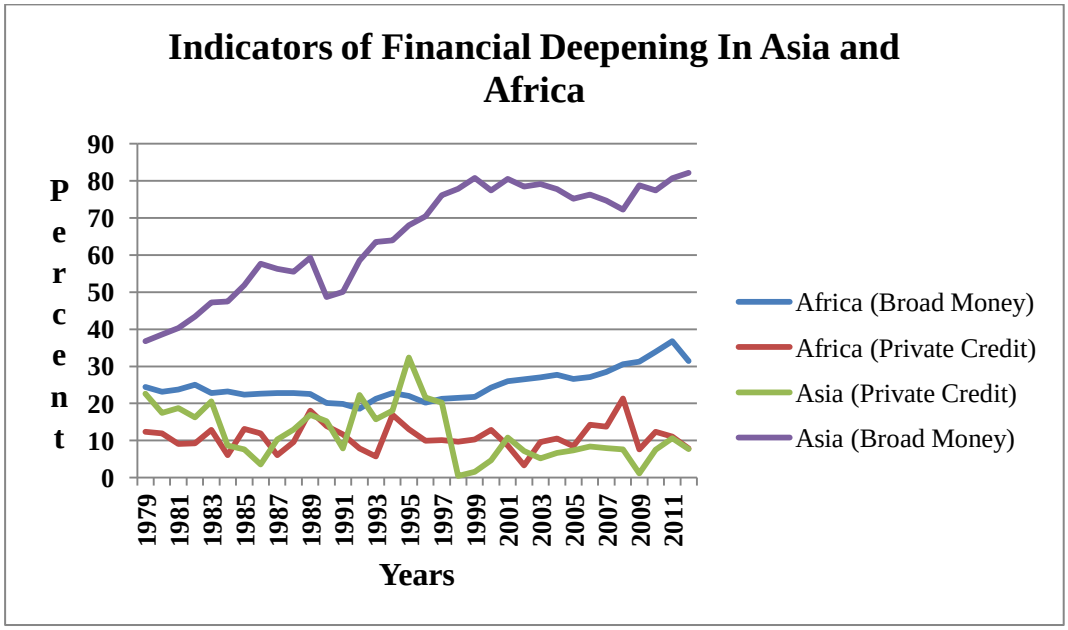


Fig 3: Financial deepening (Source: World Bank, Databank, 2012)

As shown in the figure above, the results of financial liberalization looks more of a success in Asia than Africa. The figure takes into account the ratio of broad money (cash *plus* deposits in the commercial banking system) to national income as a proxy for the success of financial reform. Comparatively financial reforms started a bit earlier in Asian than Africa. Malaysia for instance initiated its liberalization process in 1978 with its interest rates. However, African countries such as Gambia and Ghana sparked off their liberalization process in the late

1980s. Financial liberalization explains the instance whereby a country allows inward and outward foreign equity investment. In practice, foreign investors can purchase or sell domestic securities without any restriction whiles domestic investors can purchase or sell foreign securities. Financial liberalization gives rise to integration which describes increased correlation between markets **(**Pill et al 1995).

Financial liberalization has immense importance on economy of the developing countries. For instance, interest rates that are freely determined by the market forces tend to be more positive and real in nature hence boosting the resource-base of the financial system. This owes to the fact that a positive interest rate will benefit the borrower and encourage savings. A high interest rate will motivate individuals to save with the objective of reaping higher returns. On the other hand, it would also motivate borrowers to invest the borrowed resources in a more reasonable, strategic and profitable manner thereby boosting the economy of the country in question. Further, the financial sector has the ability to distribute equitably resources to vital sectors of the economy for productive investment. Financial liberalization is therefore a pivotal component of a country's economic welfare and growth **(**Pill et al 1995 Bekaert et al 2006).

As defined above, financial liberalization seeks to delimit government influence on the pricing and allocation of credit in a country. Furthermore, governments must put in place measures to allow free-flow of capital both in and out the country. However, to achieve the full benefits of financial liberalization, implementation of financial policies should be accompanied by sound and stable macro-economic policies, sound banking institutions, sound legal framework, well structured accounting and formidable management infrastructures as well as supervisory infrastructures of the financial system. Sound macro-economic policies such as favorable balance of trade, good fiscal policies and inflation would ensure that the demand for money is increased substantially after liberalization. Inflation stood at 20% and over 100% in Ghana and Zambia respectively during the year of interest rate deregulation and such a poor macroeconomic condition accounts for poor implementation of financial policies that limit to a greater extend the effects of such reforms. Liberalization on the

other hand has the tendency to provide the freedom to financial institutions to make poor decisions especially with respect to lending (Pill et al 1995).

3.1.1 Emerging Markets Perspective

Entry of foreign investors into Emerging stock markets has become possible as a result of financial liberalization. Over the years many researchers have tracked the liberalization process of Emerging economies and foremost among them is Bekaert & Harvey (2000; 2002a) who have built a database of the "Chronology of Important Financial, Economic and Political Events in Emerging Markets". In this database are the historical financial events of Emerging markets which are well documented with the appropriate dates.

Depicted in the table is a sample of twenty (20) Emerging markets with their official liberalization dates for financial reforms such as the introduction of American Depository Receipts (ADR). Using an algorithm in Bai, Lumsdaine, and Stock (1998), Bekaert & Harvey calculated the estimate of the cumulative net U.S. capital flows. They mentioned that the U.S. portfolio flows data are obtained from the U.S. Treasury Bulletin which shows the portfolio flows to the countries listed in the table below. Market capitalization is obtained from International Financial Cooperation (IFC) Bekaert & Harvey (2000; 2002a). It can be seen from the table below that the wave liberalization swept across the Emerging markets in the later part of the 1980s and early 1990s.

Table 8: Emerging Stock Markets Liberalization Dates

Country	*Official Liberalization Date*	*First ADR Introduction*	*First Country Fund Introduction*	*Estimate of increase in Net US Capital Flow*	*Cumulative Net US Flows to Market Cap*
	Year/day	*Year/day*	*Year/day*	*Year/day*	**Dec-95**
Argentina	*89.11*	*91.08*	*91.1*	*93.04*	*0.2181*
Brazil	*91.05*	*92.01*	*87.1*	*88.06*	*0.1114*
Chile	*92.01*	*90.03*	*89.09*	*88.01*	*0.0745*
Colombia	*91.02*	*92.12*	*92.05*	*93.08*	*0.04*
Greece	*87.12*	*88.08*	*88.09*	*86.12*	*0.0357*
India	*92.11*	*92.02*	*86.06*	*93.04*	*0.0114*
Indonesia	*89.09*	*91.04*	*89.01*	*93.06*	*0.0669*
Jordan	*95.12*	*NA*	*NA*	*NA*	*NA*
Korea	*92.01*	*90.11*	*84.08*	*93.03*	*0.048*
Malaysia	*88.12*	*92.08*	*87.12*	*92.04*	*0.0159*
Mexico	*89.05*	*89.01*	*81.06*	*90.05*	*0.1897*
Nigeria	*95.08*	*NA*	*NA*	*NA*	*NA*
Pakistan	*91.02*	*NA*	*91.07*	*93.04*	*0.0123*
Philippines	*91.06*	*91.03*	*87.05*	*90.01*	*0.1232*
Portugal	*86.07*	*90.06*	*87.08*	*94.08*	*0.0637*
Taiwan	*91.01*	*91.12*	*86.05*	*92.08*	*0.0021*
Thailand	*87.09*	*91.01*	*85.07*	*88.07*	*0.0184*
Turkey	*89.08*	*90.07*	*89.12*	*89.12*	*0.0442*
Venezuela	*90.01*	*91.08*	*NA*	*94.02*	*0.0005*
Zimbabwe	*93.06*	*NA*	*NA*	*NA*	*NA*

Over the course of 25 years of financial liberalization in Emerging markets, its impact on the economies of the Emerging countries has been studied in detail. These diverse studies have yielded diverse results with some being positive, others negative and still others mixed. Variety of countries from diverse continents have been used in these studies. The following outlines some of the research work done on Emerging markets with respect to financial liberalization.

Taskin et al (2003) examine how capital market liberalization transforms segmented stock markets into integrated stock markets employing data on 15 Emerging markets. According to them, after liberalization, the local stock market returns is affected by the world returns and for that matter co-moves with the world market. They discovered that local markets are better integrated with the world market after liberalization by strengthening the information flow from the

world market to the local stock market. Haung et al (2000) also found that financial market liberalization results in increased volatility in such markets as South Korea, Mexico and Turkey whiles minimal or no increase in volatility was observed in the other seven markets studied.

Bekaert et al (2005) using a number of measures of equity market liberalization, examined the impact of financial liberalization on growth of the economy of the countries studied. They found out that equity market liberalization increased economic growth. They realized that equity market liberalization results in "*1% increase in annual real per capita GDP growth and find this increase to be statistically significant*". To ensure the robustness of the results, alternative liberalization dates, different sample groups, business cycle effects and host of other variables were used in the analysis Bekaert et al (2005).

Bekaert et al (2002b) in trying to deduce the best form model suitable for assessing the impact of market liberalization realized that "*the cost of capital always decreases after a capital market liberalization with the effect varying between 5 and 75 basis points*". This adds to the literature that liberalization is advantageous to the economy in that the cost of capital is reduced significantly.

On the other hand, Kawakatsu et al (1999) employing data from nine different Emerging countries (Argentina, Brazil, Chile, Colombia, India, Korea, Mexico, Thailand, and Venezuela), examined how Emerging market stock prices change in times of financial liberalization. Their study is based on the efficient market theory which proposes that information becomes readily available as markets are opened up to the general public and even foreign investors hence this should affect the prices of assets to an extent. The results of Kawakatsu et al (1999) in contrary to the theory, shows that liberalization does not in any significant way better the efficiency of Emerging markets. This result according to Kawakatsu et al (1999) might be as a result of the proxy for financial liberalization. They used the official liberalization dates of the various markets. However liberalization is a gradual process and has to be tracked over a period of time.

3.1.2 African Stock Markets Perspective

Liberalization of African stock markets and integration of these markets into the world market can be said to be of immense importance to the field of finance; considering the potential of these markets to grow - compared to the advanced markets, and the benefits of portfolio diversification that they possess. It is therefore, highly imperative that the liberalization process of African stock markets, their performance over the years, stability, impact on economic growth and its role on the global financial scene be analyzed. There have been a couple of previous literatures that sought to track the liberalization process in African and one example is Fowowe (2008).

Table 9 below, according to Fowowe (2008) depicts the year countries in Sub Sahara Africa (SSA) made major strides towards liberalizing their respective markets. South Africa is the first country to make a move at liberalizing its market in 1980 and this account for the highly developed state of this market. Also, the presence of the British in South Africa till early 1990s may have been a reason for making moves to liberalize their financial sector at such an early date. South Africa gained independence in 1992. The remaining countries made an attempt to liberalize the financial system at the end of 1980 and even countries like Cameroun, Kenya and Malawi thought of liberalization in early 1990s.

Table 9: Starting Dates of Major Moves Towards Liberalization in SSA

Country	Date (Year)	Source
Botswana	*1989*	*Bank of Botswana (2001)*
Burundi	*1986*	*Hussain & Faruqee(1994)*
Cameroon	*1990*	*Galbis (1993)*
Congo, Rep	*1990*	*Reinhart & Tokatlidis (2003)*
Cote d'Ivoire	*1989*	*Galbis (1993)*
Gambia,	*1986*	*Moreira (1999)*
Ghana	*1987*	*Honohan (2000)*
Kenya	*1991*	*Demirguc-Kunt & Detragiache (1998)*
Madagascar	*1994*	*Reinhart & Tokatlidis (2003)*
Malawi	*1992*	*Honohan (2000)*
Mali	*1989*	*Reinhart & Tokatlidis (2003)*
Mauritius	*1981*	*Galbis (1993)*
Nigeria	*1987*	*Galbis (1993)*
Senegal	*1989*	*Reinhart & Tokatlidis (2003)*
Sierra Leone	*1991*	*Honohan (2000)*
South Africa	*1980*	*Williamson & Mahar (1998)*
Uganda	*1988*	*Galbis (1993)*
Zambia	*1992*	*Demirguc-Kunt & Detragiache (1998)*
Zimbabwe	*1993*	*Naude (1995)*

Source: Fowowe (2008)

In the proceeding table, Fowowe (2008) presents five different measures of financial liberalization and the dates each of the nineteen (19) respective SSA countries implemented the measures. "*No"* means that a country did not undertake any comprehensive action in that particular financial liberalization measure. For instance, there were no major policy implementations that aimed at bank denationalization and restructuring in Burundi and Malawi, prudential regulation in Sierra Leone as well as the removal of directed credit in Botswana, Madagascar, and Zambia. This emphasizes that there were no clearly defined regulations and implementations in these measures of financial liberalization. It could also be that they were not formally announced but implemented alongside other measures.

Table 10: Starting Years of Financial Liberalization

Country	*Bank denationalization restructuring*	*Interest rate liberalization*	*Prudential Regulation*	*Free entry into Banking*	*Removal of Direct Credit*
	Year	***Year***	***Year***	***Year***	***Year***
Botswana	*1990*	*1986*	*1991*	*1990*	*No*
Burundi	*No*	*1988*	*1992*	*No*	*1986*
Cameroon	*1991*	*1990*	*1990*	*No*	*1991*
Congo, Rep	*1991*	*1990*	*1991*	*No*	*1991*
Cote d'Ivoire	*1989*	*1989*	*1990*	*No*	*1989*
Gambia,	*1985*	*1985*	*1985*	*No*	*1990*
Ghana	*1989*	*1987*	*1989*	*1987*	*1988*
Kenya	*1988*	*1990*	*1985*	*1994*	*1991*
Madagascar	*1988*	*1985*	*1988*	*1988*	*No*
Malawi	*no*	*1988*	*1989*	*1990*	*1991*
Mali	*1989*	*1989*	*1990*	*No*	*1989*
Mauritius	*1995*	*1981*	*1988*	*1999*	*1981*
Nigeria	*1988*	*1987*	*1988*	*1987*	*1985*
Senegal	*1981*	*1989*	*1990*	*no*	*1989*
Sierra Leone	*1992*	*1992*	*No*	*No*	*1992*
South Africa	*1989*	*1980*	*1983*	*1983*	*1980*
Uganda	*1992*	*1992*	*1993*	*No*	*1992*
Zambia	*1995*	*1992*	*1994*	*1991*	*No*
Zimbabwe	*1996*	*1991*	*1996*	*1991*	*1991*

Source: Fowowe (2008)

Below are other countries in Africa and their respective liberalization start-dates. These do not however have dates for implementation of major financial reforms as depicted above.

Table 11: Liberalization Dates of Other African Countries

Country	***Date (Year)***
Tanzania	*1991*
Rwanda	*1991*
Burkina Faso	*1989*
Togo	*1989*
Benin	*1990*
Senegal	*1989*
Guinea	*1985*
Swaziland	*1982*
Ethiopia	*1993*
Sudan	*1997*
Malawi	*1988*
Congo	*1990*
Cape Verde	*1993*
Chad	*1990*
Namibia	*1991*
Gabon	*1990*
Mozambique	*1994*
Mauritania	*1990*
Niger	*1989*

Source: Fowowe (2008)

Previous literatures on liberalization in Africa are few and these aim at trying to establish the impact of financial liberalization on economic growth in the countries studied. Fowowe (2008) employed data bordering on a variety of proxies for financial liberalization for 19 countries in Sub-Saharan Africa (SSA). Fowowe (2008) studied the effects of financial liberalization on the growth of the countries in question. He finds that there is a positive and statistically significant effect of financial liberalization on economic growth and it can be inferred that financial liberalization results in an economic growth of about 0.7 percentage points in the sample countries studied. Ahmed and Suardi (2009), employing a dataset on 25 African countries between the years, 1971–2005 examines the effects of financial liberalization on growth volatility and consumption in Africa. They found out that financial liberalization stabilizes income and consumption growth. Saleem (2013) also studied the regional integration between African stock markets and found that regionally African markets are very integrated especially after financial liberalization. Using MVAR-EGARCH, Kuttu (2012) studied the volatility dynamics between four Sub Saharan African countries and found South

Africa to be a key source of information to the other markets. He also found that these markets are integrated but not on the basis of trade bloc.

However, Fowowe (2011) undertook a study that sought to examine the empirical literature and experiences of SSA countries with respect to financial liberalization. He found that financial liberalization policies in SSA have achieved much less considering the high expectations. In the same vein, Karikari (2010) finds that liberalization did not directly improve growth of the SSA countries. Using a dataset of 21 countries in SSA between the years 1981–2009, Ahmed (2013) tried to study the role of financial liberalization in boosting financial deepening and economic growth in SSA countries and finds that financial liberalization is negatively associated with income growth in SSA countries. In effect, Ahmed (2013) found that financial liberalization may lead to negative results in the form of lower economic growth. However, after controlling for key macro-economic factors such as: institutional quality, fiscal imbalances and inflation, he found financial liberalization to have significant impact on growth.

Misati and Nyamongo (2011) employing a larger data size of 34 countries from 1983 to 2008 of SSA countries, studied the relationship between financial liberalization, bank crisis and economic growth. Also they studied the effects of financial liberalization and bank crisis on economic growth. They found that financial liberalization inhibits or retards growth more than boosting growth of the economy. On the other hand, they found that liberalization positively affects banking crisis. This emphasizes the fact that financial liberalization may lead to volatility in the financial system and its subsequent implications. However, they discovered that the relationship between financial liberalization and growth are mixed.

3.2 Financial Markets Integration

The wave of financial liberalizations that swept across the continent of Africa in the 1990s has given rise to equity portfolio flows from the advanced markets to these developing markets. The increased interest in these under developed markets mainly stems from the expected returns and diversification benefits of

investing in such markets. Divecha, et al (1992); Harvey (1993) and Wilcox (1992) studied the benefits of diversifying ones portfolio with these under developed markets. Divecha, et al (1992) found that these markets even though volatile tend to be uncorrelated to other developed markets hence investment in these markets yield lower portfolio risk. They found that an investor who invest 20% in these markets would have reduced the total risk of the portfolio from 18.3% to 17.5% whiles at the same time increasing returns from 12.6% to 17.5%. Harvey (1993) also fines that low or no correlations of developing equity markets with developed countries' equity markets reduces the unconditional portfolio risk of a world investor. Similar sentiments are echoed by other researches in the field of finance.

However, as these markets become more open to foreign investors, they also tend to correlate highly with the developed markets thereby diminishing the returns that were once enjoyed through diversification. Many researchers have found that developing countries' financial markets are partially or fully integrated into the world market. Bekaert and Urias (1996) suggest that Emerging markets do correlate with the world market returns after liberalization. Tai (2007) found that stock markets for India, Korea, Malaysia, Philippines, and Thailand were segmented from the world capital markets prior to their official liberalization period, but have become fully integrated into the world market since. Tai (2007) employed a GARCH –in- mean model in his study. Employing a GARCH model, Billio et al (2010) found a strong linkage between Asian equity markets and the US market. Collins et al (2003) found that most African markets, except Egypt and South Africa, were not fully integrated into the world market and hence did not suffer from contagion during the Hong Kong financial crisis in October, 1997. Bekaert and Harvey (1995) found, using a regime switching model of integration versus segmentation, that contrary to generally held assumption that financial markets integrate over time, the countries they studied became rather less integrated into the world market over the years. The results of De Santis and Imrohoroglu (1997) were inconclusive as to whether market liberalization has a direct impact on market integration or not. Eichengreen et al (2002); Bordo et al (2001) also posited that capital mobility is on the ascendancy as a result of the

liberalization and integration thereby increasing the transmission of shocks across markets. Bekaert et al (2002b) reached some interesting conclusions with respect to liberalization and integration. The found that integration does not lower volatility but rather increases volatility. Further, after liberalization and integration, markets tend to become more sensitive to the factors of the world. This implies that correlations in some cases are more than doubled. However, they explain that this does not mean that the benefits of diversification disappear since the increased correlations are still insignificant as compared to correlations between the developed markets. Samarakoon (2011) examined the impact of the recent US financial crisis on Frontier Emerging markets by constructing shock models. He finds that the Frontier Emerging markets exhibit inter-dependence and contagion to US shocks.

3.2.1 Barriers to Integration of Financial Markets

Financial integration has its own barriers and Bekaert et al (1995) identified legal barriers as the foremost among them. Legal barriers may stem from: the diverse legal status of foreign and domestic investors, "foreign ownership restrictions and taxes on foreign investment". Moreover, differences in information, accounting standards, and investor protection may serve as a hindrance to stock -market-integration. Further, Emerging Market Specific Risks (EMSRs) may scare away foreign investment resulting in de facto segmentation. Emerging markets are known to be susceptible to: liquidity risk, political risk, economic policy risk, poor credit rating, high and variable inflation, exchange rate controls, lack of sufficient cross-listed securities and currency risks. Bekaert et al (1997) established that particularly, political risk to be priced in emerging market securities. Nishiotis (2002) concluded that indirect barriers and EMSRs often have more significant pricing effects than direct barriers to integration.

3.2.2 Measuring Market Integration

There are diverse approaches to measuring integration in the literature. One known method is by investigating the market's regulatory framework. However, Bekaert et al (1995) emphasizes that measuring market integration from the market's regulatory framework point of view is narrow and may not project the

true view of the market considering that other indirect factors also immensely affects market integration. An example of this approach is used by Edison and Warnock (2001) in which they proposed the use of the International Finance Corporation (IFC) Investable Indices. These Indices however, takes into account foreign ownership to the market capitalization represented by the IFC Global indices. It also takes into account gradual liberalizations in countries where foreign ownership restrictions were gradually relaxed over a period of time. To avoid the problems associated with this method of measuring integration, Bekaert and Harvey (1995) employed a regime switching model of integration versus segmentation. In the study, Bekaert and Harvey came to the conclusion that contrary to generally held assumption of co- integration, the countries studied became less integrated over time. Carrieri et al. (2007) studied eight Emerging markets for a period of 24 years and they found that local risk is the most important factor in explaining "time-variation in Emerging market expected returns." Global risk was noted to be conditionally priced for three countries.

Bekaert and Harvey (2000) employed bilateral capital flow data together with the IFC returns index to determine the percentage of U.S. holdings of 16 Emerging market equities with respect to the local market capitalization. They contrasted the percentage of holdings in 1980 and 1990 then the pre and post liberalization dates. The results show that *the more liberalized a market, the more the influx of foreign investors* and hence *the more integrated the market*.

Further, other multivariate GARCH models can be used to model integration and these include the diagonal VECH model proposed by Bollerslev et al. (1988), the constant correlation model by Bollerslev (1990), the factor ARCH (FARCH) model by Engle et al. (1990), and the BEKK model proposed by Engle and Kroner (1995). Tai (2007) for instance used the BEKK model to examine integration between six (6) Asian countries and find that all the markets are integrated into the world market after liberalization.

3.3 Spillover

The onset of technological advancement in financial markets across the globe emphasizes that returns and volatility on one market may spread to markets in different regions or continent (global spillover). Advanced technology gives rise to quick dissemination of information both locally and internationally. Moreover, news such as that relating to macro-economic indicators is quickly transmitted to another country faster and easily if there is real-linkages between countries. Consequently, shocks in one market may force investors to cautiously liquidate their portfolios in other countries. These scenarios and paths describe what is termed as spillover- effects.

Gebka et al (2007) studied returns and volatility spillovers between Emerging capital markets of Central and Eastern Europe, Latin America, and South-East Asia countries. They identified evidence of both intra- and inter-regional spillovers. They found that common factors play an important role in the intra-regional interdependencies. Employing a bivariate EGARCH model for Japan and Asian market Miyakoshi (2003), modeled the returns and volatility spillovers from Japan and the US to seven Asian equity markets. It was evident that in terms of returns, the US market influenced the Asian market. On the other hand, the Japan market affects the Asian markets with respect to volatility. Zhou et al (2012) investigated the volatility spillover between the US market and the Chinese market and found a limited spillover especially during the 2008 subprime crisis and this they assumed that it was the result of the restrictions on foreign investment imposed by the Chinese Government.

