Onwumere, J. U. J.; Braimah, A. G.; Idolor, E. J.

Article

Volatility transmission and spillovers : a review of literature

Accounting and taxation review

Provided in Cooperation with:
University of Benin, Benin City, Nigeria

Reference: Onwumere, J. U. J./Braimah, A. G. et. al. (2018). Volatility transmission and spillovers : a review of literature. In: Accounting and taxation review 2 (1), S. 199 - 232.

ISSN: 2635-2966 (Print), ISSN: 2635-2958 (Online).

Available online at http://www.atreview.org
Original Research Article

Volatility Transmission and Spillovers: A Review of Literature

J.U.J Onwumere[1], A. G. Braimah[2], & E. J. Idolor[3*]
[1]Department Of Banking and Finance, Faculty of Business Administration, University of Nigeria, Nsukka, Enugu Campus, Enugu State Nigeria.
[2]Department of Accountancy, Auchi Polytechnic, Auchi, Edo
[3]Department of Banking and Finance, Faculty of Management Sciences, University of Benin, Nigeria.

* For correspondence, email:eseseoghene.Idolor@uniben.edu

Received: 21 /02/2018 Accepted: 29/03/2018

Abstract

This paper is about volatility transmission and spillover among stock markets. Volatility Transmission refers to the means, medium or channel through which financial shocks move across borders. The essence of the paper, therefore, is to examine the possible movement of such volatilities beyond the national economies where they are generated; to other economies where their impact is felt on a short and long-term basis. From the extant literature on volatility transmissions, spillovers and contagion, we observe that the existence of growing economic ties among nations increasingly continues to increase the level of interdependence among stock markets on a worldwide scale thereby further fostering volatility transmissions across borders. Overall, we posit, from our review of the extant literature that African markets are segmented at the regional and global level, as domestic volatility is more likely influenced by idiosyncratic local shocks which indicate the proportion of volatility generated within the markets that are not attributable to either global or regional factors. It is therefore recommended that the potential for gains from international portfolio diversification and the scope for the success of policies aimed at the stabilisation of the stock market in Nigeria and indeed the rest of Africa exist.

Keywords: Volatility, Transmission, Spillover, Meltdown, Interdependence, Bourse, Idiosyncratic.

JEL Classification Codes: *G11, G15*

1.0 INTRODUCTION

When the sub-prime financial crisis struck in the United States of America, especially when it spread to other advanced, emerging and frontier economies and pushed the global economy into recession; designing an effective policy response to the crisis became the number one priority to policymakers around the globe. The ultimate goal of wide-ranging central banks and government interventions was to address the fragility of bourses and banking systems to volatility transmissions/spillovers, and attempt to restore confidence in the financial markets. Achieving these goals required a delicate consideration of the sources of stress and the availability of suitable remedies against the backdrop of heightened uncertainty about financial and macroeconomic prospects. Reaching consensus on how quick and aggressive policy actions should be, how much weight should be put on macroeconomic and financial sector policies, and what specific form they should take particularly given various legal, political and other constraints has been a challenge both at the national and global levels (Ait-Sahalia, Andritzky, Jobst, Nowak,& Tamirisa, 2009).From time to time in the annals of history, every economy experiences a downturn. The downturn or recession may be internally contrived or externally induced via volatility transmissions and spillovers. The result is rising prices, retarded GDP growth rate, reduced investment flows, diminishing incomes due to rising consumption expenditure and increasing unemployment. The hardest hit institution in such a scenario is often the stock market because it serves as a barometer of the economic health of a nation (Osaze, 2011).Furthermore, such volatility transmissions among financial markets exist because of real economic and financial ties between world economies in our contemporary period that is characterised by rapidly increasing levels of globalisation among developed and emerging economies. As a result of the existence of such ties, new information arising from one country affects not only local stock market returns and volatility but also the stock market returns and volatility of financial assets traded on the floor of other bourses (stock markets). The new information arising from such markets may be absorbed (impounded) immediately by other markets, or with a lag, depending on the presence and number of informed investors, information asymmetry, existence of feedback traders, herd mentality behaviour, market frictions and market microstructure changes. The magnitude and speed of volatility transmission provide valuable insight into the nature and swiftness of dissemination of such new information among countries. The size of its effect naturally reflects how global investors feel about news, as well as their appraisal of its impact on commodity and asset prices across markets (Kaminsky & Reinhart, 2002, Idolor, 2014).