Beirne et al (2010) employed a Tri-variate VAR-GARCH (1, 1)-in-mean model to examine the global and regional spillover for 41 Emerging markets in Asia, Europe, Latin America and Middle East. They concluded that spillovers from regional and global markets are present in most of the Emerging markets. Singh et al (2010) also examined the same markets as Beirne et al (2010) described above using VAR (15) to model returns spillover and AR-GARCH to model volatility spillover. Included in the sample countries are Egypt, Morocco and Tunisia which

are African markets but are classified as Emerging. They found greater regional influence among Asian and European stock markets.

3.4 Contagion Effects

Contagion, as defined in the literature is a bit narrower, simple and vague especially with regards to developing markets. They argue that stock markets are very volatile in developing markets and for that matter the co-movements within these markets during times of crisis might be just coincidental. Forbes and Rigobon (2002), thereby define "*contagion as the increase in the probability of crisis beyond what could be foreseen by the linkages between fundamentals*". They posit that stock markets in countries with similar fundamentals would definitely move together no matter the period; hence contagion should be the excess crisis beyond the expected crisis level for which the fundamentals cannot explicitly explain. Contagion therefore, is a level of correlation over and above market expectations. In similar lights, Tai (2007) in his study on contagion during 1997 Asian crisis controlled for fundamentals and Purchasing Power Parity (PPP) as well. Edwards (2000) also explained contagion as the instance in which the degree of international transmission of shocks far exceeds market expectations.

Bekaert et al (2003a) employed a model that allows for time-varying expected returns and time-varying risk loadings for their sample. Their found no evidence of contagion effect resulting from the Mexican crisis. Meanwhile, they found significant increases in residual correlation, especially in Asia, during the Asian crisis. Dungey et al (2004) employed a different methodology and found similar results for Asia and that currency risk account for equity market contagion. Connolly (2003) also established that foreign market returns exert much influence on the subsequent domestic market returns. Collins et al (2002) studied the African markets and found evidence to suggest that most African markets did not experience any contagion effects during the Asian crisis in 1997 with the exception of South Africa and Egypt. They employed a correlation coefficient adjustment process in their study. Carrieri et al. (2007) also identified local risk as the most dominant factor that accounts for time variation in Emerging market expected returns. However, global risk is also conditionally priced. Samarakoon

(2011) concludes that there is a "*bi-directional, yet asymmetric, interdependence and contagion in emerging markets, with important regional variations*". He identified contagion isdriven more by Emerging market shocks. Further, frontier markets are interdependent on the U.S. shocks as well as prone to contagion from U.S. shocks. With the exception for Latin America, there is no contagion from U.S. to Emerging markets. But there is contagion from Emerging markets to the U.S. Ahlgren et al (2010) using the co-breaking model of co-movements, found that Emerging stock markets did co-break after the World Trade Center terrorist attacks in 2001 leading to the conclusion that there are short-term linkages between the markets but not contagion.

3.5 Modeling Contagion

There is no single consensus on the definition of contagion in academia and so also there is not a single method that all and sundry agree to be the tried and tested method for measuring contagion.

3.5.1 Correlation (Excess movement)

Forbes and Rigobon (2002) measured contagion by comparing the cross-market linkage at times of stable period and linkage at crisis period. They employed the correlation coefficient as a measure for the linkage between stock markets. This method assumes unconditional correlation coefficients (constant coefficient). However, it can be argued that correlations between markets vary and therefore not constant; hence diminishing the accuracy of this method. Also correlation coefficient is biased in high volatility regimes emphasizing the point that the results might be misleading considering that volatility also account for contagion. Shocks or crisis between markets, like a virus is not transferred from one entity to another in a symmetric way.

3.5.2 Mean Contagion

Baur (2003) employed a model that incorporates the change in transmission of a shock in one market to another in the same region or a global shock to other

markets. The model can be estimated using a maximum likelihood method, OLS, or a GARCH process using the ML method.

3.5.3 Volatility Contagion

In crises period it is expected that the uncertainty or risk associated with the returns of an asset increases significantly. Based on this assumption, Baur (2003) measured contagion by distinguishing normal volatility in normal period from abnormal volatility in crisis period. This method exhibit some resemblance to volatility spillover as discussed in Lin et al., 1994 and Edwards, 1998. Edwards (1998) measured volatility spillover by using GARCH (1, 1) specification with an additional exogenous regressor that affects volatility. In the case of any significant effect of the exogenous variable on the conditional volatility signifies contagion or volatility spillover. However, volatility contagion according to Baur (2003) measures the changes in volatility spillover and can be estimated using the EGARCH model.

5. METHODOLOGY

5.1 ARCH Model

Over the past few decades, economists have set out to develop an analytical framework to deal with uncertainty and this has as its aim to model second and possibly higher moments. Engle is one of the pioneers in this field and Engle (1982) is one of the most commonly cited literature used to model second moments. According to Engle (1982) the second moments are unobservable and can be modeled by functional form for the conditional variance**.** This can take into account the first and second moments simultaneously. This method of modeling uncertainty - particularly second moments is termed as the Autoregressive Conditional Heteroskedasticity (ARCH) model. The ARCH model assumes that the conditional variances depend on elements in the information set in an autoregressive manner (Engle 1982). ARCH also distinguishes between the conditional and unconditional variances and it allows the conditional variance to change over time with respect to the past errors (Engle 1982).

5.2 GARCH Model

The ARCH process exhibits certain properties that makes analysis cumbersome such as the need for a long lag in the conditional variance equation. Also the problem of non-negativity constraints persist and usually this requires a fixed lag structure to get rid of these hindrances (Engle 1982). These shortcomings with the ARCH process necessitated the need for an improved model that is more flexible in the lag structure and this resulted in the GARCH model proposed by Bollerslev (1986). In a GARCH model, the variance term depends upon the lagged variances as well as the lagged squared residuals - hence allowing persistence in volatility with a relatively small number of parameters.

The linear ARCH model of Engle (1982) was generalized by Bollerslev (1986) through modifications that paved way for previous conditional variances to appear in the current conditional variance equation. This new model is referred to as the Generalized ARCH, or GARCH model.

5.3 Multivariate GARCH Models

Multivariate ARCH (M-ARCH) models allow the "variances and co-variances to depend on the information set in a vector ARMA manner" and are mostly applied to multivariate financial models which require both the variances and co-variances to be modeled (Engle and Kroner 1995). In the same light, a multivariate GARCH (M-GARCH) "*model allows the conditional variance-covariance matrix of the errors ε_t to depend on elements of the information set*". This means that the multivariate ARCH and GARCH models also specify equations for how the co-variances move over time. There are mainly three (3) types of multivariate GARCH models and these are VECH, Diagonal VECH and the Diagonal BEKK model.

Overview of the Various Multivariate GARCH Models

Even in the simplest form of cases, a bivariate VECH model estimation is a cumbersome task. Consider the basic VECH model below;

$$u_t | \Omega_{t-1} \sim N(0, H_t), \text{...} (1)$$

$$VECH\ (Ht) = C + AVECH\ (\beta_{t-1}\, \beta'_{t-1}) + \text{ BVECH } (H_{t-1}) \ldots\ldots(2)$$

The simple bivariate VECH model above had a 2x2 conditional variance-covariance matrix, Ꞷ is a 2x1 disturbance vector, C is a 3x1 parameter vector, A and B are 3x3 parameter matrices. This model requires that 21 parameters are estimated and this is shown below;

$$H_t = \begin{bmatrix} h_{11t} & h_{12t} \\ h_{21t} & h_{22t} \end{bmatrix} \quad \Omega_t = \begin{bmatrix} u_{1t} \\ U_{2t} \end{bmatrix} \quad A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{33} \end{bmatrix} \; B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{33} \end{bmatrix}$$

$$C_t = \begin{bmatrix} C_{11} \\ c_{21} \\ c_{31} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

As mentioned earlier, even in a bivariate scenario, an unrestricted VECH model yields 21 parameters emphasizing that as the number of assets increase, the estimation of the model may become difficult and voluminous to interpret. With this in mind, Bollerslev et al (1988) restricted the conditional variance-covariance

in a form so that A and B as shown in equation (2) is diagonal and hence will reduce the number of parameters to 9. This is termed as the diagonal VECH model. The diagonal VECH does not give a guarantee that the covariance matrix will be positive since a variance-covariance matrix must be positive and semi-definite (Brooks 2008). It should be noted that when non-linear optimization technique is employed as in the case of all multivariate GARCH models, the resulting matrix may not be positive definite and that would mean that the variance could be negative hence breaching the non-negativity constraints.

The insight into the above mentioned shortcomings of the VECH and diagonal VECH model gave rise to the diagonal BEKK model which addresses the difficulties associated with the previous two models (Engle and Kroner 1995). The diagonal BEKK model ensures that the *H* matrix is always positive.

$$H_t = W'W + A'H_{t-1}A + B'\Omega_{t-1}\,\Omega'_{t-1}\,B \ldots\ldots\ldots\ldots(4)$$

Where A, and B are 2x2 matrices of the parameters and W is an upper triangular matrix of the parameters. The quadratic form of the terms on the right hand side ensures that the covariance matrix is always positive definite. It can also be seen that the number of parameters reduces significantly to eight (8) and this is shown in the conditional covariance matrix below;

$$H_t = C_0'C_0 + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1},\varepsilon_{2,t-1} \\ \varepsilon_{1,t-1},\varepsilon_{2,t-1} & \varepsilon^2_{2,t-1} \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix}' H_{t-1} \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} \ldots(5)$$

5.3.1 The Diagonal BEKK Model

Comparatively, the diagonal BEKK model economizes on parameters through the imposition of restrictions both across and within equations than the VECH model. As depicted above, the BEKK model uses only eight parameters in the bivariate scenario whiles the VECH model uses 18 to 21 parameters (excluding and including constants respectively).The BEKK model will be positive definite even under very weak conditions. The same cannot be said about the VECH models. The model also inculcates “all positive definite diagonal representations and nearly all positive definite VEC representations” (Engle and Kroner 1995). BEKK

model is proven to be a convenient model for the estimation and for analysis of simultaneous equations systems (Engle and Kroner 1995).

5.3.2 Bivariate VAR-GARCH BEKK model

In this study, the returns and volatility dynamics between African equity markets, the US and World market are examined using a Bi-variate VAR-GARCH-BEKK model. Basically VAR-GARCH (1, 1) - BEKK model is specified in this study. Inputted into the models are the returns of each of the market indices under consideration lagged one period.

$$\begin{bmatrix} r_{1,t} \\ r_{2,t} \end{bmatrix} = \begin{bmatrix} a_{1,0} \\ a_{2,0} \end{bmatrix} + \begin{bmatrix} \beta_{1,1} & \beta_{1,2} \\ \beta_{2,1} & \beta 2 \end{bmatrix} \begin{bmatrix} r_{1,t-1} \\ r_{2,t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1,t} \\ \mu_{2,t} \end{bmatrix} \text{.....(6)}$$

$$u_t \left| \Omega_{t-1} \sim N(0, H_t), \right. \text{.....(7)}$$

rt is an n×1 vector of adjusted daily returns at time t for individual market under consideration. The vector μt captures the innovation for each market at time t as well as the n×n conditional variance-covariance matrix Ht. The market information lagged one period is denoted by Ωt-1. The n×1 vector is the constant.. The own and cross market mean spillovers is captured by the estimates of matrix β, which is the parameters of the vector autoregressive (VAR) term.

In the spirit of Engle and Kroner (1995), general conditional covariance matrix for VAR-GARCH (1, 1) - BEKK model is specified as depicted below;

$$Ht = W^{*'}{}_0 \; W_0^* + \sum_{i=1}^{p} A_{1k}^{*'} U_{t-1} U_{t-1}^{'} A_{1k}^{*} + \sum_{j=1}^{q} G_j^{*'} H_{i-j} G_j^{*} \text{....(8)}$$

Where W′ is a constant (n x n) positive upper triangular matrix, A (ARCH parameters) is the symmetric (n x n) matrix and captures the degree of innovation from market *i* to market j, G*′ (GARCH parameters) of the symmetric (n x n) matrix indicate the persistence in the conditional volatility between market *i* and *j*. The conditional variance equation consists of three distinct terms and these are;

Firstly, the ω_{ij} term which is the upper diagonal n x n matrix $W^{*\prime}{}_0 W^{*}{}_0$ is presented. Secondly the a_{ij} elements of the symmetric n x n matrix **A*** (ARCH

term) which captures the degree of innovation from market *i* to market *j* and thirdly the b_{ij} elements of the symmetric n x n matrix B which is the GARCH term captures the persistence in the conditional volatility between market *i* and market *j*.

According to Engle and Kroner (1995), the BEKK model can be estimated using the full information maximum likelihood or an instrumental variables estimator. *"The log likelihood function of the joint distribution is the sum of all the log-likelihood functions of the conditional distribution, i.e. the sum of the logs of the multivariate-normal distribution*" *Engle and Kroner (1995).* Letting L_t be the log-likelihood of observation *t, n* be the number of stock exchange and *L* be the joint log likelihood gives,

$$L = \sum_{t=1}^{T} l_t, \text{.....(9)}$$

$$L_t = \frac{n}{2} In(2\pi) - \frac{1}{2} In \left|H_{r\,f,t}\right| - \frac{1}{2} v_t^{'} H_{r\,f\,,t}^{-1} v_t \text{.....(10)}$$

The log likelihood method above can be maximized using the BHHH algorithm. There are many nonlinear maximization methods in existence; however Engle and Kroner (1995) prescribes the Berndt, Hall, Hall and Hausman (BHHH) algorithm since it is convenient and useful in practice. The BHHH algorithm is an iterative method of calculating the optimal parameters. However, in this study, BFGS (Broyden, Fletcher, Goldfarb, Shanno) algorithm is used since it works better with RATS software.

The Ljung-Box Q-statistic which is distributed as χ^2 with (p – k) degrees of freedom, where k is the number of explanatory variables is is used to test for independence of higher relationships as shown in volatility clustering by the MGARCH model Huang and Yang, (2000).

4. DATA

The data used in this study stretches over a period of fifteen (15) years starting from 19th February 1998 to 18th February, 2013 generating 3913 observations. The daily price data for the various indices are used in this study namely: MSCI

benchmark index for US, MSCI world index, MSCI BRIC countries index and MSCI Emerging market index. Also: the Kenya, South Africa, Mauritius, Tunisia, Egypt, Zambia and Morocco stock indices were gathered from DataStream and made available by the various stock exchanges under consideration. The diverse sources of data collection have little or no effect on the ability to compare the data. Conversely, the high correlation between these indices makes it acceptable to compare them despite the difference in sources. The price data is then transformed to a simple percentage returns with the formula;

$$Ret = \left[\frac{P_{t-}P_{t-1}}{P_{t-1}}\right] * 100$$

4.1. Adjusting for Thin Trading

Thin trading may be defined as the non-trading of shares or inconsistency of trading. It is established that thin trading may potentially lead to serial correlation in the returns series. This may result in biasness of the result and hence any inferences made will be inaccurate and misleading. Biasness maybe introduced in that prices recorded at the end of the trading period may reflect trading that occurred prior to the recording period. In the spirit of Miller et al (1994); Appiah-Kusi et al (2003); Mlambo et al (2005), this study adjusts for thin trading through a Moving Average (MA) process which fixes the problem of non-trading. An AR (1) in the form (1) below will be run;

$$r = \alpha + \beta r_{t-1} + \varepsilon_t$$

Using the residuals from the above equation, adjusted returns is calculated as follows;

$$\boldsymbol{r_t^{adj} = \frac{\varepsilon_t}{(1-\beta)}}$$

r_t^{adj} is the returns at time *t*, adjusted for thin trading. This model assumes that the non-trading adjustment is constant over time. This holds true in the case of highly developed and liquid markets. However, for Emerging and Frontier Emerging markets (African markets), it is assumed that the needed adjustment will change over time thereby the best way to estimate the above model is recursively.

4.1.1 Recursive Identification

Recursive Identification describes the estimation algorithms where the estimated parameters are updated for any additional observation. In other word, recursive identification is used when the need for a new parameter estimate for each additional observation. Recursive identification is primarily as in this case used to model system dynamics that vary over time. It is assumed that the estimate obtained for N observations is employed in the calculation of N+1 observations. This method thereby allows for unique betas for each observation used in calculating the adjusted returns as shown in the formula above.

4.2 Descriptive statistics

Table (2) depicts the descriptive statistics on the data used in the empirical analysis. A careful examination of the skewness and kurtosis shows that the data is not normally distributed. Skewness measures the extent of non-symmetry around the mean of a distribution whiles kurtosis measures how fat the tail of the distribution are. Fat-tails implies that the data is leptokurtic; a common characteristic of financial data which exhibits excess peakedness at the mean. This feature calls for the use of non-linear models and in this case VAR-GARCH-Bekk model. These are termed as the standardized third and fourth moments of a distribution. A normally distributed series is not skewed and has coefficient of kurtosis of 3. As shown in the table all the countries indices have excess kurtosis emphasizing that the data exhibits fatter tails. Also, most of the indices are skewed to the left or negative with the exception of Kenya, Zambia, Mauritius and Tunisia which are skewed to the right or positive. Practically it means that

positive shocks are more prevalent on the Kenya, Zambia, Mauritius and Tunisia equity markets than negative shocks. Further, it also shows that investors have higher probability of reaping positive results in these markets that the others with negative skewness. This is confirmed by the Jarque-Berra test for normality. The null hypothesis for JB test of normality is rejected for all the indices meaning that the distribution is not normal.

The standard deviation as a measure of volatility or risk shows that Zambia is the most volatile market with a standard deviation of 1.87 and this may be attributable to the fact that the equity market of Zambia is very new and investors may be wary of its long-term survival. Egypt is the second most volatile country with a standard deviation of 1.84 which obviously is attributable to the political uprisings in the country over the last few years and the unstable nature of the country. South Africa comes third with a standard deviation of 1.79 whiles the other series are 1.6 or below.

The Adjusted Dickey Fuller test is used to test for the presence of unit root in the data whiles KPSS test for stationarity. The joint use of stationarity and unit root tests is referred to as confirmatory data analysis. The ADF has a null hypothesis of the presence of unit root and as shown in the table, all the indices are statistically significant at the 1% significant level meaning that the null hypothesis is rejected in favor of the alternate hypothesis of no unit root presence in the data. The KPSS test on the other hand has a null hypothesis of stationarity and as depicted in the table, all the indices were statistically insignificant hence the null hypothesis is not rejected meaning the data is stationary.

LB in the table represents the Ljung-Box *Q*-statistics for residual serial correlation up to the 15th order. The LB statistics show that there is autocorrelation in returns for all the indices and this signifies the presence of ARCH effects and this is confirmed by the ARCH test. The ARCH test is a Lagrange multiplier (LM) test for autoregressive conditional heteroskedasticity (ARCH) in the residuals (Engle 1982). The *Obs*R-squared statistic* is Engle's LM test statistic, computed as the number of observations multiplied by the $\boldsymbol{R^2}$ from the test regression. All the indices are statistically significant at 1% significant level and have large values

which signify the presence of ARCH effects in the data hence justifying the model selection for the analysis.

Kenya Data Further Analysis

The graphical presentation of the Kenyan market looked abnormal in that it shows an extremely high returns in the year 2000 and then the subsequent returns are almost level without any visible fluctuations. To verify that the correct data is used in the analysis, the price data from MSCI is collected and a correlation ran with the data used in the study which is collected from DataStream. As shown in the table below, a correlation coefficient of 0.91 proves that our data for Kenya can be trusted. However, upon careful examination, it is found that the Kenyan data contains some extreme outliers on the 11th January, 2000 and 12th January, 2000 and these affects the graphical presentation of the Kenyan market. A better solution to get rid of the outliers is to find the average price and replace these outliers with it. After this manipulation, the graphical representation became normal.

Table 12: Correlation of MSCI and DataStream, Kenya Data

	MSCI	*DataStream*
MSCI	1	
DataStream	0.912456363	1

Table 13: Descriptive and Other Statistics

	BRIC	EM	US	WORLD	KENYA	MOROCCO	ZAMBIA	MAURITIUS	TUNISIA	SA	EGYPT
Mean	*0.610119*	*0.537075*	*0.29637*	*0.23263*	*0.12980*	*0.40640*	*1.01704*	*0.50802*	*0.54825*	*0.83630*	*0.47132*
Median	*0.1001850*	*0.11123*	*0.02455*	*0.059629*	*0.000000*	*0.016579*	*0.000000*	*0.000000*	*0.021264*	*0.099937*	*0.011844*
Maximum	*14.46189*	*10.59764*	*11.67535*	*9.523239*	*62.58993*	*7.374357*	*16.39967*	*7.968750*	*4.826863*	*13.75700*	*30.18969*
Minimum	*-11.23008*	*-9.51119*	*-9.07519*	*-7.06315*	*-38.93944*	*-10.19323*	*-12.81175*	*-7.06221*	*-6.15963*	*-12.06064*	*-40.90254*
Std. Dev.	*25.96984*	*20.85071*	*21.07339*	*17.40596*	*26.15466*	*15.77440*	*30.15371*	*13.06205*	*11.34282*	*29.01505*	*29.72566*
Skewness	*-0.07679*	*-0.34177*	*-0.01125*	*-0.17053*	*11.24785*	*-0.20262*	*0.728489*	*0.245970*	*0.057129*	*-0.12172*	*-1.77719*
Kurtosis	*10.59916*	*9.956330*	*10.50321*	*9.799638*	*657.1712*	*11.03862*	*12.62227*	*16.62814*	*8.265028*	*8.121948*	*98.20156*
Jarque-Bera	*9419.046***	*7965.850***	*9179.038***	*7557.209***	*69854551***	*10562.43***	*15441.82***	*30320.58***	*4521.728***	*4286.955***	*1479762***
ADF (T-Stat)	*-52.18516***	*-49.46009***	*-67.46723***	*-44.18093***	*-44.44441***	*-54.39588***	*-48.04722***	*-25.36652***	*-38.87953***	*-59.26789***	*-54.63251***
KPSS (LM Stat)	*0.143129*	*0.102385*	*0.078877*	*0.066760*	*0.249917*	*0.30111*	*0.263863*	*0.215462*	*0.219111*	*0.095327*	*0.146734*
ARCH(LM Test)	*1189.624***	*1113.169***	*1082.364***	*1164.097***	*719.5654***	*491.9035***	*170.9633***	*765.1698***	*472.8574***	*878.4693***	*66.3774***
LB15	*32.645***	*37.400***	*24.654***	*27.942***	*18.631***	*18.234***	*32.074***	*39.647***	*18.950***	*36.258***	*68.249***
Sum	*148.0592*	*130.3348*	*71.92252*	*56.45357*	*31.50090*	*98.62324*	*246.8105*	*123.2840*	*133.0444*	*202.9471*	*114.3783*
Sum Sq. Dev.	*10147.62*	*6541.345*	*6681.811*	*4558.496*	*10292.56*	*3743.959*	*13680.66*	*2567.131*	*1935.834*	*12666.95*	*13295.00*
Observations	*3913*	*3913*	*3913*	*3913*	*3913*	*3913*	*3913*	*3913*	*3913*	*3913*	*3913*

** denotes statistically significant at 1% significant level. ARCH (LM) is the Lagrange multiplier test for ARCH up to lag 15, LB_{15} is Ljung-Box Q-statistic at lag 15 and ADF denotes Augmented Dickey Fuller for unit root test. KPSS denotes Kwiatkowski–Phillips–Schmidt–Shin test for stationary process. KPSS Lagrange Multiplier is not significant and hence we cannot reject the null hypothesis of stationary. Standard Deviation is annualized and so is the mean.

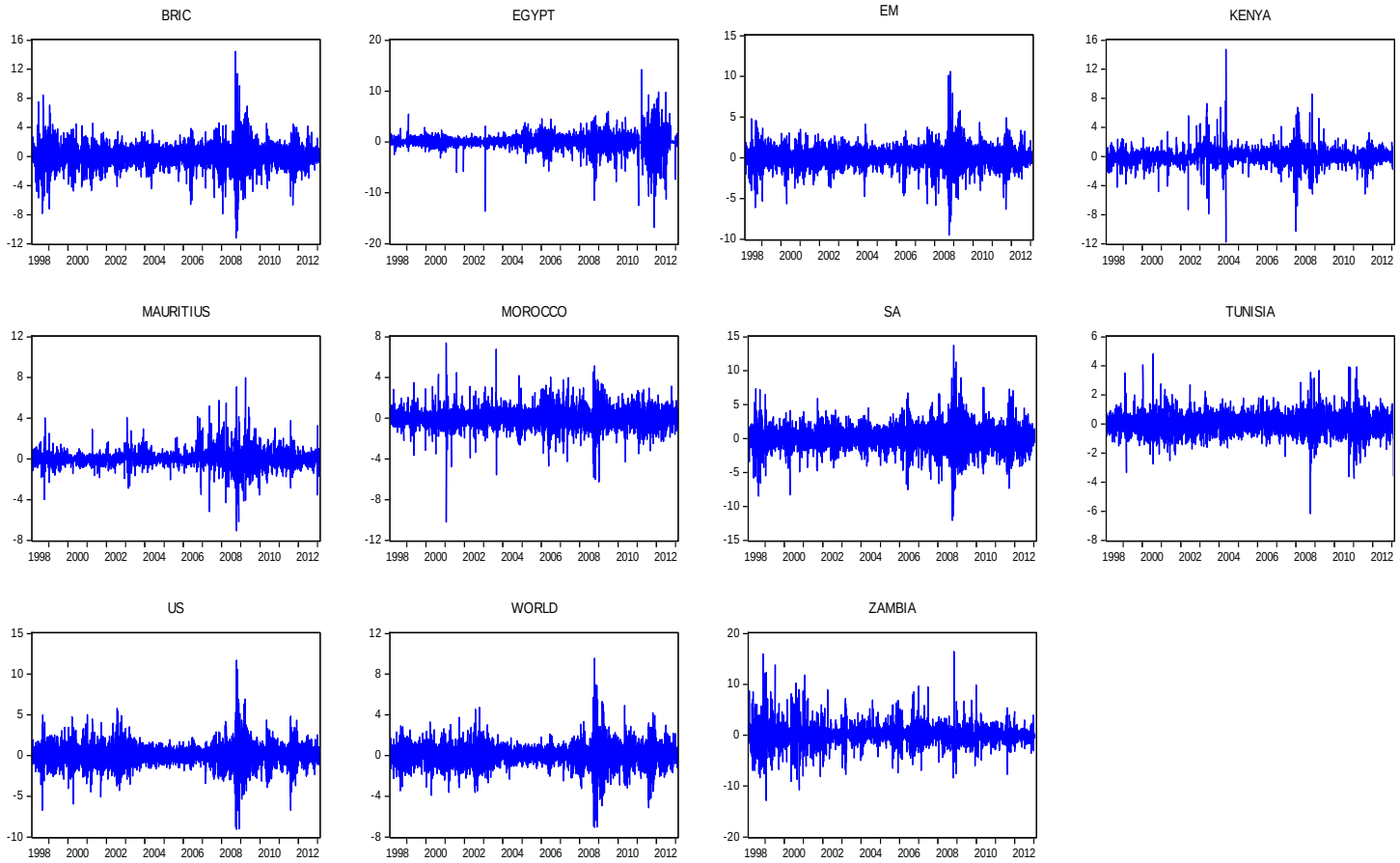


Fig 4: Graphical Presentation of the Series

4.2.1 Volatility Clustering

Volatility clustering defines the instance whereby financial data exhibits volatility in bunches. It can be explained to be the tendency in which large returns of either sign are expected to follow larger returns and small returns of either sign to follow small returns. This is attributable to the fact that information set which is the main driver of financial markets also appear in bunches rather than being spaced evenly. Volatility clustering is a very common feature of financial data and it is one of the main motivations for the use of non-linear models which take into account this feature. With this in mind, the VAR GARCH – BEKK model is deemed appropriate for this study.

The figure above shows that all the series under consideration exhibit some form of volatility clustering at one point in time. The MSCI benchmark index for the US as shown in the figure shows unusually high volatility clustering toward the end of the year 2008 and this can be attributed to the sub-prime crisis around that period. The MSCI world index, MSCI Emerging market index, and the MSCI BRIC index also show some spikes during the same period. Intuitively, it can be seen from the figure above that, the African countries that are quite correlated with the world market and the US market also exhibit high volatility clustering during the same time period. However, to be certain about the correlations, the next figure shows the level of correlations among the various series.

4.2.2 Correlations

Correlation measures the linear relationship between two variables or series. In other words, movement in the two variables is on average related with respect to the correlation coefficient. Correlation, however, does not mean that changes in one series or variable causes changes in the other variable. The table below shows the correlation coefficients between the various series under consideration.

Zambia is seemingly segmented from all the other markets in the study in that it has very low correlation with the other markets. The same applies to Kenya as well. South Africa is classified under Emerging markets index and more recently part of the BRICS countries. This undoubtedly emphasize that South Africa will be highly correlated with these two indices: the world and US indices. Within

Africa, South Africa is highly correlated with the Tunis market, Morocco, Egypt and Mauritius. As neighbors in the North of Africa, Morocco is highly correlated to Tunisia. Whiles as an Emerging economy, it is also correlated with the Emerging Market Index, BRIC and to a smaller degree, the world.

Table 14: Correlations

	ZAMBIA	SA	MOROCCO	MAURITIUS	KENYA	EGYPT	Tunisia	BRIC	EM	World	US
ZAMBIA	1										
SA	0.031177	1									
MOROCCO	0.001597	**0.237593**	1								
MAURITIUS	0.063468	**0.104237**	**0.107431054**	1							
KENYA	0.018339	0.061299	0.040090989	0.076077095	1						
EGYPT	0.029838	**0.121636**	0.092023516	0.069065284	0.045673	1					
Tunisia	0.027608	**0.250629**	**0.336286374**	**0.103694793**	0.097711	0.043178	1				
BRIC	0.058034	**0.630466**	**0.180636898**	**0.145306923**	0.087832	**0.150255**	**0.148502**	1			
EM	0.045316	**0.740533**	**0.203993379**	**0.159709450**	0.088692	**0.177394**	**0.182706**	**0.893182**	1		
World	0.058502	**0.61912**	**0.194712202**	0.096030725	0.038346	**0.102297**	**0.165335**	**0.645207**	**0.681906**	1	
US	0.043558	**0.352588**	0.068379716	0.031751769	0.01361	0.045792	0.021175	**0.461939**	**0.442357**	**0.886219**	1

5. EMPIRICAL RESULTS

The empirical results section presents the results of the study and also answers the research questions posed in the introduction part of this study. Among other things, the study examines, "whether there exist international linkages between African and the World market after financial liberalization". Also, what are the returns and volatility dynamics between thinly traded African equity markets and its international counterparts? Stated differently, are there returns and volatility spillover effects between stock markets in African, the US and the world market? Finally, do stock markets in Africa provide the maximum benefits of portfolio diversification?

A bivariate GARCH – BEKK model is employed to find satisfying answers to the questions. Analysis of the seven African stock markets and their relationship with four main indices namely: the US stock index, the World index, the Emerging Markets index, and the BRIC index yielded (28) pair-wise models. The pair are:

1. *South Africa-BRIC, South Africa-EM, South Africa-World, South Africa-US,*
2. *Kenya-BRIC, Kenya-EM, Kenya-World, Kenya-US,*
3. *Morocco-BRIC, Morocco-EM, Morocco-US, Morocco-World,*
4. *Egypt-BRIC, Egypt-EM, Egypt-US, Egypt-World,*
5. *Zambia-BRIC, Zambia-EM, Zambia- US, Zambia-World,*
6. *Tunisia-BRIC, Tunisia-EM, Tunisia-US, Tunisia-World,*
7. *Mauritius-BRIC, Mauritius-EM, Mauritius-US, Mauritius-World.*

Daily total returns indices calculated by MSCI for the US, World, Emerging Markets and the BRIC markets are used in the analysis together with daily total returns from the various African stock markets from DataStream. The data spans from February 1998 to February 2013 with 3910 observations. A total of seven African countries mainly from the East, South and North Africa are sampled in this study.

This section of the study is arranged on a country by country basis and it is analyzed as presented in the tables below. Firstly, the matrix β in the mean equation, Eq. (1) is analyzed. The matrix β presents the returns dynamics between the African stock markets and the world, US, EM and BRIC indices. The diagonal parameters βii and βjj depicts the own returns spillovers or put differently, the returns spillovers within the market under consideration. On the other hand, the off-diagonal parameters βij and βji depicts the return spillovers across the markets and in this case the pair of markets under consideration. Next, the time-varying variance-covariance is analyzed and attention is focused on the matrices $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ shown in the tables below. These matrices capture the volatility dynamics within the respective markets and between the pair of markets under examination. The diagonal estimates in matrix γ shows the own ARCH effect or the ARCH effects within the specific market whereas the diagonal estimates in matrix δ captures the own GARCH effect. The off-diagonal estimates on the other hand present the cross-market shock transmission or volatility spillovers between the pairs.

5.1 Returns Spillover

5.1.1 Own Returns Spillover

First four parameters as depicted in the table below presents the matrix β in the mean equation. This part of the equation captures the linkages between the markets with respect to the returns. In the pair wise model (28 cases); it can be found that diagonal parameters βii is significant for all the markets with the exception of Tunisia, Morocco, and Zambia, which are highly insignificant. This suggests that the returns of the other four (4) markets namely: South Africa, Kenya, Mauritius, and Egypt is very dependent on their first lags or own past returns. Whereas, Tunisia, Morocco and Zambia do not dependent on its own past returns. In other words, shocks within South Africa, Kenya, Mauritius, and Egypt will have a very high influence on the returns dynamics in these markets than it would in Tunisia, Morocco and Zambia.

5.1.2 Cross Returns Spillover

On the other hand, the off-diagonal parameters βij and βji depict the return spillovers across the markets and in this case the pair of markets under consideration. South Africa receives about 19% of past returns spillover from BRIC group of countries. This is no surprising considering that South Africa is now part of the BRIC resulting in the new acronym BRICS. South Africa is also influenced by past innovations from Emerging market (8%), influenced massively by US past innovations of 57%. More so, the past innovations from the world influences the South Africa market returns by 64%. The evidence of returns spillover between South Africa, the world index and the US index indicates that there are strong linkages between these markets. Conversely, the South African market exports past return innovations to the Emerging markets emphasizing that there is a bi-directional relationship between South Africa and Emerging market index. The size of the South Africa market with respect to market capitalization and liquidity in Africa and the world at large explains the high level of return spillover between the South Africa, the US and the world market.

At the 10% significance level, Tunisia receives a meager amount of past innovations (1%) from the BRIC group of countries. Tunisia receives nothing from the rest of the markets. It however, exports past innovation to the US (4%). This is an indication that the Tunisian market is still very much segmented and isolated from other world markets.

Egypt as one of the major markets in Africa with respect to market capitalization receives past innovation from the Emerging markets (8%), from the US (9%), world (11%) and BRIC (6%) but do not export to any of the markets under consideration. It can be seen that the Egypt market is influenced highly by both the US and world market signaling the presence of integration between these markets.

Receiving past return innovations from the US, BRIC and EM at 3%, Morocco, also receives 4% of past return innovations from the world market showing a little sign of integration of the Morocco market with the world and US markets. It also exports around 3.5% of past return innovations to the US.

The returns of the Kenya market is influenced by the return past innovations from the Emerging market (5%), US (16%), and the world market (24%). The Kenya market can be said to be highly integrated with the US and World market. Even though the Kenya markets do not receive past innovations from the BRIC, it exports to the BRIC (5%), US (3%), EM (7%) and world (1%).

Mauritius market receives return past innovation from the BRIC (2%), EM (3%), US (3%) and world (6%). It however exports past return innovation to the world only (3%). Mauritius thereby is to an extent integrated with the world market as well as the US market. Finally, there exist a unidirectional relationship between Zambia and all the markets. It receives from all the markets but exports to none.

With respect to returns or mean, South Africa, Egypt, Kenya are highly integrated with the US and World market while Morocco Zambia and Mauritius are weakly integrated with these markets. Tunisia is completely segmented from the US and World market.

5.2 Volatility Spillover

The time-varying variance-covariance is analyzed and attention is focused on the matrices $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ as shown in the tables below. These matrices capture the volatility dynamics within the respective markets and between the pair of markets under examination. The diagonal estimates in matrix γ shows the own ARCH effect within the specific market whereas the diagonal estimates in matrix δ captures the own GARCH effect. The off-diagonal estimates on the other hand present the cross-market shock transmission or volatility spillovers between the pairs.

5.2.1 Own Shocks and Volatility Spillover

The estimated diagonal parameters, γ ii, γ jj and δ ii, δ jj as depicted in the tables below show that all the markets have all the parameters to be statistically significant implying that own past shocks and volatility have a major impact on the conditional variance of all the seven African markets employed in this study.

5.2.2 Cross Shock Spillover (*γ parameter*)

The off-diagonal estimates γ and δ, on the other hand present the cross-market shock transmission or volatility spillovers between the pairs. As shown in the tables below, South Africa receives shock transmission from all the indices under consideration: BRIC (3%), EM (14%), US (3%) and the world (6%). Moreover, South Africa transmits a greater amount of shocks to the BRIC countries (86%), and the world 16%. It can be inferred that the South African market is linked to the world market and the US market. But more importantly, the results signify the important role of the South African market to the BRIC countries and the higher linkages between South Africa and: Brazil, Russia, India and China.

Shock-transmission between the Tunisian market and the world market indices further strengthens the claim made earlier in spillover that the Tunisian market is highly segmented. The markets receives no shocks from any of the markets employed in this study neither does it export any shock to any of the indices analyzed.

Egypt exhibits some level of integration with the US market in that it receives some shock from the US market (1%) and exports shocks to the US and the world index. Morocco does not receive nor exports shocks to any of the markets in the studies. Kenya, like South Africa exhibits a very strong level of integration with all the indices in the study and especially with the US and the world indices.

Kenya received shock spillover from the BRIC (7%), EM (11%), US (12%) and the world (8%). It also exports shock volatility to all the markets under consideration especially the world index (54%), US (46%), EM (36%) and BRIC (37%). To buttress the inferences made with respect to the return spillover, the shocks volatility show that the Kenyan market is highly integrated with the world and the US markets.

Mauritius on the other mainly serves as source of shocks to BRIC (1%), EM (1%), US (2%) and world (3%). It only receives shocks from the EM index. Mauritius is

thereby less integrated with the world and US indices. Finally, the Zambia market also exhibits traits that identify it to be segmented from the world market. It receives shocks only from the EM and exports to the BRIC and EM.

5.2.3 Cross Volatility Spillover (δ parameter)

The off-diagonal estimates γ and δ, on the other hand present the cross-market shock transmission or volatility spillovers between the pairs. The parameter δ is next analyzed in the study to ascertain the level of volatility spillovers between the markets. In the corresponding table, it can be seen that the direction of movement between the shocks and volatility spillover between the indices are almost the same but in different magnitude. South Africa receives volatility spillover from all the indices except the BRIC and exports to all the markets. Egypt receives volatility spillover from the world index and exports to all except BRIC. Kenya receives volatility spillover from all the markets and exports to all the markets - underscoring a very high level of integration with the world and US markets. Tunisia, a much segmented market exports volatility to none of the markets and receives none from the other markets and so is Morocco. Zambia is as well segmented and exports no volatility to US or the world and receives none but exhibits regional integration though. Mauritius, uniquely exports only volatility spillover to the other markets without receiving any back.

From the analysis above, it can be summarized that out of the seven markets studied, three (3) are very integrated into the US and World market and these markets are: South Africa, Kenya and Egypt. On the other hand three (3) of the markets also exhibit traits of high level segmentation from the world and US markets. These markets are: Tunisia, Morocco and Zambia. Further, a very special case exists with respect to Mauritius in that it exports volatility to all the markets under consideration but receives none back which makes it difficult to classify as segmented or integrated.

5.3 Diagnostic tests

Panel B in the tables below presents Ljung-Box Q-statistic for 24 lags proves that there is no dependence in the standardized and squared residuals. This underscores the fitness of the GARCH model to the data.

5.4 Integration (RQ 1)

In brief, the research questions that formed the primary basis for the study are answered below: "***have the stock markets in Africa become integrated into world capital markets since liberalization? If yes, what accounts for the level of integration and if no, what account for the level of segmentation?"***

As indicated above, some markets in Africa namely: South Africa, Kenya and Egypt are very integrated with the world market and this may be attributed to such factors as the year of liberalization and this is evident when you consider for instance South Africa and Zambia. These two countries are both located in Southern part of Africa but have different financial liberalization dates. South Africa started financial liberalization in early 1980s whiles Zambia in the early 1990s. The case of South Africa can also be linked in part to the length of colonization. It gained independence in 1992 from Britain which implies that the British might have set up the necessary foundations for a sound, and solid financial market. Moreover, sound and vibrant economy and similarity between these Emerging and the advanced economies account for the level of integration between these countries. *The rise in outward FDI flows from Africa in 2012 – to $14 billion – was mainly due to large flows from South Africa in mining, the wholesale sector and health-care products* (UNCTAD 2013). In the year 2012, Foreign Direct Investment (FDI) outflow from South Africa reached 4 billion dollars and this is a testimony of the vibrancy of the South African economy (UNCTAD 2013). South Africa boasts of 592 billion in Gross Domestic Product (GDP) and ranks number 26 in the world in the year 2012. Further, South Africa exports to China 14.5%, US 7.9%, Japan 5.7%, Germany 5.5%, India 4.5%, UK 4.1% as at the year 2012. Whiles South Africa imports from China 14.9%, Germany 10.1%, US 7.3%, Saudi Arabia 7.2%, India 4.6%, Japan 4.5% as at 2012

(World Factbook, 2012). These no doubt are supporting economical reasons for the level of integration with the US and World index.

Further, tighter trade relations between the countries is also accountable for the level of market integration in these countries. South Africa is noted for its mineral endowment especially gold and so is Kenya known for the export of coffee, tea and petroleum products. 7.1%, of Kenya's export goes to Netherlands, UK 6.7%, and US 5.8%. To an extent, these economies are linked hence justified if their stock exchanges are integrated. Egypt recorded a GDP of 548.8 billion dollars in the year 2012 and it is ranked27th in the world. More so, Egypt exports crude oil and petroleum products, cotton, textiles, metal products, chemicals and processed food. Egypt exports to US 8.2%, India 7%, Italy 6.7%, Saudi Arabia 6.3%, Germany 4.4%, France 4.2% as at 2012. On the other hand, Egypt imports from China 11.9%, US 8%, Turkey 5.3%, Italy 5.1%, Germany 4.6%, Russia 4.4%, India 4.1% as at 2012 (World Factbook, 2012). According the UNCTAD World Investment Report (2013), "*investor confidence appears to have returned to North Africa, as FDI flows rose by 35 per cent to $11.5 billion in 2012"*. It went on to say that much of the growth was attributed to the rise in investment in Egypt. These underscore the stronger influence Egypt has in the world and how attractive it is hence justifiable if it is very integrated with the US and World market.

More so, market regulations, restructuring of financial system, adoption of International Accounting Standards, enactment of investor protection laws and a host of other policies account for the level of integration between the markets. Finally, political stability is a common feature that sets all the three (3) markets that are integrated with the world market apart. A stable political environment attracts foreign investment whiles an unstable one drives even those already in the market away - resulting in capital flights. The countries integrated have been politically stable until the political clashes of 2007 in Kenya and the recent Arab uprisings especially in Egypt since 2011.

Conversely; Tunisia, Morocco, Mauritius and Zambia are segmented from the world market and it is only reasonable to expect that the absence of the factors

mentioned above accounts for the level of segmentation. Politically, these markets have been quite stable except the recent Arab uprisings that started from Tunisia and spread to other parts of the region. Liberalization start dates as mentioned above also may be accountable as in the case of Zambia. 177 million dollars of FDI outflows from Zambia, 361 million dollars from Morocco, 13 million dollars from Tunisia tell the whole story of weaker trade links and weaker economy of these countries as compared to the 4 billion of South Africa (UNCTAD 2013). Weaker financial and accounting structures may to an extend account for the level of segmentation. Conclusively, the desire of the governments to remain segmented may also be another reason.

5.5 International Linkages and spillover Effects (RQ 2)

Are there international linkages, return and volatility spillover between African, the world and US stock markets? If yes, which market is the source?

There are international linkages between African, the world and US stock markets. With respect to return spillover, the following results are observed: *"South Africa receives past innovations from the US and the world indices but export none hence making the US and world indices the source"*. Tunisia serves as the source in return spillover by exporting past innovation to the US. Egypt receives from the US and world but do not export to any of the markets under consideration. Morocco receives and exports past innovation to the US. Kenya also receives and exports past innovation from and to the US and the world market. Mauritius market receives past innovation from the US and world. It however exports past innovations innovation to the world only. There exist a unidirectional relationship between Zambia and all the markets. It receives from all the markets but exports to none. Hence it can be said that returns wise, there exist strong linkages between South Africa, Egypt, Kenya and the US and World market. Morocco, Zambia has seemingly a weaker linkage with the US and the World market. Tunisia is totally segmented from the US and the World market with respect to returns spillover.

However, with respect to volatility spillover, South Africa receives volatility spillover from both US and the world. Egypt receives volatility spillover from the world index and exports to both US and world. Kenya receives volatility spillover from all the markets and exports to all the markets underscoring a very high level of integration with the world and US markets. Tunisia, a much segmented market exports volatility to none of the markets and receives none from the other markets and so is Morocco. Zambia is also segmented and exports no volatility to US or the world and as well receives none but exhibits regional integration though. Mauritius, a unique case, only exports volatility spillover to the other markets without receiving any back.

In summary, South Africa, Egypt and Kenya are strongly linked with the US and World market in terms of volatility spillover. Zambia, Tunisia, Morocco are totally segmented from these markets. Whiles Mauritius is partially segmented since it only exports volatility spillover to the US and the World market.