2.0 CONCEPTUAL FRAMEWORK

Value Meltdown and Financial Crisis; Volatility Transmission Spillovers and Contagion

A. Value Meltdown and Financial Crisis

A meltdown is a total and disastrous economic/financial failure with extremely high contagion effects akin to the melting down of a nuclear reactor. Financial crisis is dislocations in financial markets leading to a constrained flow of credit

to households and businesses and consequently the real and financial economy. The Gross Domestic Product (GDP), financial institutions and the assets they carry on their books also lose value a liquidity crisis ensues when the demand for money (or foreign currency) exceeds supply (Osaze, 2011).

Volatility Transmissions, Spill- Over's and Contagion Volatility Transmission refer to the means, medium or channel through which financial shocks move across borders. To travel across borders, information needs transmission channels. In the short run, asset price changes in equity markets are the primary channel or medium of transmission of financial shocks across borders. Owing to the dependence of numerous developed and emerging markets alike on common bank creditors and cross-market portfolio re-balancing by investment funds, financial markets and institutions have been shown to act as a major tool for cross-border shock transmission (Kodres & Pritsker, 2002; Calvo, 2004; Todorov, 2012). With the increasing level of financial market interdependency and correlations among world financial markets, volatility transmission is now used interchangeably with financial spill-over and contagion in much of the empirical literature (Mabvuto, 2011; Todorov, 2012; Park & Song, 2000). Empirical studies by researchers testing any difference in the concepts, in its very weak form are often used to indicate a clear case of volatility transmission, in its semi-strong form, it indicates a spill-over, while in its strongest form when the correlations are very significant due to turbulence or crisis in international financial markets, the results will indicate a contagion (Park & Song, 2000).

Volatility spill-over simply indicates the impact of a change in returns volatility of one stock market on the returns volatility of another stock market. Contagion is the likelihood that, significant economic changes in one country will spread to other countries. Contagion can refer to the spread of either economic booms or economic crises throughout a geographic region. Contagion has become a more prominent phenomenon as the global economy has grown and economies within certain geographical regions have become more integrated or correlated with one another. An infamous example is the "Asian Contagion", which occurred in 1997 and started in Thailand. The economic crisis in Thailand spread to bordering Southeast Asian countries and then eventually spilt over to Latin America (Investopedia, 2013). Contagion has also been implicated as a major factor that causes global financial crises. The world is a global village especially in the area of financial markets where money moves around quite quickly; what happens is that hot money being rather fast and fluid in its movement while pursuing arbitrage-driven investment opportunities quickly flee electronically once the investment environment turns sour. The underlying stocks are sold quickly, and the proceeds moved out to other more clement climes (Bob-Osaze, 2011).

The nature of volatility transmission, spill-over and contagion, has long sparked an interest among academics and practitioners to understand the extent of the linkages that exist among international stock markets. The seminal work of Grubel (1968) and later in the 1970s by Levy and Sarnat (1970), Ripley (1973), Solnik (1974), Errunza (1977) and Hilliard (1979) paved the way for studies specifically aimed at ascertaining the nature of equity market linkages and

interdependences among the world's stock markets and the resultant implications this had for international portfolio diversification and risk reduction.

The major findings of the early seminal studies were that the world's major equity markets were largely segmented, exhibiting insignificant evidence of volatility transmission, spill-over, contagion effect and returns co-movement. The studies empirically authenticated the argument for international portfolio diversification. On the contrary, following the worldwide adoption of policies aimed at the relaxation of exchange rate controls and barriers on international capital movements coupled with advances in information and communication technology, many researchers since the mid-1980s have documented a gradual shift away from international equity market segmentation towards interdependence, and a corresponding gradual decline in opportunities for international diversification as the world's financial markets get more integrated. These new studies revealed significant evidence of volatility transmission, spill-over, contagion effect and returns co-movement among the stock markets studied. The findings were valid among the significant mature markets in the United States of America, United Kingdom, Japan, France and Germany. Majority of the early works mainly studied market linkages by considering the returns co-movements among equity markets and the effect this had for policy and portfolio diversification. A few notable studies in this regard include those by Schollhammer and Sand (1987), Eun and Shim (1989), and Koch and Koch (1991).