Table 15: GARCH (1,1) results, South Africa

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations

	SOUTH AFRICA - BRIC			SOUTH AFRICA - EM			SOUTH AFRICA - US			SOUTH AFRICA - WORLD		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	-0.1661	0.0211	0.0000	-0.2259	0.0182	0.0000	-0.2494	0.0189	0.0000	-0.3462	0.0198	0.0000
β_{ij}	0.1871	0.0220	0.0000	0.0769	0.0201	0.0001	0.5666	0.0273	0.0000	0.6429	0.0358	0.0000
β_{ii}	0.0129	0.0081	0.1108	0.0445	0.0105	0.0000	0.0123	0.0058	0.0326	0.0058	0.0055	0.2944
β_{ii}	0.0340	0.0155	0.0276	-0.0924	0.0162	0.0000	-0.0723	0.0170	0.0000	0.1085	0.0150	0.0000
ω_{ii}	0.8087	0.0467	0.0000	0.9721	0.0685	0.0000	1.1194	0.0523	0.0000	1.1037	0.0351	0.0000
ω_{ij}	-0.2353	0.0239	0.0000	-0.0569	0.0805	0.4794	0.0511	0.0260	0.0490	0.0387	0.0123	0.0017
ω_{ii}	0.0000	0.0833	1.0000	-0.2526	0.0297	0.0000	0.0692	0.0340	0.0419	0.0000	0.0391	1.0000
γ_{ii}	1.0713	0.0243	0.0000	1.0986	0.0328	0.0000	1.0694	0.0281	0.0000	1.0526	0.0315	0.0000
γ_{ij}	0.0292	0.0136	0.0317	-0.1368	0.0213	0.0000	-0.0274	0.0121	0.0235	-0.0596	0.0109	0.0000
γ_{ji}	-0.8638	0.0307	0.0000	-0.0405	0.0332	0.2218	0.0513	0.0588	0.3829	0.1555	0.0633	0.0141
γ_{ij}	0.2794	0.0158	0.0000	0.3412	0.0187	0.0000	0.2583	0.0109	0.0000	0.2727	0.0136	0.0000
δ_{ii}	0.3930	0.0343	0.0000	0.2728	0.0248	0.0000	0.4325	0.0359	0.0000	0.3218	0.0295	0.0000
δ_{ij}	-0.0100	0.0070	0.1522	0.0988	0.0146	0.0000	0.0164	0.0070	0.0195	0.0390	0.0074	0.0000
δ_{ji}	0.4989	0.0254	0.0000	0.5628	0.0504	0.0000	0.1783	0.0390	0.0000	0.5417	0.0460	0.0000
δ_{jj}	0.9524	0.0070	0.0000	0.8581	0.0164	0.0000	0.9578	0.0046	0.0000	0.9261	0.0095	0.0000
Panel B: Diagnostic tests												
LogLik	-15153.77			-14914.39			-14165.85			-13124.64		
LB_i	18.009			35.188			18.817			29.379		
LB_j	45.806			64.948			28.931			36.029		
LB^2_i	0.144			0.117			0.109			0.163		
LB^2_j	25.337			31.124			44.593			36.612		

Table 16: GARCH (1,1) results, Tunisia

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations

	TUNISIA - BRIC			TUNISIA - EM			TUNISIA - US			TUNISIA - WORLD		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.0175*	*0.0168*	*0.2997*	*-0.0178*	*0.0169*	*0.2930*	*-0.0194*	*0.0176*	*0.2694*	*-0.0205*	*0.0168*	*0.2223*
β_{ij}	*0.0119*	*0.0069*	*0.0828*	*0.0092*	*0.0066*	*0.1600*	*0.0135*	*0.0101*	*0.1832*	*0.0112*	*0.0117*	*0.3378*
β_{ji}	*0.0304*	*0.0282*	*0.2811*	*0.0053*	*0.0242*	*0.8259*	*0.0447*	*0.0164*	*0.0065*	*0.0124*	*0.0148*	*0.3996*
β_{jj}	*0.0219*	*0.0165*	*0.1852*	*0.0160*	*0.0159*	*0.3128*	*-0.0465*	*0.0163*	*0.0043*	*0.1405*	*0.0170*	*0.0000*
ω_{ii}	*0.1459*	*0.0187*	*0.0000*	*0.1422*	*0.0213*	*0.0000*	*0.1522*	*0.0209*	*0.0000*	*0.1515*	*0.0180*	*0.0000*
ω_{ij}	*0.0337*	*0.0157*	*0.0318*	*0.0674*	*0.0403*	*0.0945*	*0.0106*	*0.0214*	*0.6226*	*0.0093*	*0.0189*	*0.6225*
ω_{jj}	*0.2143*	*0.0199*	*0.0000*	*0.2154*	*0.0198*	*0.0000*	*0.1113*	*0.0118*	*0.0000*	*0.0928*	*0.0101*	*0.0000*
γ_{ii}	*0.2574*	*0.0221*	*0.0000*	*0.2554*	*0.0247*	*0.0000*	*0.2574*	*0.0236*	*0.0000*	*0.2640*	*0.0221*	*0.0000*
γ_{ij}	*-0.0147*	*0.0236*	*0.5324*	*0.0210*	*0.0253*	*0.4067*	*0.0295*	*0.0210*	*0.1606*	*0.0013*	*0.0196*	*0.9456*
γ_{ji}	*0.0048*	*0.0074*	*0.5165*	*0.0027*	*0.0071*	*0.7020*	*-0.0068*	*0.0123*	*0.5773*	*-0.0157*	*0.0126*	*0.2141*
γ_{jj}	*0.2977*	*0.0112*	*0.0000*	*0.2913*	*0.0126*	*0.0000*	*0.2592*	*0.0114*	*0.0000*	*0.2575*	*0.0123*	*0.0000*
δ_{ii}	*0.9519*	*0.0089*	*0.0000*	*0.9534*	*0.0102*	*0.0000*	*0.9501*	*0.0101*	*0.0000*	*0.9483*	*0.0092*	*0.0000*
δ_{ij}	*0.0061*	*0.0071*	*0.3926*	*-0.0079*	*0.0118*	*0.5005*	*-0.0076*	*0.0085*	*0.3690*	*0.0008*	*0.0081*	*0.9255*
δ_{ji}	*-0.0025*	*0.0025*	*0.3199*	*-0.0027*	*0.0027*	*0.3216*	*0.0009*	*0.0037*	*0.8169*	*0.0045*	*0.0037*	*0.2301*
δ_{jj}	*0.9478*	*0.0037*	*0.0000*	*0.9469*	*0.0047*	*0.0000*	*0.9618*	*0.0033*	*0.0000*	*0.9621*	*0.0036*	*0.0000*

Panel B: Diagnostic tests

LogLik	*-11915.28*	*-11607.67*	*-10444.00*	*-9647.70*
LB_i	*39.729*	*39.628*	*39.605*	*39.758*
LB_j	*45.836*	*43.411*	*26.180*	*32.043*
LB^2_i	*34.354*	*36.114*	*35.027*	*33.595*
LB^2_j	*23.988*	*29.811*	*44.346*	*44.390*

Table 17: GARCH (1,1) results, Egypt

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations

	EGYPT - EM			EGYPT - US			EGYPT - WORLD			EGYPT - BRIC		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.0708*	*0.0173*	*0.0000*	*-0.0783*	*0.0185*	*0.0000*	*-0.0696*	*0.0180*	*0.0001*	*-0.0693*	*0.0195*	*0.0004*
β_{ij}	*0.0751*	*0.0111*	*0.0000*	*0.0851*	*0.0162*	*0.0000*	*0.1107*	*0.0201*	*0.0000*	*0.0601*	*0.0111*	*0.0000*
β_{ji}	*-0.0038*	*0.0105*	*0.7203*	*0.0017*	*0.0067*	*0.7983*	*0.0044*	*0.0058*	*0.4518*	*0.0022*	*0.0102*	*0.8280*
β_{ii}	*0.0091*	*0.0159*	*0.5667*	*-0.0527*	*0.0164*	*0.0013*	*0.1312*	*0.0168*	*0.0000*	*0.0138*	*0.0163*	*0.3980*
ω_{ii}	*0.1194*	*0.0050*	*0.0000*	*-0.0314*	*0.0103*	*0.0024*	*0.0480*	*0.0091*	*0.0000*	*0.1188*	*0.0049*	*0.0000*
ω_{ij}	*0.0666*	*0.0223*	*0.0028*	*0.0931*	*0.0101*	*0.0000*	*0.0867*	*0.0095*	*0.0000*	*0.0559*	*0.0230*	*0.0148*
ω_{ji}	*0.2117*	*0.0189*	*0.0000*	*0.0000*	*0.0565*	*1.0000*	*0.0000*	*0.0216*	*1.0000*	*-0.2099*	*0.0213*	*0.0000*
γ_{ii}	*0.1979*	*0.0067*	*0.0000*	*0.1927*	*0.0075*	*0.0000*	*0.1803*	*0.0058*	*0.0000*	*0.1975*	*0.0063*	*0.0000*
γ_{ij}	*0.0058*	*0.0072*	*0.4216*	*0.0073*	*0.0041*	*0.0771*	*-0.0064*	*0.0041*	*0.1184*	*0.0048*	*0.0078*	*0.5375*
γ_{ji}	*0.0026*	*0.0094*	*0.7853*	*-0.0692*	*0.0063*	*0.0000*	*0.0765*	*0.0095*	*0.0000*	*-0.0007*	*0.0071*	*0.9166*
γ_{ii}	*0.2977*	*0.0136*	*0.0000*	*0.2382*	*0.0103*	*0.0000*	*0.2591*	*0.0106*	*0.0000*	*0.2971*	*0.0133*	*0.0000*
δ_{ii}	*0.9818*	*0.0010*	*0.0000*	*0.9834*	*0.0010*	*0.0000*	*0.9855*	*0.0008*	*0.0000*	*0.9817*	*0.0009*	*0.0000*
δ_{ij}	*0.0011*	*0.0012*	*0.3904*	*-0.0008*	*0.0006*	*0.2226*	*0.0015*	*0.0007*	*0.0297*	*0.0004*	*0.0012*	*0.7706*
δ_{ji}	*-0.0039*	*0.0024*	*0.0992*	*0.0186*	*0.0012*	*0.0000*	*-0.0260*	*0.0018*	*0.0000*	*-0.0019*	*0.0017*	*0.2727*
δ_{jj}	*0.9450*	*0.0048*	*0.0000*	*0.9689*	*0.0026*	*0.0000*	*0.9630*	*0.0030*	*0.0000*	*0.9477*	*0.0045*	*0.0000*
Panel B: Diagnostic tests												
LogLik		*-14016.71*			*-12820.46*			*-12036.25*			*-14336.06*	
LB_i		*35.659*			*49.935*			*41.337*			*36.683*	
LB_j		*44.304*			*26.682*			*33.103*			*47.245*	
LB^2_i		*0.485*			*0.599*			*0.710*			*0.481*	
LB^2_j		28.008			56.395			43.509			24.078	

Table 18: GARCH (1,1) results, Morocco

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	MOROCCO - US			**MOROCCO - BRIC**			**MOROCCO - EM**			**MOROCCO - WORLD**		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.0044*	*0.0179*	*0.8043*	*-0.0124*	*0.0169*	*0.4655*	*-0.0163*	*0.0164*	*0.3223*	*-0.0082*	*0.0176*	*0.6408*
β_{ij}	*0.0313*	*0.0111*	*0.0047*	*0.0306*	*0.0081*	*0.0001*	*0.0337*	*0.0081*	*0.0000*	*0.0365*	*0.0135*	*0.0069*
β_{ji}	*0.0346*	*0.0143*	*0.0156*	*0.0180*	*0.0209*	*0.3888*	*0.0077*	*0.0175*	*0.6605*	*0.0125*	*0.0113*	*0.2709*
β_{jj}	*-0.0619*	*0.0173*	*0.0003*	*0.0128*	*0.0150*	*0.3918*	*0.0120*	*0.0152*	*0.4293*	*0.1271*	*0.0173*	*0.0000*
ω_{ii}	*0.3136*	*0.0279*	*0.0000*	*0.3278*	*0.0287*	*0.0000*	*0.3555*	*0.0287*	*0.0000*	*0.3096*	*0.0243*	*0.0000*
ω_{ij}	*-0.0266*	*0.0172*	*0.1210*	*-0.0018*	*0.0353*	*0.9583*	*-0.0060*	*0.0343*	*0.8616*	*-0.0184*	*0.0152*	*0.2258*
ω_{jj}	*0.1089*	*0.0110*	*0.0000*	*0.2067*	*0.0195*	*0.0000*	*0.2134*	*0.0185*	*0.0000*	*0.0917*	*0.0111*	*0.0000*
γ_{ii}	*0.3891*	*0.0234*	*0.0000*	*0.3920*	*0.0250*	*0.0000*	*0.4106*	*0.0236*	*0.0000*	*0.3890*	*0.0232*	*0.0000*
γ_{ij}	*0.0147*	*0.0147*	*0.3164*	*-0.0077*	*0.0252*	*0.7614*	*-0.0159*	*0.0226*	*0.4804*	*-0.0019*	*0.0117*	*0.8710*
γ_{ji}	*-0.0015*	*0.0195*	*0.9392*	*-0.0086*	*0.0186*	*0.6444*	*0.0179*	*0.0154*	*0.2452*	*-0.0068*	*0.0235*	*0.7740*
γ_{jj}	*0.2609*	*0.0115*	*0.0000*	*0.2834*	*0.0124*	*0.0000*	*0.2854*	*0.0127*	*0.0000*	*0.2663*	*0.0122*	*0.0000*
δ_{ii}	*0.8761*	*0.0169*	*0.0000*	*0.8686*	*0.0183*	*0.0000*	*0.8492*	*0.0200*	*0.0000*	*0.8762*	*0.0154*	*0.0000*
δ_{ij}	*0.0032*	*0.0082*	*0.6930*	*0.0007*	*0.0166*	*0.9663*	*0.0156*	*0.0171*	*0.3626*	*0.0082*	*0.0065*	*0.2056*
δ_{ji}	*0.0017*	*0.0062*	*0.7892*	*0.0083*	*0.0068*	*0.2195*	*0.0008*	*0.0062*	*0.9024*	*0.0094*	*0.0081*	*0.2490*
δ_{jj}	*0.9612*	*0.0033*	*0.0000*	*0.9529*	*0.0043*	*0.0000*	*0.9486*	*0.0045*	*0.0000*	*0.9587*	*0.0038*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-11243.89*			*-12735.78*			*-12421.16*			*-10451.78*		
LB_i	*29.272*			*30.789*			*32.396*			*29.461*		
LB_j	*27.751*			*46.965*			*42.913*			*33.720*		
LB^2_i	*40.329*			*38.584*			*35.404*			*40.124*		
LB^2_j	*40.828*			*28.462*			*31.503*			*37.776*		

Table 19: GARCH (1,1) results, Kenya

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations

	KENYA - BRIC			KENYA - EM			KENYA - US			KENYA - WORLD		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.3295*	*0.0194*	*0.0000*	*0.3318*	*0.0191*	*0.0000*	*0.2612*	*0.0209*	*0.0000*	*0.2300*	*0.0220*	*0.0000*
β_{ij}	*-0.0085*	*0.0094*	*0.3639*	*-0.0465*	*0.0093*	*0.0000*	*-0.1605*	*0.0118*	*0.0000*	*-0.2418*	*0.0124*	*0.0000*
β_{ji}	*-0.0460*	*0.0229*	*0.0446*	*-0.0717*	*0.0209*	*0.0006*	*-0.0333*	*0.0160*	*0.0375*	*-0.0123*	*0.0121*	*0.3087*
β_{ji}	*0.0063*	*0.0158*	*0.6912*	*-0.0470*	*0.0134*	*0.0005*	*-0.1755*	*0.0151*	*0.0000*	*-0.0016*	*0.0144*	*0.9123*
ω_{ii}	*0.5404*	*0.0135*	*0.0000*	*0.4999*	*0.0142*	*0.0000*	*0.5060*	*0.0173*	*0.0000*	*0.5596*	*0.0150*	*0.0000*
ω_{ij}	*0.0851*	*0.0068*	*0.0000*	*0.0448*	*0.0515*	*0.3841*	*-0.0115*	*0.0262*	*0.6613*	*0.0147*	*0.0239*	*0.5374*
ω_{jj}	*0.0337*	*0.0204*	*0.0993*	*0.0432*	*0.2716*	*0.8737*	*0.0498*	*0.0477*	*0.2970*	*0.0580*	*0.0317*	*0.0669*
γ_{ii}	*0.5605*	*0.0230*	*0.0000*	*0.5237*	*0.0238*	*0.0000*	*0.6624*	*0.0299*	*0.0000*	*0.8066*	*0.0331*	*0.0000*
γ_{ij}	*-0.0684*	*0.0188*	*0.0003*	*-0.1063*	*0.0184*	*0.0000*	*-0.1224*	*0.0156*	*0.0000*	*-0.0847*	*0.0153*	*0.0000*
γ_{ji}	*0.3730*	*0.0099*	*0.0000*	*0.3665*	*0.0092*	*0.0000*	*0.4592*	*0.0160*	*0.0000*	*0.5353*	*0.0219*	*0.0000*
γ_{jj}	*0.1789*	*0.0122*	*0.0000*	*0.1145*	*0.0129*	*0.0000*	*0.1563*	*0.0165*	*0.0000*	*0.2164*	*0.0164*	*0.0000*
δ_{ii}	*0.3542*	*0.0237*	*0.0000*	*0.4339*	*0.0215*	*0.0000*	*0.4516*	*0.0262*	*0.0000*	*0.3399*	*0.0246*	*0.0000*
δ_{ij}	*0.1836*	*0.0105*	*0.0000*	*0.2541*	*0.0263*	*0.0000*	*0.1235*	*0.0155*	*0.0000*	*0.0766*	*0.0139*	*0.0000*
δ_{ji}	*-0.0652*	*0.0063*	*0.0000*	*-0.0561*	*0.0126*	*0.0000*	*-0.0417*	*0.0127*	*0.0010*	*-0.0497*	*0.0175*	*0.0045*
δ_{jj}	*0.9666*	*0.0025*	*0.0000*	*0.9669*	*0.0056*	*0.0000*	*0.9711*	*0.0037*	*0.0000*	*0.9627*	*0.0038*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-12431.26*			*-12010.75*			*-10966.94*			*-10375.33*		
LB_i	*50.635*			*53.764*			*63.233*			*70.899*		
LB_j	*54.291*			*68.923*			*86.853*			*115.938*		
LB^2_i	*0.753*			*1.253*			*0.803*			*0.804*		
LB^2_j	*38.611*			*60.477*			*51.643*			*30.414*		

Table 20: GARCH (1,1) results, Mauritius

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations

	MAURITIUS - BRIC			MAURITIUS - EM			MAURITIUS - US			MAURITIUS - WORLD		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.03387*	*0.01829*	*0.06397*	*-0.03396*	*0.01572*	*0.03075*	*-0.02876*	*0.01677*	*0.08628*	*-0.02652*	*0.01854*	*0.15275*
β_{ij}	*0.02109*	*0.00484*	*0.00001*	*0.02611*	*0.00506*	*0.00000*	*0.02742*	*0.00837*	*0.00105*	*0.05547*	*0.00963*	*0.00000*
β_{ji}	*0.00666*	*0.02640*	*0.80081*	*0.00112*	*0.02162*	*0.95874*	*-0.02195*	*0.01932*	*0.25585*	*-0.02534*	*0.01308*	*0.05270*
β_{ii}	*0.00487*	*0.01622*	*0.76395*	*-0.00941*	*0.01486*	*0.52672*	*-0.04979*	*0.01716*	*0.00371*	*0.12491*	*0.01425*	*0.00000*
ω_{ii}	*0.10804*	*0.01200*	*0.00000*	*0.10719*	*0.01292*	*0.00000*	*0.10670*	*0.01233*	*0.00000*	*0.11888*	*0.01389*	*0.00000*
ω_{ij}	*-0.00670*	*0.02907*	*0.81773*	*0.01263*	*0.02991*	*0.67289*	*-0.01054*	*0.01664*	*0.52647*	*-0.00976*	*0.01530*	*0.52331*
ω_{jj}	*0.20582*	*0.01693*	*0.00000*	*0.20684*	*0.01925*	*0.00000*	*0.10334*	*0.01132*	*0.00000*	*0.08166*	*0.00981*	*0.00000*
γ_{ii}	*0.39583*	*0.02702*	*0.00000*	*0.39720*	*0.03046*	*0.00000*	*0.39174*	*0.03017*	*0.00000*	*0.41907*	*0.03254*	*0.00000*
γ_{ij}	*0.03243*	*0.02684*	*0.22686*	*0.04727*	*0.02370*	*0.04615*	*-0.00415*	*0.01410*	*0.76884*	*-0.00350*	*0.01240*	*0.77794*
γ_{ji}	*0.00905*	*0.00550*	*0.10003*	*0.01298*	*0.00636*	*0.04133*	*0.01700*	*0.00784*	*0.03018*	*0.03248*	*0.01190*	*0.00636*
γ_{ii}	*0.26161*	*0.01190*	*0.00000*	*0.25927*	*0.01385*	*0.00000*	*0.23232*	*0.01169*	*0.00000*	*0.22428*	*0.01102*	*0.00000*
δ_{ii}	*0.92160*	*0.01063*	*0.00000*	*0.92129*	*0.01184*	*0.00000*	*0.92307*	*0.01146*	*0.00000*	*0.91050*	*0.01382*	*0.00000*
δ_{ij}	*-0.00366*	*0.01005*	*0.71597*	*-0.00680*	*0.00906*	*0.45271*	*0.00624*	*0.00487*	*0.20013*	*0.00655*	*0.00431*	*0.12868*
δ_{ji}	*-0.00217*	*0.00203*	*0.28444*	*-0.00487*	*0.00255*	*0.05570*	*-0.00394*	*0.00229*	*0.08583*	*-0.00732*	*0.00361*	*0.04287*
δ_{jj}	*0.95866*	*0.00330*	*0.00000*	*0.95729*	*0.00467*	*0.00000*	*0.96931*	*0.00310*	*0.00000*	*0.97133*	*0.00282*	*0.00000*

Panel B: Diagnostic tests

LogLik	*-11637.79*	*-11332.52*	*-10146.26*	*-9406.22*
LB_i	*195.137*	*195.260*	*192.885*	*186.128*
LB_j	*48.707*	*47.802*	*26.536*	*34.223*
LB^2_i	*47.780*	*47.892*	*52.970*	*49.653*
LB^2_j	*41.069*	*44.949*	*72.508*	*81.639*

Table 21: GARCH (1,1) results, Zambia

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	ZAMBIA - BRIC			**ZAMBIA - EM**			**ZAMBIA - US**			**ZAMBIA - WORLD**		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.0047*	*0.0177*	*0.7890*	*0.0044*	*0.0181*	*0.8089*	*0.0030*	*0.0160*	*0.8504*	*0.0089*	*0.0161*	*0.5807*
β_{ij}	*0.0393*	*0.0126*	*0.0018*	*0.0466*	*0.0121*	*0.0001*	*0.0301*	*0.0159*	*0.0583*	*0.0507*	*0.0195*	*0.0091*
β_{ji}	*0.0147*	*0.0123*	*0.2337*	*0.0108*	*0.0112*	*0.3370*	*0.0067*	*0.0080*	*0.3972*	*0.0045*	*0.0069*	*0.5136*
β_{ii}	*0.0118*	*0.0157*	*0.4543*	*0.0041*	*0.0160*	*0.7960*	*-0.0451*	*0.0173*	*0.0093*	*0.1374*	*0.0152*	*0.0000*
ω_{ii}	*0.2217*	*0.0274*	*0.0000*	*0.2129*	*0.0280*	*0.0000*	*0.2549*	*0.0233*	*0.0000*	*0.2526*	*0.0235*	*0.0000*
ω_{ij}	*0.0598*	*0.0393*	*0.1284*	*0.0463*	*0.0511*	*0.3650*	*-0.0282*	*0.0172*	*0.1004*	*-0.0226*	*0.0129*	*0.0795*
ω_{jj}	*0.2329*	*0.0217*	*0.0000*	*0.2324*	*0.0194*	*0.0000*	*0.1063*	*0.0124*	*0.0000*	*0.0869*	*0.0108*	*0.0000*
γ_{ii}	*0.2650*	*0.0205*	*0.0000*	*0.2676*	*0.0239*	*0.0000*	*0.3042*	*0.0196*	*0.0000*	*0.3014*	*0.0181*	*0.0000*
γ_{ij}	*-0.0340*	*0.0139*	*0.0147*	*-0.0203*	*0.0135*	*0.1307*	*-0.0113*	*0.0087*	*0.1934*	*-0.0050*	*0.0070*	*0.4707*
γ_{ji}	*0.0516*	*0.0114*	*0.0000*	*0.0459*	*0.0155*	*0.0030*	*0.0073*	*0.0155*	*0.6392*	*-0.0031*	*0.0164*	*0.8475*
γ_{ii}	*0.3118*	*0.0142*	*0.0000*	*0.3004*	*0.0152*	*0.0000*	*0.2581*	*0.0114*	*0.0000*	*0.2555*	*0.0114*	*0.0000*
δ_{ii}	*0.9558*	*0.0069*	*0.0000*	*0.9566*	*0.0074*	*0.0000*	*0.9445*	*0.0070*	*0.0000*	*0.9454*	*0.0066*	*0.0000*
δ_{ij}	*0.0112*	*0.0058*	*0.0522*	*0.0061*	*0.0054*	*0.2570*	*0.0055*	*0.0034*	*0.1021*	*0.0030*	*0.0026*	*0.2509*
δ_{ii}	*-0.0228*	*0.0049*	*0.0000*	*-0.0188*	*0.0076*	*0.0135*	*0.0004*	*0.0052*	*0.9447*	*0.0042*	*0.0049*	*0.3963*
δ_{jj}	*0.9416*	*0.0053*	*0.0000*	*0.9432*	*0.0059*	*0.0000*	*0.9625*	*0.0032*	*0.0000*	*0.9633*	*0.0033*	*0.0000*
Panel B: Diagnostic tests												
LogLik		*-14495.94*			*-14194.55*			*-12981.20*			*-12249.84*	
LB_i		*29.495*			*30.332*			*31.366*			*31.085*	
LB_j		*46.294*			*43.884*			*26.149*			*32.120*	
LB^2_i		*20.956*			*21.738*			*19.256*			*19.643*	
LB^2_j		*24.094*			*28.443*			*45.408*			*46.362*	

5.6 Contagion Effects (RQ 3)

Were there pure contagion effects between African and the world market during the 2008 sub-prime crisis?

There is no one universal definition of contagion. Different authors use different definitions and different methodologies in quantifying contagion effects. Forbes and Rigobon (2002) for instance, thereby define contagion as: "*the increase in the probability of crisis beyond what could be foreseen by the linkages between fundamentals*". They posit that stock markets in countries with similar fundamentals would definitely move together no matter the period; hence contagion should be the excess crisis beyond the expected crisis level for which the fundamentals cannot explicitly explain. Contagion, therefore, is a level of correlation over and above market expectations. However, Edwards (2000) explains contagion as the instance in which the degree of international transmission of shocks far exceeds market expectations.

Existing literatures confirm that liberalization leads to integration and integration, in tend may result in contagion. Contagion from another standpoint is defined as *the co-movement of the markets especially in times of crisis*. This definition is employed in this study to try to establish whether there were contagion effects during the 2008 US financial crisis. The most severe part of the US financial crisis started in early September, 2008 and it lasted for 6 months up to early March, 2009. It is estimated that the US stock market fell by 43%, the Emerging markets by 50%, and frontier markets by 60% (Samarakoon 2011). To do this, the data is divided into two namely the stable period before the crisis and the crisis period. Another point of critical importance to the study of contagion is the movement of the volatility graphs of the various markets before and during the crisis.

5.6.1 Correlation (Excess movement)

Forbes and Rigobon (2002) measured contagion by comparing the cross-market linkage at times of stable period and linkage at crisis period. They employed the correlation coefficient as a measure for the linkage between stock markets. Markets that are linked turn to move more closely in times of crisis. Shown in the table below is the correlation results for the split data specifically before the crisis period and during and after the crisis period. It is worth noting that the main focus of this study is to examine whether there were pure contagion effects during the 2008 US subprime crisis even though the span of the data captures such crisis as the Russian and Asian crisis and the dotcom bubble of 2000.

It can be deduced from the table that before the US financial crisis of 2008, correlation between the markets under consideration is very low but very high during the crisis period and after. Kenya recorded a correlation coefficient of 0.0044 with the US market before the crisis but it increased to 0.1426 during and after the crisis. Mauritius recorded correlation coefficient of 0.0249 before the crisis with the world market and 0.1695during the crisis. The correlation coefficient between Zambia and the US also increased over 100% during the crisis period from 0.0318 to 0.1295. The same can be said for Egypt.

Morocco recorded a negligible correlation coefficients of 0.0298 and -0.0482 with the US and world market respectively but increased drastically to 0.4047 and 0.2292 during and after the crisis. South Africa recorded correlation of 0.3179 and 0.1503 with the US and World markets respectively pre crisis. However, during the crisis period the correlation increased over 100% to 0.7403 and 0.4829 for the US and the World market respectively. Also Tunisia recorded 0.0228 and -0.0764 correlation with the US and World market respectively but increased tremendously to 0.3163 and 0.1284 during the crisis period.

From the above analysis it can be seen that financial markets generally turn to move closely together during crisis period. The challenge however is what constitute abnormal correlation and hence contagion. There is over 100% increase in correlation between all the markets in the study during the crisis period and for this reason it can be concluded that with respect to correlation, there were contagion effects between the seven African markets under consideration , the US and the World markets.

Table 22: Correlation Before Crisis

	Bric	Egypt	EM	Kenya	Maur	Moroc	SA	Tunis	Zambia	World	US
Bric	1.0000										
Egypt	0.0812	1.0000									
EM	0.8266	0.1042	1.0000								
Kenya	0.0650	0.0023	0.0560	1.0000							
Maur	0.0387	-0.0174	0.0271	0.0462	1.0000						
Moroc	0.0225	0.0768	0.0335	0.0001	0.0261	1.0000					
SA	0.3260	0.0417	**0.4084**	0.0213	0.0239	**0.0600**	1.0000				
Tunis	-0.0011	0.0163	0.0175	0.0588	0.0204	**0.2958**	0.0641	1.0000			
Zambia	0.0228	0.0159	-0.0143	-0.0162	0.0154	-0.0215	-0.0150	0.0172	1.0000		
World	0.5226	0.0572	**0.5974**	0.0044	0.0249	**0.0298**	**0.3179**	0.0228	0.0318	1.0000	
US	0.3624	0.0070	**0.3672**	0.0038	0.0111	**-0.0482**	**0.1503**	-0.0764	0.0446	0.8740	1.0000

Table 23: Correlation during and after crisis

	Bric	Egypt	EM	Kenya	Maur	Moroc	SA	Tunis	Zambia	World	US
Bric	1.0000										
Egypt	0.1763	1.0000									
EM	**0.9625**	0.1930	1.0000								
Kenya	0.1644	0.1110	0.1827	1.0000							
Maur	**0.2251**	0.0997	**0.2387**	0.1721	1.0000						
Moroc	**0.3869**	0.1075	**0.4093**	0.1440	0.1935	1.0000					
SA	**0.7671**	0.1513	**0.8124**	0.1553	0.1739	**0.4357**	1.0000				
Tunis	**0.3221**	0.0521	**0.3598**	0.1209	0.1753	**0.4173**	**0.4136**	1.0000			
Zambia	0.1351	0.0533	0.1685	0.2004	0.1597	0.0374	**0.1528**	0.0510	1.0000		
World	**0.7865**	**0.1271**	**0.7776**	**0.1426**	0.1695	**0.4047**	**0.7403**	0.3163	0.1295	1.0000	
US	**0.6189**	**0.0674**	**0.5684**	**0.0594**	0.0654	**0.2292**	**0.4829**	0.1284	0.0517	0.9009	1.0000

5.6.2 Mean Contagion

Baur (2003) employed a model that incorporates the change in transmission of a shock in one market to another in the same region or a global shock to other markets. The model can be estimated using a GARCH process using the ML method. A similar process is employed in this study to examine whether there was mean contagion during the 2008 US financial crisis. The table below presents the mean and volatility coefficients for the split data.

Kenya, before and during the crisis exhibits a unidirectional relationship with the US and World market. It receives past innovation from these two markets, 21% from the US and 30% from the World market. However, this increases to 35% and 74% from the US and the World respectively. Egypt also exhibits a unidirectional relationship with the US and World market. It only receives past innovation from these two markets, 10% from the US and 6% from the World market. However, this increases to 36% and 74% from the US and the World respectively

Mauritius before and after the crisis exhibits a unidirectional relationship with the World market. It receives past innovation from this market, 2%. However, this increases to 20% during the crisis and also receives from the US, 16% of past innovations. Further it exhibits a bi-directional relationship during and after the crisis by exporting innovations of 6% and 5% to the US and the World respectively.

Morocco, before the crisis receives 2% of past innovations from the world market but none from the US. During and after the crisis, Morocco stopped receiving past innovations from the world market but starts receiving from the US of 8%. South Africa, before the crisis receives past innovation of 52% and 63% from the US and the World market respectively. However, during and after the crisis, past innovations received has reduced to 50% and 53% respectively whiles past innovation were exported to the US, 56%. Tunisia received 4% past innovations from the US market but increased to 6% during and after the crisis. Zambia neither exported nor received past innovations before the crisis. During and after

the crisis period, Zambia received 2% and 12% of past innovations from US and the world market respectively.

Mean wise, it can be deduced that all the markets were prone to contagion from the US and World market with the exception of South Africa. Past innovations to South Africa from these markets rather decreased during and after the crisis period but still remained high at over 50%. The strong linkages between the South African market and the US can be seen from the increased in transmission exported to the US during and after the crisis period.

3.5.3 Volatility Contagion

In crisis period it is expected that the uncertainty or risk associated with the returns of an asset increases significantly. Based on this assumption, Baur (2003) measured contagion by distinguishing normal volatility in normal periods from abnormal volatility in crises period. This method exhibit some resemblance to volatility spillover as discussed in Lin et al., 1994 and Edwards, 1998. Edwards (1998) measured volatility spillover by using GARCH (1, 1) specification with an additional exogenous regressor that affects volatility. In this study, we employ the method used by Baur (2003) to examine whether there were volatility contagion during the 2008 US financial crisis.

Egypt before the crisis only exports 3% of volatility spillover to the US. However after the crisis, Egypt exported 1.8% and received 1.5% volatility to and from the World market. Kenya exhibits bi-directional relationship with the US and world market and it exports 4% and 9% volatility to the US and World market and receives 7% and 4% volatility from these markets respectively before the crisis. During and after the crisis, the volatility intake from the US and World market increased to 25% and 24% respectively. The volatility export from Kenya to US and the World also was 7% and 8%.

No volatility spillover for Mauritius before the crisis but during and after the crisis Mauritius received volatility from both the US and the World, 8% and 2%. It also exported volatility to US, 3%. Morocco neither received nor export volatility to neither markets either before or after the crisis. South Africa received volatility from the US and the world before the crisis, 1.4% and 3% respectively as well as exports volatility of 12%

and 41%. After the crisis, the volatility received from the US increased to 3% .Tunisia exhibits a unidirectional relationship with the US and World market, receiving volatility of 3% from both markets. After the crisis, Tunisia rather exports volatility to the US, 8% and the World 2%. Zambia receives nor exports volatility to US or the world market before the crisis. However, it exports to the US, 1.4% and the World 7% during and after the crisis.

From the above analysis, it's clear that volatility wise, markets move together during crises. The contagion effect from the US and world market firstly, highly affected the Kenya stock market 25% and 24% respectively. The Kenya Stock market is the only market to also exhibit bi-directional relationship with the US and World market before and during the crisis. South Africa, Egypt, Mauritius, and Zambia were all prone to some volatility contagion from the US and World market.

The above analysis shows that there were pure contagion effects during the US financial crisis of 2008. Kenya, South Africa, Egypt and Mauritius were the most affected countries during the crisis period. The graphical presentation in the appendix 4 serves as a further prove of this fact.

3.5.4 Results of GARCH Process Before Contagion

Table 24: Egypt (Before Crisis)

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	EGYPT - EM			**EGYPT - US**			**EGYPT - WORLD**			**EGYPT - BRIC**		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.0013*	*0.0209*	*0.9508*	*-0.0045*	*0.0236*	*0.8496*	*-0.0163*	*0.0223*	*0.4642*	*0.0030*	*0.0212*	*0.8882*
β_{ij}	*0.0756*	*0.0116*	*0.0000*	*0.0739*	*0.0107*	*0.0000*	*0.1031*	*0.0185*	*0.0000*	*0.0612*	*0.0094*	*0.0000*
β_{ji}	*0.0171*	*0.0234*	*0.4642*	*0.0046*	*0.0156*	*0.7685*	*0.0032*	*0.0140*	*0.8210*	*0.0257*	*0.0246*	*0.2962*
β_{ii}	*0.0273*	*0.0193*	*0.1576*	*-0.0589*	*0.0203*	*0.0037*	*0.1451*	*0.0201*	*0.0000*	*0.0101*	*0.0177*	*0.5680*
ω_{ii}	*0.2733*	*0.0199*	*0.0000*	*0.2356*	*0.0247*	*0.0000*	*0.2085*	*0.0242*	*0.0000*	*0.2730*	*0.0198*	*0.0000*
ω_{ij}	*0.0873*	*0.0355*	*0.0139*	*-0.0127*	*0.0173*	*0.4630*	*-0.0067*	*0.0176*	*0.7017*	*0.0570*	*0.0390*	*0.1431*
ω_{ii}	*0.2756*	*0.0297*	*0.0000*	*0.0649*	*0.0121*	*0.0000*	*0.0592*	*0.0105*	*0.0000*	*0.2602*	*0.0185*	*0.0000*
γ_{ii}	*0.3632*	*0.0278*	*0.0000*	*0.3884*	*0.0279*	*0.0000*	*0.3977*	*0.0270*	*0.0000*	*0.3318*	*0.0234*	*0.0000*
γ_{ij}	*0.0420*	*0.0346*	*0.2239*	*0.0102*	*0.0131*	*0.4363*	*0.0062*	*0.0121*	*0.6096*	*-0.0073*	*0.0361*	*0.8400*
γ_{ji}	*-0.0404*	*0.0139*	*0.0037*	*-0.1133*	*0.0128*	*0.0000*	*-0.1507*	*0.0144*	*0.0000*	*-0.0155*	*0.0103*	*0.1319*
γ_{ii}	*0.2789*	*0.0188*	*0.0000*	*0.1798*	*0.0124*	*0.0000*	*0.1854*	*0.0133*	*0.0000*	*0.2912*	*0.0078*	*0.0000*
δ_{ii}	*0.9022*	*0.0123*	*0.0000*	*0.8965*	*0.0140*	*0.0000*	*0.9005*	*0.0125*	*0.0000*	*0.9127*	*0.0106*	*0.0000*
δ_{ij}	*-0.0278*	*0.0189*	*0.1413*	*-0.0033*	*0.0058*	*0.5694*	*-0.0024*	*0.0054*	*0.6515*	*-0.0029*	*0.0189*	*0.8771*
δ_{ji}	*0.0095*	*0.0048*	*0.0482*	*0.0226*	*0.0035*	*0.0000*	*0.0315*	*0.0045*	*0.0000*	*0.0018*	*0.0033*	*0.5840*
δ_{jj}	*0.9418*	*0.0078*	*0.0000*	*0.9824*	*0.0025*	*0.0000*	*0.9808*	*0.0027*	*0.0000*	*0.9446*	*0.0014*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-8905*			*-8655*			*-7752*			*-7088*		
LB_i	*40.8*			*50.26*			*48.62*			*41.25*		
LB_j	*42.24*			*26.12*			*28.13*			*44.54*		
LB^2_i	*0.547*			*1.002*			*1.227*			*0.491*		
LB^2_j	*30.97*			*45.1*			*65.79*			*25.01*		

Table 25: Kenya (Before Crisis)

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	KENYA - BRIC			**KENYA - EM**			**KENYA - US**			**KENYA - WORLD**		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.3109*	*0.0246*	*0.0000*	*0.3108*	*0.0232*	*0.0000*	*0.2281*	*0.0293*	*0.0000*	*0.2065*	*0.0297*	*0.0000*
β_{ij}	*-0.0149*	*0.0121*	*0.2211*	*-0.0659*	*0.0125*	*0.0000*	*-0.2113*	*0.0137*	*0.0000*	*-0.3040*	*0.0158*	*0.0000*
β_{ji}	*-0.0172*	*0.0256*	*0.5020*	*-0.0475*	*0.0240*	*0.0478*	*-0.0102*	*0.0173*	*0.5546*	*0.0032*	*0.0132*	*0.8081*
β_{jj}	*0.0067*	*0.0166*	*0.6857*	*-0.0364*	*0.0160*	*0.0229*	*-0.1769*	*0.0184*	*0.0000*	*0.0216*	*0.0186*	*0.2462*
ω_{ii}	*0.5545*	*0.0179*	*0.0000*	*0.5033*	*0.0171*	*0.0000*	*0.5479*	*0.0187*	*0.0000*	*0.5731*	*0.0149*	*0.0000*
ω_{ij}	*0.1657*	*0.0301*	*0.0000*	*0.1507*	*0.0317*	*0.0000*	*0.0106*	*0.0159*	*0.5040*	*0.0534*	*0.0163*	*0.0010*
ω_{jj}	*0.0000*	*0.1475*	*1.0000*	*0.0000*	*0.1047*	*1.0000*	*0.0000*	*0.0809*	*1.0000*	*0.0000*	*0.0424*	*1.0000*
γ_{ii}	*0.6587*	*0.0317*	*0.0000*	*0.6243*	*0.0351*	*0.0000*	*0.8000*	*0.0389*	*0.0000*	*0.9442*	*0.0411*	*0.0000*
γ_{ij}	*-0.0621*	*0.0227*	*0.0062*	*-0.1092*	*0.0218*	*0.0000*	*-0.0940*	*0.0167*	*0.0000*	*-0.0621*	*0.0163*	*0.0001*
γ_{ji}	*0.4166*	*0.0131*	*0.0000*	*0.4059*	*0.0116*	*0.0000*	*0.4467*	*0.0214*	*0.0000*	*0.5455*	*0.0304*	*0.0000*
γ_{jj}	*0.1956*	*0.0158*	*0.0000*	*0.1340*	*0.0157*	*0.0000*	*0.1524*	*0.0173*	*0.0000*	*0.2206*	*0.0177*	*0.0000*
δ_{ii}	*0.3154*	*0.0310*	*0.0000*	*0.4042*	*0.0267*	*0.0000*	*0.4024*	*0.0297*	*0.0000*	*0.3219*	*0.0239*	*0.0000*
δ_{ij}	*0.1113*	*0.0306*	*0.0003*	*0.1947*	*0.0318*	*0.0000*	*0.0732*	*0.0147*	*0.0000*	*0.0422*	*0.0122*	*0.0005*
δ_{ji}	*-0.0975*	*0.0109*	*0.0000*	*-0.0953*	*0.0112*	*0.0000*	*-0.0414*	*0.0129*	*0.0013*	*-0.0942*	*0.0200*	*0.0000*
δ_{jj}	*0.9686*	*0.0041*	*0.0000*	*0.9700*	*0.0049*	*0.0000*	*0.9816*	*0.0030*	*0.0000*	*0.9690*	*0.0041*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-8789*			*-8440*			*-7668*			*-7091*		
LB_i	*46.82*			*52.03*			*53.16*			*58.66*		
LB_j	*50.52*			*64.75*			*71.19*			*84.21*		
LB^2_i	*0.727*			*0.972*			*0.766*			*0.861*		
LB^2_j	*42.1*			*57.56*			*31.9*			*20.2*		

Table 26: Mauritius (Before Crisis)

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	MAURITIUS - BRIC			**MAURITIUS - EM**			**MAURITIUS - US**			**MAURITIUS - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.0126*	*0.0207*	*0.5427*	*-0.0169*	*0.0230*	*0.4614*	*-0.0031*	*0.0211*	*0.8839*	*-0.0062*	*0.0197*	*0.7531*
β_{ij}	*0.0100*	*0.0051*	*0.0512*	*0.0128*	*0.0060*	*0.0317*	*0.0066*	*0.0076*	*0.3841*	*0.0210*	*0.0098*	*0.0328*
β_{ji}	*0.0649*	*0.0348*	*0.0623*	*0.0455*	*0.0298*	*0.1269*	*0.0071*	*0.0215*	*0.7407*	*-0.0079*	*0.0193*	*0.6810*
β_{jj}	*0.0124*	*0.0183*	*0.4958*	*0.0167*	*0.0170*	*0.3270*	*-0.0405*	*0.0200*	*0.0434*	*0.1475*	*0.0207*	*0.0000*
ω_{ii}	*0.1090*	*0.0132*	*0.0000*	*0.0985*	*0.0125*	*0.0000*	*0.1186*	*0.0137*	*0.0000*	*0.1132*	*0.0116*	*0.0000*
ω_{ij}	*0.0277*	*0.0434*	*0.5235*	*0.0556*	*0.0445*	*0.2117*	*0.0252*	*0.0163*	*0.1228*	*0.0134*	*0.0185*	*0.4682*
ω_{jj}	*0.2517*	*0.0304*	*0.0000*	*0.2640*	*0.0295*	*0.0000*	*0.0748*	*0.0132*	*0.0000*	*0.0744*	*0.0121*	*0.0000*
γ_{ii}	*0.3884*	*0.0319*	*0.0000*	*0.3717*	*0.0301*	*0.0000*	*0.4162*	*0.0278*	*0.0000*	*0.4006*	*0.0253*	*0.0000*
γ_{ij}	*0.0410*	*0.0320*	*0.2004*	*0.0653*	*0.0273*	*0.0166*	*0.0358*	*0.0215*	*0.0954*	*0.0148*	*0.0153*	*0.3334*
γ_{ji}	*0.0062*	*0.0060*	*0.3028*	*0.0119*	*0.0063*	*0.0594*	*0.0137*	*0.0089*	*0.1243*	*0.0179*	*0.0128*	*0.1626*
γ_{jj}	*0.2740*	*0.0178*	*0.0000*	*0.2772*	*0.0174*	*0.0000*	*0.1995*	*0.0128*	*0.0000*	*0.2147*	*0.0143*	*0.0000*
δ_{ii}	*0.9207*	*0.0127*	*0.0000*	*0.9286*	*0.0116*	*0.0000*	*0.9080*	*0.0127*	*0.0000*	*0.9148*	*0.0101*	*0.0000*
δ_{ij}	*-0.0110*	*0.0116*	*0.3455*	*-0.0164*	*0.0104*	*0.1152*	*-0.0120*	*0.0089*	*0.1779*	*-0.0038*	*0.0062*	*0.5373*
δ_{ji}	*-0.0021*	*0.0027*	*0.4437*	*-0.0057*	*0.0030*	*0.0553*	*-0.0044*	*0.0025*	*0.0799*	*-0.0053*	*0.0042*	*0.2077*
δ_{jj}	*0.9505*	*0.0068*	*0.0000*	*0.9442*	*0.0075*	*0.0000*	*0.9779*	*0.0028*	*0.0000*	*0.9734*	*0.0038*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-7690*			*-7458*			*-6562*			*-5911.7*		
LB_i	*150.3*			*152.82*			*147.5*			*145.78*		
LB_j	*43.1*			*43.052*			*24.88*			*28.247*		
LB^2_i	*47.85*			*48.192*			*50.76*			*49.08*		
LB^2_j	*30.69*			*33.751*			*34.11*			*40.61*		

Table 27: Morocco (Before Crisis)