However, with the seminal works of Engle (1982) and later Bollerslev (1986) on the modelling of conditional variance and volatility, the extent to which volatility is transmitted internationally received considerable interest, especially among academics, practitioners and regulators. These studies, fuelled by growing concerns about the possible effect of volatility on national and regional financial markets as well as the need for policymakers, regulators, traders and speculators to understand the effect of overnight news transmission from one market to another; has not been confined just to equity markets, but also to other financial markets.For instance, Clare and Lekkos (2000) and Christiansen (2007) examine the inter-market linkages in the international bond markets, Fehle (2000) examine the level of international linkages between numerous swap markets, Engle and Kroner (1995) examine volatility transmission, spill-over and contagion among mature equity markets and give sufficient conditions for testing its impact with an array of multivariate GARCH models.

Indeed, in the last two decades, we have seen how different financial crisis that originated from particular regions or countries have extended geographically to other regions with far-reaching and pervasive impact on national economies. A classic example is the recent global financial meltdown that originated from the United States of America during the sub-prime crisis of 2008; whose impact was felt in numerous foreign financial markets within a short period. This has in no small measure significantly led to very extensive research by academics on the nature of interrelationship among different stock markets. As far as international markets are becoming more and more integrated, information generated in one

stock market can without any doubt, affect other stock markets. To this end, financial instability has become an important issue for the reason that financial crises such as bank collapses or stock market crashes may directly influence a country's economy (Todorov, 2012). The implication of this is that, if a stock market is integrated with another country's stock market, domestic financial stability would greatly depend on the financial stability of another country. Such interdependencies would highlight the vulnerability of a domestic economy to negative external shocks. By implication, the converse would be true for positive external shocks as well. Ng (2000) highlights another crucial point why understanding market interdependencies through volatility transmission, spill-over and contagion effect is critical, most especially, in the evaluation of regulatory proposals to restrict international capital flows. Such a restrictive policy would perhaps be a mitigating factor to the vulnerability and instability that may arise due to deepened financial integration. Consequently, turbulence in financial markets has led to numerous calls for reforming the whole global financial system with the aim of improving its stability (Rogoff, 1999; Eichengreen, 1999; Bob-Osaze, 2007; Olowe, 2009; Mabvuto, 2011, Idolor, 2014; Idolor & Braimah, 2015).

Volatility transmission, spillover and contagion among equity markets may impair the smooth functioning of the financial system and adversely affect economic performance or stability (Rajni & Mahendra, 2007; Mollah, 2009; Eriki & Idolor, 2009; Eguavoen, 2012). Furthermore, it has some negative implications. One of how it affects the economies of individual countries could be through its effect on consumer spending (Campbell, 1996; Starr-McCluer, 1998; Ludrigson & Steindel, 1999; Porteba, 2000; Rajni & Mahendra, 2007; Olowe, 2009). The impact of stock market volatility transmission, spill-over and contagion on consumer spending in interdependent markets is related via the wealth effect (Rajni & Mahendra, 2007). Increased wealth will drive up consumer spending. However, a drastic fall in the level of wealth as a result of crisis and turbulence originating from foreign markets will weaken consumer confidence and thus drive down consumer spending (Rajni & Mahendra, 2007), basically because volatility itself is akin to a double-edged sword with both positive and negative qualities (Ikponmwosa, 2013).