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	MOROCCO - BRIC			**MOROCCO - EM**			**MOROCCO - US**			**MOROCCO - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.0100*	*0.0220*	*0.6497*	*-0.0169*	*0.0230*	*0.4614*	*-0.0031*	*0.0211*	*0.8839*	*-0.0062*	*0.0197*	*0.7531*
β_{ij}	*0.0370*	*0.0085*	*0.0000*	*0.0128*	*0.0060*	*0.0317*	*0.0066*	*0.0076*	*0.3841*	*0.0210*	*0.0098*	*0.0328*
β_{ji}	*0.0225*	*0.0230*	*0.3274*	*0.0455*	*0.0298*	*0.1269*	*0.0071*	*0.0215*	*0.7407*	*-0.0079*	*0.0193*	*0.6810*
β_{jj}	*0.0060*	*0.0193*	*0.7567*	*0.0167*	*0.0170*	*0.3270*	*-0.0405*	*0.0200*	*0.0434*	*0.1475*	*0.0207*	*0.0000*
ω_{ii}	*0.4901*	*0.0339*	*0.0000*	*0.0985*	*0.0125*	*0.0000*	*0.1186*	*0.0137*	*0.0000*	*0.1132*	*0.0116*	*0.0000*
ω_{ij}	*0.0432*	*0.0388*	*0.2647*	*0.0556*	*0.0445*	*0.2117*	*0.0252*	*0.0163*	*0.1228*	*0.0134*	*0.0185*	*0.4682*
ω_{jj}	*0.2433*	*0.0298*	*0.0000*	*0.2640*	*0.0295*	*0.0000*	*0.0748*	*0.0132*	*0.0000*	*0.0744*	*0.0121*	*0.0000*
γ_{ii}	*0.5188*	*0.0280*	*0.0000*	*0.3717*	*0.0301*	*0.0000*	*0.4162*	*0.0278*	*0.0000*	*0.4006*	*0.0253*	*0.0000*
γ_{ij}	*-0.0015*	*0.0297*	*0.9600*	*0.0653*	*0.0273*	*0.0166*	*0.0358*	*0.0215*	*0.0954*	*0.0148*	*0.0153*	*0.3334*
γ_{ji}	*0.0198*	*0.0155*	*0.2024*	*0.0119*	*0.0063*	*0.0594*	*0.0137*	*0.0089*	*0.1243*	*0.0179*	*0.0128*	*0.1626*
γ_{jj}	*0.2903*	*0.0179*	*0.0000*	*0.2772*	*0.0174*	*0.0000*	*0.1995*	*0.0128*	*0.0000*	*0.2147*	*0.0143*	*0.0000*
δ_{ii}	*0.7060*	*0.0359*	*0.0000*	*0.9286*	*0.0116*	*0.0000*	*0.9080*	*0.0127*	*0.0000*	*0.9148*	*0.0101*	*0.0000*
δ_{ij}	*-0.0182*	*0.0272*	*0.5030*	*-0.0164*	*0.0104*	*0.1152*	*-0.0120*	*0.0089*	*0.1779*	*-0.0038*	*0.0062*	*0.5373*
δ_{ji}	*-0.0075*	*0.0086*	*0.3795*	*-0.0057*	*0.0030*	*0.0553*	*-0.0044*	*0.0025*	*0.0799*	*-0.0053*	*0.0042*	*0.2077*
δ_{jj}	*0.9468*	*0.0069*	*0.0000*	*0.9442*	*0.0075*	*0.0000*	*0.9779*	*0.0028*	*0.0000*	*0.9734*	*0.0038*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-8724*			*-7458*			*-6562*			*-5912*		
LB_i	*50.52*			*152.8*			*147.5*			*145.8*		
LB_j	*45.69*			*43.05*			*24.88*			*28.25*		
LB^2_i	*28.42*			*48.19*			*50.76*			*49.08*		
LB^2_j	*24.02*			*33.75*			*34.11*			*40.61*		

Table 28: South Africa (Before Crisis)

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	SOUTH AFRICA - BRIC			**SOUTH AFRICA - EM**			**SOUTH AFRICA - US**			**SOUTH AFRICA - WORLD**		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.1420*	*0.0263*	*0.0000*	*-0.1949*	*0.0210*	*0.0000*	*-0.2433*	*0.0205*	*0.0000*	*-0.3165*	*0.0224*	*0.0000*
β_{ij}	*0.1628*	*0.0257*	*0.0000*	*0.0176*	*0.0213*	*0.4086*	*0.5237*	*0.0276*	*0.0000*	*0.6325*	*0.0448*	*0.0000*
β_{ji}	*0.0072*	*0.0079*	*0.3580*	*0.0350*	*0.0104*	*0.0008*	*0.0071*	*0.0063*	*0.2609*	*0.0041*	*0.0058*	*0.4814*
β_{jj}	*0.0423*	*0.0183*	*0.0204*	*-0.0725*	*0.0165*	*0.0000*	*-0.0645*	*0.0193*	*0.0008*	*0.1307*	*0.0194*	*0.0000*
ω_{ii}	*0.9302*	*0.0493*	*0.0000*	*0.8696*	*0.0255*	*0.0000*	*1.1509*	*0.0643*	*0.0000*	*1.1172*	*0.0539*	*0.0000*
ω_{ij}	*-0.2506*	*0.0293*	*0.0000*	*-0.2708*	*0.0069*	*0.0000*	*0.0534*	*0.0147*	*0.0003*	*0.0424*	*0.0128*	*0.0009*
ω_{jj}	*0.0000*	*0.1273*	*0.9999*	*0.2589*	*0.0230*	*0.0000*	*0.0000*	*0.0372*	*1.0000*	*0.0000*	*0.0253*	*1.0000*
γ_{ii}	*1.2107*	*0.0302*	*0.0000*	*1.2447*	*0.0319*	*0.0000*	*1.2003*	*0.0302*	*0.0000*	*1.0684*	*0.0452*	*0.0000*
γ_{ij}	*0.0609*	*0.0179*	*0.0007*	*-0.1417*	*0.0104*	*0.0000*	*-0.0210*	*0.0124*	*0.0916*	*-0.0398*	*0.0110*	*0.0003*
γ_{ji}	*-0.9121*	*0.0379*	*0.0000*	*-0.0712*	*0.0454*	*0.1171*	*0.2230*	*0.0648*	*0.0006*	*0.6027*	*0.1036*	*0.0000*
γ_{jj}	*0.2556*	*0.0195*	*0.0000*	*0.3352*	*0.0182*	*0.0000*	*0.2021*	*0.0120*	*0.0000*	*0.2180*	*0.0132*	*0.0000*
δ_{ii}	*0.3086*	*0.0319*	*0.0000*	*0.1867*	*0.0035*	*0.0000*	*0.3489*	*0.0432*	*0.0000*	*0.3108*	*0.0450*	*0.0000*
δ_{ij}	*-0.0278*	*0.0092*	*0.0026*	*0.0998*	*0.0027*	*0.0000*	*0.0141*	*0.0071*	*0.0483*	*0.0265*	*0.0076*	*0.0005*
δ_{ji}	*0.4890*	*0.0264*	*0.0000*	*0.7060*	*0.0178*	*0.0000*	*0.1216*	*0.0358*	*0.0007*	*0.4061*	*0.0706*	*0.0000*
δ_{jj}	*0.9590*	*0.0077*	*0.0000*	*0.8436*	*0.0069*	*0.0000*	*0.9737*	*0.0039*	*0.0000*	*0.9513*	*0.0087*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-10804*			*-10554*			*-9897*			*-9101*		
LB_i	*17.66*			*27.31*			*15.52*			*21.69*		
LB_j	*42.29*			*61.12*			*27.29*			*30.69*		
LB^2_i	*0.164*			*0.133*			*0.148*			*0.2*		
LB^2_j	*22.7*			*36.31*			*29.03*			*32.39*		

Table 29: Tunisia (Before Crisis)

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	TUNISIA - BRIC			**TUNISIA - EM**			**TUNISIA - US**			**TUNISIA - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.0205*	*0.0203*	*0.3128*	*0.0167*	*0.0194*	*0.3891*	*0.0142*	*0.0204*	*0.4843*	*0.0135*	*0.0202*	*0.5036*
β_{ij}	*0.0142*	*0.0077*	*0.0662*	*0.0156*	*0.0092*	*0.0900*	*0.0028*	*0.0123*	*0.8184*	*0.0136*	*0.0157*	*0.3868*
β_{ji}	*0.0347*	*0.0350*	*0.3216*	*0.0068*	*0.0334*	*0.8383*	*0.0464*	*0.0230*	*0.0442*	*0.0329*	*0.0180*	*0.0680*
β_{jj}	*0.0200*	*0.0193*	*0.3011*	*0.0365*	*0.0201*	*0.0701*	*-0.0445*	*0.0215*	*0.0384*	*0.1467*	*0.0195*	*0.0000*
ω_{ii}	*0.1119*	*0.0098*	*0.0000*	*0.1146*	*0.0148*	*0.0000*	*0.1287*	*0.0221*	*0.0000*	*0.1341*	*0.0217*	*0.0000*
ω_{ij}	*0.2489*	*0.0036*	*0.0000*	*0.3080*	*0.0596*	*0.0000*	*0.0588*	*0.0258*	*0.0227*	*0.0956*	*0.0220*	*0.0000*
ω_{jj}	*0.1652*	*0.0311*	*0.0000*	*0.0871*	*0.1635*	*0.5943*	*-0.0583*	*0.0298*	*0.0502*	*0.0415*	*0.0346*	*0.2313*
γ_{ii}	*0.1811*	*0.0057*	*0.0000*	*0.1765*	*0.0196*	*0.0000*	*0.1986*	*0.0238*	*0.0000*	*0.1990*	*0.0241*	*0.0000*
γ_{ij}	*0.1453*	*0.0244*	*0.0000*	*0.1336*	*0.0312*	*0.0000*	*0.1092*	*0.0247*	*0.0000*	*0.0673*	*0.0190*	*0.0004*
γ_{ji}	*0.0069*	*0.0069*	*0.3172*	*0.0058*	*0.0078*	*0.4515*	*-0.0005*	*0.0157*	*0.9771*	*0.0002*	*0.0169*	*0.9895*
γ_{jj}	*0.3222*	*0.0162*	*0.0000*	*0.3232*	*0.0192*	*0.0000*	*0.2324*	*0.0158*	*0.0000*	*0.2498*	*0.0181*	*0.0000*
δ_{ii}	*0.9731*	*0.0020*	*0.0000*	*0.9736*	*0.0053*	*0.0000*	*0.9658*	*0.0089*	*0.0000*	*0.9652*	*0.0088*	*0.0000*
δ_{ij}	*-0.0531*	*0.0016*	*0.0000*	*-0.0599*	*0.0147*	*0.0000*	*-0.0267*	*0.0093*	*0.0043*	*-0.0258*	*0.0079*	*0.0011*
δ_{ji}	*-0.0068*	*0.0024*	*0.0043*	*-0.0083*	*0.0032*	*0.0084*	*-0.0049*	*0.0043*	*0.2547*	*-0.0076*	*0.0053*	*0.1523*
δ_{jj}	*0.9282*	*0.0058*	*0.0000*	*0.9201*	*0.0098*	*0.0000*	*0.9675*	*0.0044*	*0.0000*	*0.9597*	*0.0060*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-8167*			*-7927*			*-7048*			*-6383*		
LB_i	*49.81*			*49.62*			*49.29*			*49.05*		
LB_j	*43.21*			*39.81*			*24.22*			*27.79*		
LB^2_i	*21.27*			*23.19*			*18.7*			*18.22*		
LB^2_j	*17.92*			*22.48*			*23.12*			*25.84*		

Table 30: Zambia (Before Crisis)

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	ZAMBIA - BRIC			**ZAMBIA - EM**			**ZAMBIA - US**			**ZAMBIA - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.0422*	*0.0188*	*0.0251*	*-0.0436*	*0.0195*	*0.0251*	*-0.0401*	*0.0221*	*0.0696*	*-0.0374*	*0.0208*	*0.0731*
β_{ij}	*0.0085*	*0.0150*	*0.5680*	*0.0171*	*0.0173*	*0.3206*	*-0.0287*	*0.0220*	*0.1937*	*-0.0199*	*0.0308*	*0.5178*
β_{ji}	*0.0251*	*0.0144*	*0.0812*	*0.0244*	*0.0156*	*0.1168*	*0.0139*	*0.0111*	*0.2098*	*0.0089*	*0.0075*	*0.2336*
β_{jj}	*0.0281*	*0.0216*	*0.1922*	*0.0434*	*0.0224*	*0.0531*	*-0.0408*	*0.0205*	*0.0472*	*0.1579*	*0.0192*	*0.0000*
ω_{ii}	*0.1641*	*0.0272*	*0.0000*	*0.1801*	*0.0269*	*0.0000*	*0.2169*	*0.0334*	*0.0000*	*0.1938*	*0.0293*	*0.0000*
ω_{ij}	*-0.2484*	*0.0534*	*0.0000*	*-0.2408*	*0.0520*	*0.0000*	*-0.0462*	*0.0173*	*0.0075*	*-0.0483*	*0.0172*	*0.0050*
ω_{jj}	*0.2451*	*0.0515*	*0.0000*	*0.2520*	*0.0474*	*0.0000*	*0.0673*	*0.0177*	*0.0001*	*0.0718*	*0.0144*	*0.0000*
γ_{ii}	*0.2018*	*0.0159*	*0.0000*	*0.2085*	*0.0178*	*0.0000*	*0.2393*	*0.0253*	*0.0000*	*0.2186*	*0.0220*	*0.0000*
γ_{ij}	*-0.0375*	*0.0136*	*0.0059*	*-0.0273*	*0.0139*	*0.0499*	*-0.0108*	*0.0086*	*0.2054*	*-0.0063*	*0.0067*	*0.3482*
γ_{ji}	*-0.0400*	*0.0146*	*0.0061*	*-0.0267*	*0.0154*	*0.0837*	*0.0021*	*0.0202*	*0.9152*	*-0.0232*	*0.0248*	*0.3487*
γ_{jj}	*0.3501*	*0.0225*	*0.0000*	*0.3370*	*0.0195*	*0.0000*	*0.2136*	*0.0159*	*0.0000*	*0.2433*	*0.0172*	*0.0000*
δ_{ii}	*0.9742*	*0.0042*	*0.0000*	*0.9731*	*0.0046*	*0.0000*	*0.9647*	*0.0076*	*0.0000*	*0.9705*	*0.0060*	*0.0000*
δ_{ij}	*0.0107*	*0.0050*	*0.0321*	*0.0085*	*0.0047*	*0.0724*	*0.0049*	*0.0025*	*0.0551*	*0.0030*	*0.0020*	*0.1305*
δ_{ji}	*0.0281*	*0.0064*	*0.0000*	*0.0261*	*0.0073*	*0.0003*	*0.0029*	*0.0053*	*0.5835*	*0.0128*	*0.0072*	*0.0760*
δ_{jj}	*0.9141*	*0.0118*	*0.0000*	*0.9131*	*0.0106*	*0.0000*	*0.9746*	*0.0038*	*0.0000*	*0.9655*	*0.0049*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-10333*			*-10100*			*-9213*			*-8563*		
LB_i	*40.56*			*40.6*			*39.42*			*40.27*		
LB_j	*40.72*			*39.24*			*25.11*			*27.02*		
LB^2_i	*21.61*			*19.43*			*15.22*			*17.44*		
LB^2_j	*19.15*			*20.93*			*25.37*			*27.78*		

3.5.5 Spillover and Volatility During and After Crisis

Table 31: Crisis Results - Egypt

Panel A: VAR(1)- GARCH BEKK (1. 1)-BEKK estimations												
	EGYPT - EM			**EGYPT - US**			**EGYPT - WORLD**			**EGYPT - BRIC**		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.0547*	*0.0387*	*0.1571*	*-0.0496*	*0.0407*	*0.2228*	*-0.0472*	*0.0389*	*0.2248*	*-0.2062*	*0.0383*	*0.0000*
β_{ij}	*0.1543*	*0.0348*	*0.0000*	*0.1419*	*0.0415*	*0.0006*	*0.3566*	*0.0540*	*0.0000*	*0.7444*	*0.0586*	*0.0000*
β_{ji}	*-0.0090*	*0.0118*	*0.4430*	*-0.0118*	*0.0121*	*0.3294*	*0.0112*	*0.0074*	*0.1321*	*-0.0049*	*0.0096*	*0.6069*
β_{jj}	*0.0219*	*0.0296*	*0.4582*	*-0.0360*	*0.0313*	*0.2499*	*-0.0446*	*0.0332*	*0.1789*	*0.0190*	*0.0289*	*0.5115*
ω_{ii}	*1.3590*	*0.0952*	*0.0000*	*1.3547*	*0.1015*	*0.0000*	*1.3603*	*0.1021*	*0.0000*	*0.3084*	*0.1680*	*0.0664*
ω_{ij}	*0.0762*	*0.0338*	*0.0242*	*0.1168*	*0.0338*	*0.0005*	*-0.0214*	*0.0268*	*0.4237*	*-0.0092*	*0.1315*	*0.9443*
ω_{jj}	*-0.1149*	*0.0429*	*0.0074*	*-0.1114*	*0.0440*	*0.0113*	*0.1348*	*0.0232*	*0.0000*	*0.1342*	*0.0303*	*0.0000*
γ_{ii}	*0.4099*	*0.0389*	*0.0000*	*0.4280*	*0.0426*	*0.0000*	*0.3884*	*0.0386*	*0.0000*	*0.7934*	*0.0570*	*0.0000*
γ_{ij}	*0.0181*	*0.0155*	*0.2422*	*0.0260*	*0.0142*	*0.0665*	*-0.0111*	*0.0100*	*0.2645*	*0.0451*	*0.0121*	*0.0002*
γ_{ji}	*-0.0669*	*0.0394*	*0.0895*	*-0.1331*	*0.0487*	*0.0063*	*-0.0543*	*0.0792*	*0.4930*	*-1.1340*	*0.0778*	*0.0000*
γ_{jj}	*0.2691*	*0.0188*	*0.0000*	*0.2616*	*0.0206*	*0.0000*	*0.3213*	*0.0230*	*0.0000*	*0.1677*	*0.0251*	*0.0000*
δ_{ii}	*0.8359*	*0.0238*	*0.0000*	*0.8314*	*0.0271*	*0.0000*	*0.8420*	*0.0231*	*0.0000*	*0.7625*	*0.0187*	*0.0000*
δ_{ij}	*-0.0130*	*0.0083*	*0.1180*	*-0.0167*	*0.0076*	*0.0289*	*0.0065*	*0.0055*	*0.2399*	*-0.0148*	*0.0041*	*0.0003*
δ_{ji}	*0.0324*	*0.0124*	*0.0088*	*0.0387*	*0.0156*	*0.0132*	*0.0348*	*0.0235*	*0.1375*	*0.1757*	*0.0345*	*0.0000*
δ_{jj}	*0.9630*	*0.0051*	*0.0000*	*0.9638*	*0.0057*	*0.0000*	*0.9425*	*0.0072*	*0.0000*	*0.9751*	*0.0051*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-5284*	*-5210*		*-5210*			*-4880*			*-4783*		
LB_i	*20.885*	*20*		*20*			*18.91*			*17.1*		
LB_j	*33.139*	*33.57*		*33.57*			*17.39*			*26.53*		
LB^2_i	*0.2144*	*0.221*		*0.221*			*0.218*			*0.463*		
LB^2_j	*24.478*	*26.54*		*26.54*			*40.02*			*74.81*		

Table 32: Crisis Results - Kenya

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	KENYA - BRIC			***KENYA - EM***			***KENYA - US***			***KENYA - WORLD***		
Parameters	*Coeff.*	*SE.*	*Sig.*	*Coeff.*	*SE.*	*Sig.*	*Coeff.*	*SE.*	*Sig.*	*Coeff.*	*SE.*	*Sig.*
β_{ii}	*0.3813*	*0.0294*	*0.0000*	*0.3784*	*0.0285*	*0.0000*	*0.3810*	*0.0267*	*0.0000*	*0.3954*	*0.0245*	*0.0000*
β_{ij}	*0.0335*	*0.0101*	*0.0009*	*0.0269*	*0.0119*	*0.0233*	*0.0537*	*0.0174*	*0.0020*	*0.0558*	*0.0191*	*0.0035*
β_{ji}	*-0.1016*	*0.0559*	*0.0689*	*-0.0995*	*0.0507*	*0.0497*	*-0.0769*	*0.0363*	*0.0341*	*-0.0886*	*0.0369*	*0.0165*
β_{jj}	*0.0105*	*0.0282*	*0.7108*	*-0.0534*	*0.0278*	*0.0551*	*-0.0597*	*0.0262*	*0.0225*	*0.0999*	*0.0293*	*0.0006*
ω_{ii}	*0.1846*	*0.0496*	*0.0002*	*0.1623*	*0.0262*	*0.0000*	*0.1969*	*0.0235*	*0.0000*	*0.1696*	*0.0257*	*0.0000*
ω_{ij}	*0.0333*	*0.0542*	*0.5386*	*0.0386*	*0.0551*	*0.4833*	*-0.0998*	*0.0378*	*0.0083*	*-0.0822*	*0.0517*	*0.1114*
ω_{ii}	*0.1316*	*0.0631*	*0.0370*	*0.1071*	*0.0691*	*0.1210*	*0.0001*	*0.0748*	*0.9986*	*0.0000*	*0.1445*	*1.0000*
γ_{ii}	*0.2975*	*0.0506*	*0.0000*	*0.2844*	*0.0365*	*0.0000*	*0.2373*	*0.0333*	*0.0000*	*0.2298*	*0.0330*	*0.0000*
γ_{ij}	*0.0212*	*0.0660*	*0.7480*	*-0.0403*	*0.0656*	*0.5388*	*-0.2033*	*0.0387*	*0.0000*	*-0.2027*	*0.0403*	*0.0000*
γ_{ji}	*0.0877*	*0.0209*	*0.0000*	*0.0877*	*0.0140*	*0.0000*	*0.1905*	*0.0178*	*0.0000*	*0.1823*	*0.0257*	*0.0000*
γ_{ii}	*0.2494*	*0.0244*	*0.0000*	*0.2451*	*0.0250*	*0.0000*	*0.2038*	*0.0285*	*0.0000*	*0.1850*	*0.0325*	*0.0000*
δ_{ii}	*0.8992*	*0.0414*	*0.0000*	*0.9156*	*0.0188*	*0.0000*	*0.8762*	*0.0206*	*0.0000*	*0.9045*	*0.0199*	*0.0000*
δ_{ij}	*0.1014*	*0.0341*	*0.0029*	*0.1079*	*0.0309*	*0.0005*	*0.2473*	*0.0242*	*0.0000*	*0.2375*	*0.0365*	*0.0000*
δ_{ji}	*-0.0346*	*0.0049*	*0.0000*	*-0.0354*	*0.0051*	*0.0000*	*-0.0728*	*0.0072*	*0.0000*	*-0.0783*	*0.0100*	*0.0000*
δ_{jj}	*0.9591*	*0.0066*	*0.0000*	*0.9589*	*0.0068*	*0.0000*	*0.9449*	*0.0070*	*0.0000*	*0.9428*	*0.0100*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-3580*			*-3503*			*-3167*			*-3089*		
LB_i	*41.43*			*40.98*			*38.02*			*37.42*		
LB_j	*32.28*			*33.57*			*17.18*			*19.06*		
LB^2_i	*19.64*			*18.25*			*26.05*			*23.95*		
LB^2_j	*24.93*			*24.01*			*32.79*			*29.09*		

Table 33: Crisis Results - Mauritius

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	MAURITIUS - BRIC			**MAURITIUS - EM**			**MAURITIUS - US**			**MAURITIUS - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.0918*	*0.0245*	*0.0002*	*-0.1121*	*0.0273*	*0.0000*	*-0.0894*	*0.0288*	*0.0019*	*-0.0977*	*0.0329*	*0.0029*
β_{ij}	*0.1177*	*0.0142*	*0.0000*	*0.1193*	*0.0133*	*0.0000*	*0.1588*	*0.0220*	*0.0000*	*0.2053*	*0.0233*	*0.0000*
β_{ji}	*-0.0311*	*0.0401*	*0.4379*	*-0.0608*	*0.0366*	*0.0963*	*-0.0672*	*0.0292*	*0.0215*	*-0.0539*	*0.0259*	*0.0371*
β_{jj}	*0.0329*	*0.0297*	*0.2680*	*-0.0540*	*0.0261*	*0.0381*	*-0.0881*	*0.0290*	*0.0024*	*0.0885*	*0.0300*	*0.0032*
ω_{ii}	*0.2284*	*0.0271*	*0.0000*	*0.2358*	*0.0274*	*0.0000*	*0.1946*	*0.0335*	*0.0000*	*0.1463*	*0.0292*	*0.0000*
ω_{ij}	*-0.0138*	*0.0635*	*0.8284*	*-0.0596*	*0.0373*	*0.1097*	*-0.0775*	*0.0321*	*0.0156*	*-0.1153*	*0.0296*	*0.0001*
ω_{jj}	*0.0000*	*0.0873*	*1.0000*	*-0.1119*	*0.0386*	*0.0037*	*-0.1250*	*0.0267*	*0.0000*	*0.1122*	*0.0286*	*0.0001*
γ_{ii}	*0.3311*	*0.0392*	*0.0000*	*0.4553*	*0.0302*	*0.0000*	*0.3711*	*0.0374*	*0.0000*	*0.3014*	*0.0418*	*0.0000*
γ_{ij}	*0.1395*	*0.0384*	*0.0003*	*0.0283*	*0.0404*	*0.4834*	*-0.1490*	*0.0344*	*0.0000*	*-0.0362*	*0.0276*	*0.1892*
γ_{ji}	*-0.0800*	*0.0208*	*0.0001*	*0.0917*	*0.0180*	*0.0000*	*0.1574*	*0.0253*	*0.0000*	*-0.0316*	*0.0260*	*0.2227*
γ_{jj}	*0.2823*	*0.0247*	*0.0000*	*0.2324*	*0.0187*	*0.0000*	*0.2162*	*0.0265*	*0.0000*	*0.2905*	*0.0271*	*0.0000*
δ_{ii}	*0.8863*	*0.0191*	*0.0000*	*0.8635*	*0.0183*	*0.0000*	*0.8991*	*0.0179*	*0.0000*	*0.9462*	*0.0148*	*0.0000*
δ_{ij}	*-0.2566*	*0.0211*	*0.0000*	*0.0255*	*0.0170*	*0.1336*	*0.0757*	*0.0157*	*0.0000*	*0.0216*	*0.0100*	*0.0296*
δ_{ji}	*0.0958*	*0.0073*	*0.0000*	*-0.0184*	*0.0053*	*0.0005*	*-0.0318*	*0.0083*	*0.0001*	*0.0137*	*0.0088*	*0.1197*
δ_{jj}	*0.9609*	*0.0077*	*0.0000*	*0.9666*	*0.0045*	*0.0000*	*0.9578*	*0.0053*	*0.0000*	*0.9479*	*0.0097*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-4007*			*-3902*			*-3588*			*-3501*		
LB_i	*56.95*			*67.096*			*59.41*			*56.306*		
LB_j	*33.81*			*32.603*			*17.32*			*18.581*		
LB^2_i	*35.17*			*15.591*			*22.17*			*26.925*		
LB^2_j	*33.52*			*26.839*			*86.82*			*37.749*		

Table 34: Crisis Results - Morocco

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	MOROCCO - BRIC			**MOROCCO - EM**			**MOROCCO - US**			**MOROCCO - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.0004*	*0.0286*	*0.9881*	*0.0058*	*0.0296*	*0.8444*	*-0.0182*	*0.0286*	*0.5246*	*-0.0138*	*0.0328*	*0.6733*
β_{ij}	*-0.0034*	*0.0189*	*0.8572*	*-0.0218*	*0.0185*	*0.2400*	*0.0790*	*0.0229*	*0.0006*	*0.0232*	*0.0298*	*0.4351*
β_{ji}	*0.0017*	*0.0381*	*0.9643*	*0.0417*	*0.0378*	*0.2705*	*0.0387*	*0.0261*	*0.1379*	*0.0076*	*0.0284*	*0.7895*
β_{jj}	*-0.0028*	*0.0307*	*0.9272*	*-0.0621*	*0.0302*	*0.0399*	*-0.0716*	*0.0325*	*0.0274*	*0.0933*	*0.0327*	*0.0043*
ω_{ii}	*0.6127*	*0.0627*	*0.0000*	*0.1323*	*0.0232*	*0.0000*	*0.1439*	*0.0405*	*0.0004*	*0.1377*	*0.0315*	*0.0000*
ω_{ij}	*-0.0439*	*0.0506*	*0.3855*	*0.1176*	*0.1092*	*0.2815*	*-0.0157*	*0.1099*	*0.8861*	*0.0061*	*0.0730*	*0.9329*
ω_{jj}	*0.0000*	*0.0651*	*1.0000*	*-0.0971*	*0.1145*	*0.3965*	*0.1461*	*0.0290*	*0.0000*	*0.1350*	*0.0227*	*0.0000*
γ_{ii}	*0.2908*	*0.0381*	*0.0000*	*0.1552*	*0.0223*	*0.0000*	*0.1743*	*0.0291*	*0.0000*	*0.1878*	*0.0294*	*0.0000*
γ_{ij}	*-0.0926*	*0.0449*	*0.0391*	*-0.0136*	*0.0550*	*0.8042*	*0.0234*	*0.0319*	*0.4623*	*-0.0049*	*0.0287*	*0.8632*
γ_{ji}	*0.1808*	*0.0247*	*0.0000*	*0.0236*	*0.0179*	*0.1882*	*-0.0273*	*0.0263*	*0.2984*	*-0.0193*	*0.0289*	*0.5054*
γ_{jj}	*0.2525*	*0.0266*	*0.0000*	*0.2849*	*0.0232*	*0.0000*	*0.3297*	*0.0264*	*0.0000*	*0.2944*	*0.0272*	*0.0000*
δ_{ii}	*0.6989*	*0.0625*	*0.0000*	*0.9783*	*0.0046*	*0.0000*	*0.9730*	*0.0103*	*0.0000*	*0.9710*	*0.0093*	*0.0000*
δ_{ij}	*0.1200*	*0.0340*	*0.0004*	*-0.0148*	*0.0260*	*0.5705*	*0.0029*	*0.0210*	*0.8897*	*0.0038*	*0.0147*	*0.7984*
δ_{ji}	*0.0138*	*0.0169*	*0.4163*	*-0.0009*	*0.0060*	*0.8876*	*0.0124*	*0.0086*	*0.1506*	*0.0108*	*0.0084*	*0.1980*
δ_{jj}	*0.9400*	*0.0089*	*0.0000*	*0.9600*	*0.0077*	*0.0000*	*0.9371*	*0.0095*	*0.0000*	*0.9494*	*0.0088*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-4022*			*-3943*			*-3630*			*-3505*		
LB_i	*13.02*			*16.4*			*18.84*			*17.45*		
LB_j	*32.7*			*32.55*			*17.36*			*19.23*		
LB^2_i	*50.86*			*25.89*			*27.95*			*25.38*		
LB^2_j	*20.96*			*24.98*			*38.74*			*33.06*		

Table 35: Crisis Results - South Africa

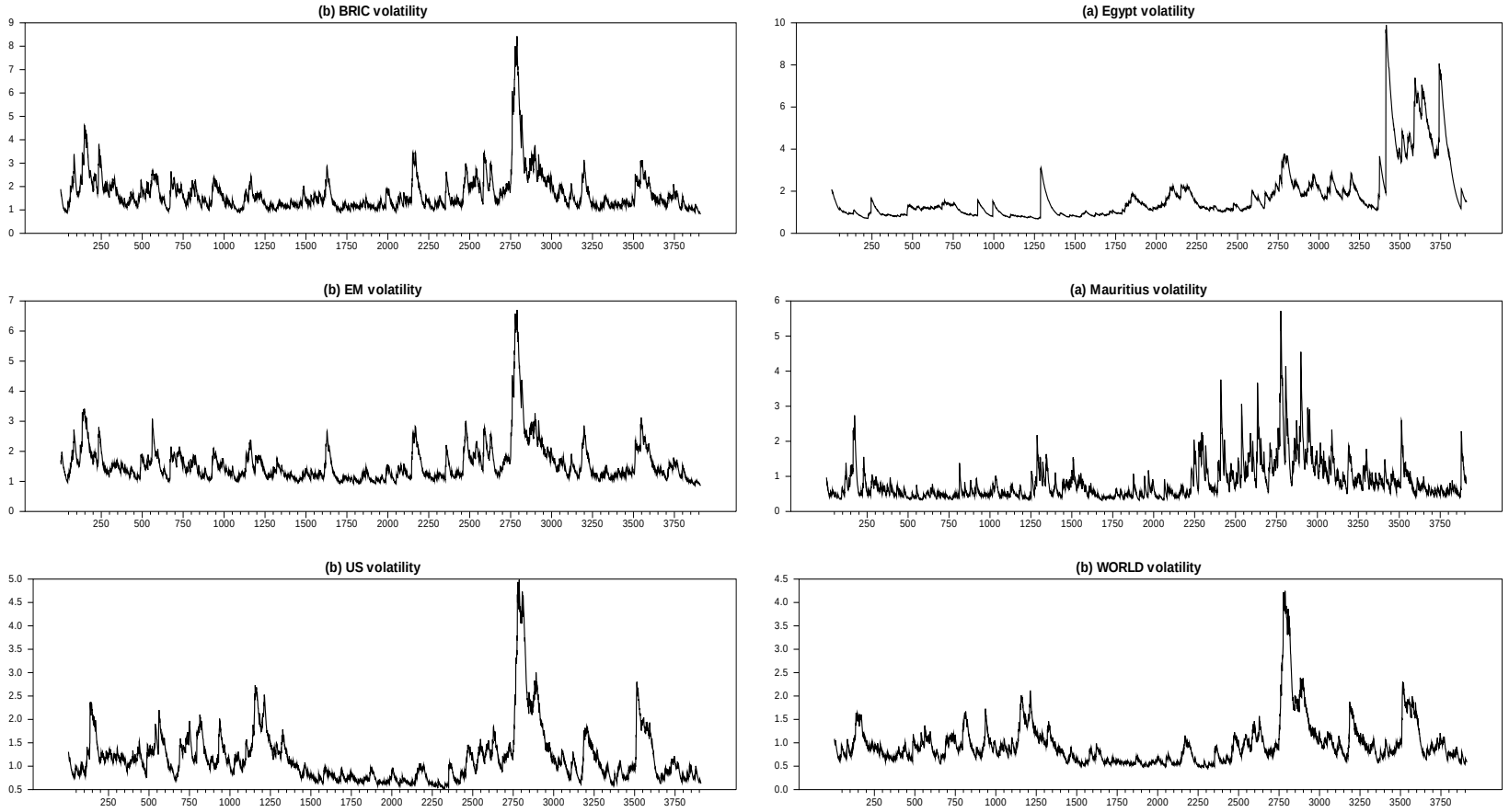
Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	SOUTH AFRICA - BRIC			**SOUTH AFRICA - EM**			**SOUTH AFRICA - US**			**SOUTH AFRICA - WORLD**		
Parameters	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.1710*	*0.0402*	*0.0000*	*-0.1185*	*0.0417*	*0.0045*	*-0.1940*	*0.0320*	*0.0000*	*-0.2478*	*0.0423*	*0.0000*
β_{ij}	*0.2181*	*0.0466*	*0.0000*	*0.1358*	*0.0528*	*0.0101*	*0.5040*	*0.0516*	*0.0000*	*0.5253*	*0.0703*	*0.0000*
β_{ji}	*0.0404*	*0.0350*	*0.2480*	*0.1323*	*0.0347*	*0.0001*	*0.0560*	*0.0203*	*0.0058*	*0.0045*	*0.0246*	*0.8545*
β_{jj}	*-0.0197*	*0.0412*	*0.6323*	*-0.1638*	*0.0448*	*0.0003*	*-0.1083*	*0.0359*	*0.0025*	*0.0995*	*0.0429*	*0.0203*
ω_{ii}	*-0.0853*	*0.0718*	*0.2344*	*-0.0057*	*0.0749*	*0.9397*	*0.0796*	*0.0490*	*0.1039*	*0.0737*	*0.0408*	*0.0707*
ω_{ij}	*0.1314*	*0.0514*	*0.0106*	*-0.1559*	*0.0429*	*0.0003*	*-0.1476*	*0.0214*	*0.0000*	*-0.1082*	*0.0218*	*0.0000*
ω_{jj}	*0.0000*	*0.1966*	*1.0000*	*-0.0125*	*0.0234*	*0.5935*	*0.0000*	*0.1990*	*1.0000*	*0.0000*	*0.1707*	*0.9999*
γ_{ii}	*0.0375*	*0.0492*	*0.4454*	*0.1482*	*0.0548*	*0.0068*	*0.2265*	*0.0330*	*0.0000*	*0.2527*	*0.0542*	*0.0000*
γ_{ij}	*-0.1339*	*0.0457*	*0.0034*	*0.0143*	*0.0490*	*0.7703*	*-0.0655*	*0.0341*	*0.0545*	*-0.0538*	*0.0408*	*0.1878*
γ_{ji}	*0.3011*	*0.0454*	*0.0000*	*0.2296*	*0.0573*	*0.0001*	*0.0108*	*0.0524*	*0.8374*	*-0.0407*	*0.0949*	*0.6685*
γ_{jj}	*0.3652*	*0.0372*	*0.0000*	*0.2724*	*0.0432*	*0.0000*	*0.3869*	*0.0339*	*0.0000*	*0.3333*	*0.0508*	*0.0000*
δ_{ii}	*1.0918*	*0.0156*	*0.0000*	*1.0701*	*0.0156*	*0.0000*	*0.9728*	*0.0092*	*0.0000*	*0.9629*	*0.0165*	*0.0000*
δ_{ij}	*0.1610*	*0.0157*	*0.0000*	*0.1038*	*0.0157*	*0.0000*	*0.0274*	*0.0093*	*0.0031*	*0.0225*	*0.0124*	*0.0694*
δ_{ji}	*-0.2123*	*0.0233*	*0.0000*	*-0.1852*	*0.0235*	*0.0000*	*0.0006*	*0.0183*	*0.9721*	*0.0210*	*0.0310*	*0.4990*
δ_{jj}	*0.8145*	*0.0156*	*0.0000*	*0.8496*	*0.0173*	*0.0000*	*0.9121*	*0.0130*	*0.0000*	*0.9306*	*0.0183*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-4237*			*-4062*			*-4055*			*-3739*		
LB_i	*22.32*			*22.04*			*24.26*			*24.4*		
LB_j	*34.49*			*34.25*			*20.66*			*18.96*		
LB^2_i	*24.95*			*26.98*			*36.98*			*38.76*		
LB^2_j	*31.92*			*28.67*			*38.65*			*38.75*		

Table 36: Crisis Results - Tunisia

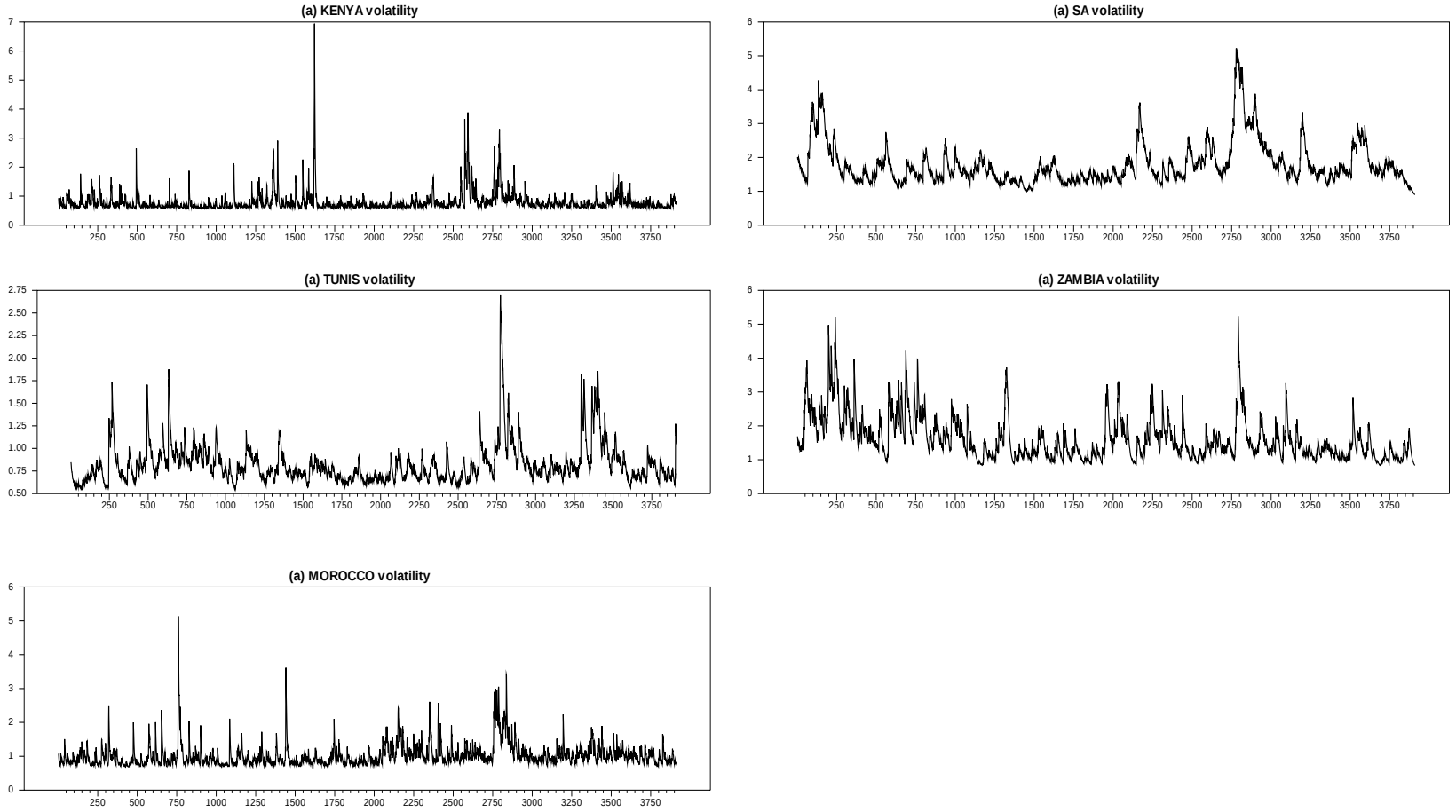
Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	TUNISIA - BRIC			**TUNISIA - EM**			**TUNISIA - US**			**TUNISIA - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*-0.071*	*0.030*	*0.019*	*-0.070*	*0.033*	*0.036*	*-0.080*	*0.032*	*0.012*	*-0.075*	*0.034*	*0.029*
β_{ij}	*0.013*	*0.013*	*0.325*	*0.004*	*0.013*	*0.770*	*0.061*	*0.018*	*0.001*	*0.036*	*0.021*	*0.085*
β_{ji}	*-0.008*	*0.043*	*0.844*	*0.000*	*0.038*	*0.995*	*0.016*	*0.030*	*0.588*	*-0.058*	*0.030*	*0.054*
β_{jj}	*0.015*	*0.027*	*0.571*	*-0.051*	*0.025*	*0.045*	*-0.025*	*0.030*	*0.404*	*0.141*	*0.027*	*0.000*
ω_{ii}	*0.312*	*0.050*	*0.000*	*0.341*	*0.079*	*0.000*	*0.626*	*0.070*	*0.000*	*0.705*	*0.039*	*0.000*
ω_{ij}	*0.078*	*0.042*	*0.066*	*0.083*	*0.054*	*0.127*	*0.093*	*0.031*	*0.003*	*0.147*	*0.038*	*0.000*
ω_{jj}	*0.000*	*0.239*	*1.000*	*-0.064*	*0.098*	*0.512*	*0.134*	*0.022*	*0.000*	*-0.106*	*0.041*	*0.010*
γ_{ii}	*0.419*	*0.040*	*0.000*	*0.422*	*0.046*	*0.000*	*0.543*	*0.041*	*0.000*	*0.595*	*0.043*	*0.000*
γ_{ij}	*-0.113*	*0.034*	*0.001*	*-0.079*	*0.049*	*0.110*	*0.014*	*0.035*	*0.683*	*-0.012*	*0.036*	*0.736*
γ_{ji}	*0.034*	*0.019*	*0.076*	*0.038*	*0.026*	*0.146*	*-0.180*	*0.047*	*0.000*	*-0.280*	*0.039*	*0.000*
γ_{jj}	*0.275*	*0.019*	*0.000*	*0.276*	*0.020*	*0.000*	*0.291*	*0.022*	*0.000*	*0.268*	*0.027*	*0.000*
δ_{ii}	*0.844*	*0.037*	*0.000*	*0.826*	*0.063*	*0.000*	*0.495*	*0.123*	*0.000*	*0.238*	*0.120*	*0.047*
δ_{ij}	*0.040*	*0.022*	*0.071*	*0.024*	*0.042*	*0.572*	*-0.083*	*0.052*	*0.114*	*-0.088*	*0.062*	*0.159*
δ_{ji}	*-0.001*	*0.005*	*0.904*	*0.002*	*0.006*	*0.812*	*0.075*	*0.021*	*0.000*	*0.161*	*0.027*	*0.000*
δ_{jj}	*0.958*	*0.005*	*0.000*	*0.959*	*0.007*	*0.000*	*0.956*	*0.008*	*0.000*	*0.970*	*0.012*	*0.000*
Panel B: Diagnostic tests												
LogLik	*-3785*			*-3717*			*-3415*			*-3284*		
LB_i	*26.94*			*26.62*			*28.92*			*27.63*		
LB_j	*32.79*			*32.16*			*19.2*			*21.65*		
LB^2_i	*40.54*			*39.83*			*44*			*51.5*		
LB^2_j	*24.05*			*25.05*			*42.78*			*35.16*		

Table 37: Crisis Results - Zambia

Panel A: VAR(1)- GARCH(1. 1)-BEKK estimations												
	ZAMBIA - BRIC			**ZAMBIA - EM**			**ZAMBIA - US**			**ZAMBIA - WORLD**		
Variable	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.	Coeff.	SE.	Sig.
β_{ii}	*0.1145*	*0.0322*	*0.0004*	*0.1085*	*0.0314*	*0.0006*	*0.1089*	*0.0311*	*0.0005*	*0.1109*	*0.0345*	*0.0013*
β_{ij}	*0.0631*	*0.0167*	*0.0002*	*0.0538*	*0.0173*	*0.0019*	*0.0997*	*0.0253*	*0.0001*	*0.1176*	*0.0279*	*0.0000*
β_{ji}	*-0.0024*	*0.0315*	*0.9386*	*-0.0008*	*0.0301*	*0.9781*	*-0.0291*	*0.0227*	*0.2014*	*-0.0169*	*0.0241*	*0.4838*
β_{jj}	*-0.0001*	*0.0267*	*0.9959*	*-0.0571*	*0.0268*	*0.0329*	*-0.0622*	*0.0312*	*0.0460*	*0.0942*	*0.0313*	*0.0026*
ω_{ii}	*0.3181*	*0.0456*	*0.0000*	*0.2485*	*0.0345*	*0.0000*	*0.3509*	*0.0477*	*0.0000*	*0.3358*	*0.0447*	*0.0000*
ω_{ij}	*0.0559*	*0.0449*	*0.2133*	*0.0871*	*0.0465*	*0.0608*	*-0.0020*	*0.0526*	*0.9704*	*-0.0162*	*0.0356*	*0.6499*
ω_{jj}	*0.1480*	*0.0355*	*0.0000*	*-0.0001*	*0.7328*	*0.9998*	*0.1483*	*0.0200*	*0.0000*	*0.1318*	*0.0211*	*0.0000*
γ_{ii}	*0.4309*	*0.0408*	*0.0000*	*0.3317*	*0.0388*	*0.0000*	*0.4606*	*0.0439*	*0.0000*	*0.4619*	*0.0368*	*0.0000*
γ_{ij}	*-0.0077*	*0.0358*	*0.8306*	*-0.0566*	*0.0262*	*0.0308*	*-0.0264*	*0.0347*	*0.4464*	*0.0003*	*0.0238*	*0.9896*
γ_{ji}	*-0.0939*	*0.0175*	*0.0000*	*0.1022*	*0.0162*	*0.0000*	*-0.1087*	*0.0328*	*0.0009*	*-0.1846*	*0.0309*	*0.0000*
γ_{jj}	*0.2719*	*0.0230*	*0.0000*	*0.2817*	*0.0211*	*0.0000*	*0.3181*	*0.0239*	*0.0000*	*0.2795*	*0.0235*	*0.0000*
δ_{ii}	*0.8702*	*0.0216*	*0.0000*	*0.9183*	*0.0141*	*0.0000*	*0.8558*	*0.0258*	*0.0000*	*0.8480*	*0.0221*	*0.0000*
δ_{ij}	*-0.0372*	*0.0178*	*0.0364*	*0.0423*	*0.0126*	*0.0008*	*0.0025*	*0.0285*	*0.9297*	*-0.0142*	*0.0139*	*0.3048*
δ_{ji}	*0.0391*	*0.0064*	*0.0000*	*-0.0428*	*0.0064*	*0.0000*	*0.0452*	*0.0141*	*0.0014*	*0.0733*	*0.0126*	*0.0000*
δ_{jj}	*0.9631*	*0.0063*	*0.0000*	*0.9559*	*0.0052*	*0.0000*	*0.9445*	*0.0087*	*0.0000*	*0.9572*	*0.0076*	*0.0000*
Panel B: Diagnostic tests												
LogLik	*-4169*			*-4095*			*-3765*			*-3682*		
LB_i	*27.24*			*30.21*			*28.38*			*27.98*		
LB_j	*32.14*			*32.89*			*17.18*			*18.72*		
LB^2_i	*35.35*			*32.18*			*34.35*			*36.05*		
LB^2_j	*24.55*			*24.81*			*45.52*			*36.76*		



Figures 5- 10: Graphical presentation of volatility



Figures 11-14: Graphical presentation of volatility

5.7 Policy Implications

5.7.1 Portfolio Management and Diversification (RQ 4)

In the literature, international investment theory asserts that market segmentation has a positive bearing on international portfolio value. The theory on asset allocation posits that an asset contains both diversifiable and un-diversifiable risks (systematic risks) and for that matter a well-diversified portfolio has the potential to reduce the risk associated with the non-avoidable risk which is the systematic risk. In practice, international investors diversify their risks by investing in different assets across diverse borders with the aim of reducing considerably the negative effects of shocks and volatility from one market to the other. This, in the long run ensures that international investors reap positive results in the end. Without much guessing, it can be assumed reasonably that Emerging and Frontier Emerging markets provide the perfect segmented blend of markets that international investors include in their portfolios to enhance their returns; knowing that the developed markets are very integrated and hence offer little or no benefits of diversification. As pointed out, all the stock markets in Africa are Frontier Emerging markets or at best Emerging markets. Hence, the benefits of these markets to portfolio management and portfolio diversification cannot be underestimated. Evidence of this fact, is the 5% increase in foreign direct investment (FDI) to Africa from the year 2011 to 2012 (UNCTAD, 2013). It is estimated that over 50 billion dollars was invested in the African market by international firms and investors.

However, the emerging trend of integration or co-movements between the developed markets and the Emerging and Frontier Emerging financial markets may reduce the benefits of diversification for international investors. In other words, the diversification benefits erode away with the higher level of integration between the developed and developing financial markets. With this in mind, we can re-visit the research question posed in the introduction; "*do stock markets in Africa provide the maximum benefits of portfolio diversification"?* The results as presented in the previous pages show that part of the seven (7) African stock markets studied, three (3) namely: South Africa, Kenya and Egypt are integrated

with the world market whiles Zambia, Tunisia, Morocco are segmented. Mauritius serves as a source of export of shocks to the US and the World market.

It can be concluded from the above results that the Zambian market, Tunisian Market, Mauritian and the Moroccan market possess to an extent very feasible benefits of diversification considering that they are more segmented. In their study, Lagoarde-Segot et al (2007) analyzed the benefits of diversification on seven countries in the Middle East and North Africa (MENA). Included in this study are Egypt, Tunisia and Morocco and other four countries from the MENA region. They established an overwhelming diversification benefits in the MENA region. However, to assess the efficiency of portfolio diversifications of three African equity markets, Onour (2010) used equity price indices of Egypt, Morocco, and Tunisia and a co-integration method. He found that portfolio diversification strategies that include all these markets may not be effective as result of high transaction cost. He also cautioned international investors to be cautious in their portfolio strategies involving these markets. Another supporting evidence is the UNCTAD World Report on Investment (2013), it asserted that "*Investor confidence appears to have returned to North Africa, as FDI flows rose by 35 per cent to $11.5 billion in 2012. Much of the growth was due to a rise in investment in Egypt. However, across the sub-region, FDI flows also increased to Morocco and Tunisia, but decreased to Algeria and the Sudan"*. The above conclusion supports the findings of this study that these markets are still green for investment and provide maximum portfolio benefits.

Diversification benefits with African stock markets are dwindling over the years as a result of increased correlation with the US and World markets. However, the reduced benefits of diversification do not disappear entirely. Further, the increased correlations between the African and the developed markets are still small as compared to correlations between the developed markets (Harvey 1993). Divecha, et al (1992) find that these Emerging and Frontier Emerging markets even though volatile tend to be uncorrelated to other developed markets hence investment in these markets yield lower portfolio risk. Hence, the African market would provide some diversification benefits for a foreseeable future.

6. CONCLUSIONS

In this study, the level of financial integration between African equity markets, the world market, US market, Emerging markets index and the BRIC index were analyzed. Additionally, the return and volatility spillover between these markets were assessed. Moreover, the international linkages between the US, the world and the African equity markets are established.

Furthermore, it was pointed out that from the seven African markets studied, three (3) are very integrated into the US and World market and these are; South Africa, Kenya and Egypt. These markets are prone to returns and volatility spillover from the US and the world index. Egypt and Kenya exports volatility to the US and world. Collins (2003) found out that South Africa and Egypt were severely affected during the 1997-1998 Asian crisis. Samarakoon on the other hand, concluded that South Africa and Egypt were not affected by the 2008 U.S. financial crisis.

On the other hand, three (3) of the markets exhibited traits of high-level segmentation from the US and the world markets. These markets are: Tunisia, Morocco and Zambia. Meanwhile, a very special case exists with respect to Mauritius, for it exports volatility to all the markets under consideration but receives none back which makes it difficult to classify as segmented or integrated.

Return wise, South Africa receives past innovations from the US and the world indices but export none - hence making the US and the world indices *'the source'*. Tunisia serves as the source in return spillover by exporting past innovation to the US. Egypt receives from the US and the world but do not export to any of the markets under consideration. Morocco receives and exports past innovation to the US. Kenya also receives and exports past innovation from and to the US and the world market. Mauritius market receives return past innovation from the US and world but exports past return innovation to the world only. There exist a unidirectional relationship between Zambia all the markets. It receives from all the markets but exports to none.

Volatility wise, there is a spillover between the markets - in that South Africa receives volatility spillover from both the world and US. Egypt receives volatility spillover from the world index and exports to both US and world. Kenya receives volatility spillover from all the markets and exports to all the markets. This underscores a very high level of integration with the world and US markets. Tunisia, a much segmented market exports volatility to none of the markets and receives none from the other markets and so is Morocco and Zambia. Mauritius uniquely exports only volatility spillover to the other markets without receiving any back.

With as similar length of data, one particular suggestion for future studies is that the performance of African stock markets can be assessed during the various financial scenarios such as the Asian crisis of 1997, Russian crisis of 1998, the dotcom bubble of 2000 and even the sovereign debt crisis raging in Europe at the moment. This will be a very comprehensive study and the VAR GARCH- BEKK model can also be employed in such a study.

6.1 Contribution

The level of integration between the South Africa, Egypt, US and world market has been extensively established in the diverse literatures. Hence it is an expected scenario from the onset of this study. Truly as documented in other previous literatures, the South Africa and Egypt markets are well integrated with the US and world markets.

Surprisingly, however is the level of integration between the Kenyan, US and the world market. Kenya, like South Africa exhibits a very strong level of integration with all the indices in the study and especially with the US and the world indices.

With respect to returns, the Kenya market is influenced by the return past innovations from the US (16%), and the world market (24%). The Kenya market can be said to be highly integrated with the US and world market. Kenya market exports to the US (3%) and world (1%). Volatility wise, Kenya received shock spillover from the US (12%) and the world (8%). It also exports shock volatility

to all the markets under consideration especially the world index (54%), US (46%). This is a very intriguing results that adds to the existing knowledge about the level of integration of the Kenyan market.

Looking into the future and considering the fact that increased correlations between the African and the developed markets are still small compared to correlations between the developed markets; *Diversification* and the *benefits of diversification with* African stock markets will not disappear entirely. The African market will continue to serve as a secondary choice for *'wise-investors'* and a haven away from the highly correlated developed markets.

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APPENDICES

Appendix 1: ADF Test Results

Null Hypothesis: BRIC has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=30)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-52.18516	0.0001
Test critical values:	1% level	-3.431836	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BRIC)
Method: Least Squares
Date: 03/02/13 Time: 20:57
Sample (adjusted): 2/20/1998 2/18/2013
Included observations: 3912 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BRIC(-1)	-0.821101	0.015734	-52.18516	0.0000
C	0.031097	0.025348	1.226769	0.2200

R-squared	0.410549	Mean dependent var	-3.28E-05
Adjusted R-squared	0.410398	S.D. dependent var	2.064193
S.E. of regression	1.585002	Akaike info criterion	3.759559
Sum squared resid	9822.821	Schwarz criterion	3.762766
Log likelihood	-7351.698	Hannan-Quinn criter.	3.760697
F-statistic	2723.290	Durbin-Watson stat	1.985442
Prob(F-statistic)	0.000000		

Null Hypothesis: EGYPT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-54.63251	0.0001
Test critical values:	1% level	-3.431836	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EGYPT)
Method: Least Squares
Date: 03/02/13 Time: 20:59
Sample (adjusted): 2/20/1998 2/18/2013
Included observations: 3912 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EGYPT(-1)	-0.865802	0.015848	-54.63251	0.0000
C	0.025182	0.029219	0.861846	0.3888

R-squared	0.432899	Mean dependent var	2.51E-05
Adjusted R-squared	0.432754	S.D. dependent var	2.426152
S.E. of regression	1.827275	Akaike info criterion	4.044040
Sum squared resid	13055.23	Schwarz criterion	4.047246
Log likelihood	-7908.142	Hannan-Quinn criter.	4.045178
F-statistic	2984.711	Durbin-Watson stat	1.990348
Prob(F-statistic)	0.000000		

Null Hypothesis: EM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-49.46009	0.0001
Test critical values:	1% level	-3.431836	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EM)
Method: Least Squares
Date: 03/02/13 Time: 21:00
Sample (adjusted): 2/20/1998 2/18/2013
Included observations: 3912 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EM(-1)	-0.769642	0.015561	-49.46009	0.0000
C	0.025348	0.020128	1.259318	0.2080

R-squared	0.384862	Mean dependent var	-0.000334
Adjusted R-squared	0.384705	S.D. dependent var	1.604440
S.E. of regression	1.258535	Akaike info criterion	3.298285
Sum squared resid	6193.089	Schwarz criterion	3.301491
Log likelihood	-6449.445	Hannan-Quinn criter.	3.299423
F-statistic	2446.300	Durbin-Watson stat	1.983997
Prob(F-statistic)	0.000000		

Null Hypothesis: KENYA has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-44.44441	0.0000
Test critical values:	1% level	-3.431837	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(KENYA)
Method: Least Squares
Date: 03/02/13 Time: 21:01
Sample (adjusted): 2/23/1998 2/18/2013
Included observations: 3911 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
KENYA(-1)	-1.058154	0.023808	-44.44441	0.0000
D(KENYA(-1))	-0.046617	0.015980	-2.917244	0.0036
C	0.008523	0.025766	0.330796	0.7408

R-squared	0.555894	Mean dependent var	-0.000333
Adjusted R-squared	0.555667	S.D. dependent var	2.417218
S.E. of regression	1.611276	Akaike info criterion	3.792697
Sum squared resid	10145.99	Schwarz criterion	3.797508
Log likelihood	-7413.619	Hannan-Quinn criter.	3.794404
F-statistic	2445.853	Durbin-Watson stat	2.002252
Prob(F-statistic)	0.000000		

Null Hypothesis: MAURITIUS has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-25.36652	0.0000
Test critical values:	1% level	-3.431838	
	5% level	-2.862083	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MAURITIUS)
Method: Least Squares
Date: 03/02/13 Time: 21:02
Sample (adjusted): 2/25/1998 2/18/2013
Included observations: 3909 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAURITIUS(-1)	-0.695169	0.027405	-25.36652	0.0000
D(MAURITIUS(-1))	-0.182263	0.024882	-7.325008	0.0000
D(MAURITIUS(-2))	-0.146461	0.021121	-6.934418	0.0000
D(MAURITIUS(-3))	-0.084176	0.015947	-5.278647	0.0000
C	0.021758	0.012776	1.703094	0.0886

R-squared	0.438919	Mean dependent var	0.000152
Adjusted R-squared	0.438344	S.D. dependent var	1.063357
S.E. of regression	0.796920	Akaike info criterion	2.385152
Sum squared resid	2479.356	Schwarz criterion	2.393174
Log likelihood	-4656.780	Hannan-Quinn criter.	2.387999
F-statistic	763.4985	Durbin-Watson stat	1.999517
Prob(F-statistic)	0.000000		

Null Hypothesis: MOROCCO has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-54.39588	0.0001
Test critical values:	1% level	-3.431836	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MOROCCO)
Method: Least Squares
Date: 03/02/13 Time: 21:02
Sample (adjusted): 2/20/1998 2/18/2013
Included observations: 3912 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MOROCCO(-1)	-0.861693	0.015841	-54.39588	0.0000
C	0.021711	0.015500	1.400730	0.1614

R-squared	0.430769	Mean dependent var	-0.000246
Adjusted R-squared	0.430623	S.D. dependent var	1.284351
S.E. of regression	0.969133	Akaike info criterion	2.775682
Sum squared resid	3672.349	Schwarz criterion	2.778889
Log likelihood	-5427.234	Hannan-Quinn criter.	2.776820
F-statistic	2958.912	Durbin-Watson stat	2.005030
Prob(F-statistic)	0.000000		

Null Hypothesis: SA has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-59.26789	0.0001
Test critical values:	1% level	-3.431836	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SA)
Method: Least Squares
Date: 03/02/13 Time: 21:03
Sample (adjusted): 2/20/1998 2/18/2013
Included observations: 3912 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SA(-1)	-0.946473	0.015969	-59.26789	0.0000
C	0.049147	0.028748	1.709582	0.0874

R-squared	0.473236	Mean dependent var	0.000114
Adjusted R-squared	0.473102	S.D. dependent var	2.476055
S.E. of regression	1.797313	Akaike info criterion	4.010974
Sum squared resid	12630.61	Schwarz criterion	4.014180
Log likelihood	-7843.465	Hannan-Quinn criter.	4.012112
F-statistic	3512.683	Durbin-Watson stat	1.998513
Prob(F-statistic)	0.000000		

Null Hypothesis: TUNISIA has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-38.87953	0.0000
Test critical values:	1% level	-3.431837	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TUNISIA)
Method: Least Squares
Date: 03/02/13 Time: 21:03
Sample (adjusted): 2/23/1998 2/18/2013
Included observations: 3911 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TUNISIA(-1)	-0.811009	0.020860	-38.87953	0.0000
D(TUNISIA(-1))	-0.048327	0.015975	-3.025160	0.0025
C	0.027671	0.011138	2.484405	0.0130

R-squared	0.427412	Mean dependent var	-0.000216
Adjusted R-squared	0.427118	S.D. dependent var	0.918379
S.E. of regression	0.695111	Akaike info criterion	2.111278
Sum squared resid	1888.267	Schwarz criterion	2.116088
Log likelihood	-4125.603	Hannan-Quinn criter.	2.112985
F-statistic	1458.573	Durbin-Watson stat	1.999366
Prob(F-statistic)	0.000000		

Null Hypothesis: US has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-67.46723	0.0001
Test critical values:	1% level	-3.431836	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(US)
Method: Least Squares
Date: 03/02/13 Time: 21:04
Sample (adjusted): 2/20/1998 2/18/2013
Included observations: 3912 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
US(-1)	-1.075840	0.015946	-67.46723	0.0000
C	0.019868	0.020842	0.953265	0.3405

R-squared	0.537925	Mean dependent var	8.88E-05
Adjusted R-squared	0.537807	S.D. dependent var	1.917299
S.E. of regression	1.303472	Akaike info criterion	3.368451
Sum squared resid	6643.245	Schwarz criterion	3.371658
Log likelihood	-6586.691	Hannan-Quinn criter.	3.369589
F-statistic	4551.828	Durbin-Watson stat	2.006495
Prob(F-statistic)	0.000000		

Null Hypothesis: WORLD has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-44.18093	0.0000
Test critical values:	1% level	-3.431837	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(WORLD)
Method: Least Squares
Date: 03/02/13 Time: 21:05
Sample (adjusted): 2/23/1998 2/18/2013
Included observations: 3911 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
WORLD(-1)	-0.933897	0.021138	-44.18093	0.0000
D(WORLD(-1))	0.065117	0.015962	4.079439	0.0000
C	0.013490	0.017104	0.788680	0.4303

R-squared	0.440787	Mean dependent var	-5.82E-05
Adjusted R-squared	0.440501	S.D. dependent var	1.429805
S.E. of regression	1.069490	Akaike info criterion	2.973007
Sum squared resid	4470.001	Schwarz criterion	2.977817
Log likelihood	-5810.715	Hannan-Quinn criter.	2.974714
F-statistic	1540.198	Durbin-Watson stat	2.000844
Prob(F-statistic)	0.000000		

Null Hypothesis: ZAMBIA has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-48.04722	0.0001
Test critical values:	1% level	-3.431837	
	5% level	-2.862082	
	10% level	-2.567102	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ZAMBIA)
Method: Least Squares
Date: 03/02/13 Time: 21:05
Sample (adjusted): 2/23/1998 2/18/2013
Included observations: 3911 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ZAMBIA(-1)	-1.117150	0.023251	-48.04722	0.0000
D(ZAMBIA(-1))	0.054410	0.015973	3.406414	0.0007
C	0.070578	0.029857	2.363902	0.0181

R-squared	0.531145	Mean dependent var	4.22E-05
Adjusted R-squared	0.530905	S.D. dependent var	2.722891
S.E. of regression	1.864923	Akaike info criterion	4.085083
Sum squared resid	13591.78	Schwarz criterion	4.089894
Log likelihood	-7985.380	Hannan-Quinn criter.	4.086790
F-statistic	2213.597	Durbin-Watson stat	2.001935
Prob(F-statistic)	0.000000		

Appendix 2: Arch Effects Test (Test of Significance)

BRIC

F-statistic	113.6877	Prob. F(15,3881)	0.0000
Obs*R-squared	1189.624	Prob. Chi-Square(15)	0.0000

EM

Heteroskedasticity Test: ARCH

F-statistic	103.4596	Prob. F(15,3881)	0.0000
Obs*R-squared	1113.169	Prob. Chi-Square(15)	0.0000

US

Heteroskedasticity Test: ARCH

F-statistic	99.49552	Prob. F(15,3881)	0.0000
Obs*R-squared	1082.364	Prob. Chi-Square(15)	0.0000

WORLD

Heteroskedasticity Test: ARCH

F-statistic	110.2091	Prob. F(15,3881)	0.0000
Obs*R-squared	1164.097	Prob. Chi-Square(15)	0.0000

KENYA

Heteroskedasticity Test: ARCH

F-statistic	58.59304	Prob. F(15,3881)	0.0000
Obs*R-squared	719.5654	Prob. Chi-Square(15)	0.0000

MOROCCO

Heteroskedasticity Test: ARCH

F-statistic	37.37686	Prob. F(15,3881)	0.0000
Obs*R-squared	491.9035	Prob. Chi-Square(15)	0.0000

ZAMBIA

Heteroskedasticity Test: ARCH

F-statistic	11.87157	Prob. F(15,3881)	0.0000
Obs*R-squared	170.9633	Prob. Chi-Square(15)	0.0000

MAURITIUS

Heteroskedasticity Test: ARCH

F-statistic	63.21382	Prob. F(15,3881)	0.0000
Obs*R-squared	765.1698	Prob. Chi-Square(15)	0.0000

TUNISIA

Heteroskedasticity Test: ARCH

F-statistic	35.72981	Prob. F(15,3881)	0.0000
Obs*R-squared	472.8574	Prob. Chi-Square(15)	0.0000

SOUTH AFRICA

Heteroskedasticity Test: ARCH

F-statistic	75.29799	Prob. F(15,3881)	0.0000
Obs*R-squared	878.4693	Prob. Chi-Square(15)	0.0000

EGYPT

Heteroskedasticity Test: ARCH

F-statistic	4.483356	Prob. F(15,3881)	0.0000
Obs*R-squared	66.37740	Prob. Chi-Square(15)	0.0000

Appendix 3: Descriptive Statistics and Correlation of Adjusted Data

Table 1: Descriptive Statistics for Adjusted Data

	BRIC	EGYPT	EM	KENYA	MAURITIUS	MOROCCO	SA	TUNISIA	ZAMBIA
Mean	*0.0030*	*- 0.0395*	*- 0.0074*	*- 0.1825*	*- 0.0118*	*- 0.0230*	*0.4617*	*- 0.0014*	*- 0.0269*
Median	*0.047383*	*- 0.0164*	*0.060593*	*- 0.0066*	*- 0.0201*	*- 0.0116*	*0.041932*	*- 0.0084*	*- 0.0562*
Maximum	*17.2468*	*34.5738*	*13.3027*	*24.8421*	*9.7412*	*8.5325*	*104.4524*	*6.2946*	*15.4896*
Minimum	*- 13.4038*	*- 47.9348*	*- 11.8070*	*- 40.0762*	*- 8.1997*	*- 10.5691*	*- 12.8675*	*- 7.2310*	*- 11.6428*
Std. Dev.	*30.4525*	*33.5831*	*27.4850*	*19.5893*	*15.4763*	*17.3402*	*42.2066*	*13.6491*	*27.1567*
Skewness	*0.071784*	*- 1.8674*	*- 0.1862*	*- 6.8861*	*0.401459*	*- 0.1411*	*16.17827*	*0.149745*	*0.695625*
Kurtosis	*11.35366*	*108.1654*	*9.261820*	*355.3722*	*18.67909*	*10.65728*	*650.7537*	*8.503738*	*12.39544*
Jarque-Bera	*11372.29*	*1804090.*	*6410.622*	*20259635*	*40155.46*	*9565.420*	*68527940*	*4949.543*	*14696.68*
Probability	-	-	-	-	-	-	-	-	-
Sum	*0.716903*	*- 9.5668*	*- 1.7937*	*- 44.2447*	*- 2.8674*	*- 5.5723*	*111.9462*	*- 0.3413*	*- 6.5342*
Sum Sq. Dev.	*13942.39*	*16956.45*	*11357.52*	*5769.387*	*3601.016*	*4520.642*	*26782.65*	*2800.907*	*11087.82*
Observations	*3910*	*3910*	*3910*	*3910*	*3910*	*3910*	*3910*	*3910*	*3910*

Table 2: Correlation for Adjusted Data

	BRIC	EGYPT	EM	KENYA	MAURITIUS	MOROCCO	SA	TUNISIA	ZAMBIA
BRIC	*1*								
EGYPT	***0.13177***	*1.00000*							
EM	***0.88626***	***0.14882***	*1.00000*						
KENYA	*0.09234*	*0.04591*	*0.09167*	*1.00000*					
MAURITIUS	***0.12915***	*0.06131*	***0.12948***	*0.08460*	*1.00000*				
MOROCCO	***0.17268***	*0.08667*	***0.18787***	*0.04025*	***0.10238***	*1.00000*			
SA	***0.46474***	*0.08357*	***0.53294***	*0.05109*	*0.07751*	***0.17546***	*1.00000*		
TUNISIA	***0.13719***	*0.03608*	***0.16354***	*0.07517*	*0.09370*	***0.34463***	***0.17518***	*1.00000*	
ZAMBIA	*0.05602*	*0.02865*	*0.04104*	*0.02793*	*0.06300*	*-0.00357*	*0.02305*	*0.02720*	*1.00000*