3.0. EMPIRICAL LITERATURE

With the existence of liberalised financial markets, the current financial globalisation debate typically emphasises the spill-over effects among the world's capital markets, whereby innovations in one market are transmitted to other markets. This has implications for international portfolio diversification and the stability of the global financial system. Largely stemming from Markowitz (1959) theory of portfolio selection, the pioneering works of Grubel (1968) and later in the 1970s research by Levy and Sarnat (1970), Ripley (1973), Solnik (1974), Errunza (1977) and Hilliard (1979) paved the way for studies on the interdependence of the world's stock markets and the resultant implications for international diversification. The major findings of these works can be summarised in three broad categories. Firstly, the major result of these works was that international correlations of stock returns from the world's major equity markets were very low (Markowitz, 1959; Grubel, 1968). Secondly, by

implication of their findings, domestic country-specific, rather than international factors were much more important for the pricing of domestic stocks (Levy & Sarnat, 1970; Ripley, 1973). For the above two reasons, these studies empirically validated the argument for international portfolio diversification.

Thirdly, from a methodological perspective, these studies mainly considered first moment linkages in returns based on simple correlation and Granger causality tests and mainly focused on the stock markets of mature economies such as those of the United States of America, Germany, Japan, United Kingdom and France (Solnik, 1974, Errunza, 1977; Hilliard, 1979). Owing to the relaxation of exchange rate controls, removal of barriers to international portfolio flows, and advances in technology and communication systems, many authors since the 1980s have documented a gradual shift away from international equity market segmentation towards interdependence. A few notable examples include the studies by Schollhammer and Sand (1987), Eun and Shim (1989), Von Furstenberg and Joen (1989) and Koch and Koch (1991) among many others.

Despite using a wide variety of methodologies, all the above studies principally assessed the interdependence of stock markets regarding the conditional first moment of the distribution of returns. However, since the seminal works of Engle (1982) and Bollerslev (1986) on Autoregressive Conditional Heteroskedasticity (ARCH) modelling, there has been increasing interest in the analysis of stock market interactions in both the first and second moments of returns (Mabvuto, 2011). This section reviews the empirical literature on volatility transmission, spill-over, contagion and stock market interdependence (in mature, emerging and frontier markets), placing particular emphasis on the main issues raised and addressed in the empirical literature concerning interdependence in the developed, emerging and African stock markets. The section also reviews issues related to the liberalisation and interdependence of stock markets, regional versus global interdependence of stock markets, as well as empirical studies relating to African markets, as well as other, frontier and emerging stock markets.

A. Volatility Spill-over Effects and Interdependence of Stock Markets in Mature Emerging and Frontier Markets

Since the 1997 Asian crisis, there has been an extensive body of empirical literature on the second moment interdependence of capital markets in mature and emerging markets. This body of literature has mainly focused on assessing the manner in which the volatility of one stock market is transmitted to another, predominantly referred to as volatility transmission, spill-over and contagion effects. For instance, Hamao *et al.* (1990), using daily and intra-day stock prices for the US, Japanese and UK markets for the period 1985 to 1988, adopt a univariate generalised autoregressive conditional heteroskedasticity in mean (GARCH-M) Model. They find unidirectional spill-over effects from the US to UK and Japan, and the UK to Japan. Considering a slightly different period (1988 to 1992) and adopting a GARCH and Exponential GARCH (or EGARCH) framework, Bae and Karolyi (1994) find evidence of price volatility

spill-over effects between the US and Japan, and in fact demonstrate that ignoring the asymmetry effect in the transmission mechanism of volatility significantly understates the magnitude and persistence of volatility shocks originating from the US or Japan to either market. Similar results are arrived at by Koutmos and Booth (1995) when they consider daily stock returns for the same markets as Hamao *et al.* (1990) for the period 1986 to 1993 using an extended multivariate EGARCH model. Indeed, these findings are not only confined to the relatively old empirical literature and the three largest mature markets: a cross review of the recent volatility transmission literature for instance Isakov and Pérignon (2000), Cifarelli and Paladino (2005), and Aragó-Manzana and Fernández-Izquierd (2007) all point to the intensification of the interdependence of stock markets in mature markets.

The interest in understanding the transmission mechanism of shocks has not been restricted to mature markets only, but also to emerging market economies. Volatility spill-over effects originating from mature markets, and the role these effects play in the stochastic return generating a process of equity markets in emerging economies, have gained prominence in the empirical literature. For instance, Wei Liu and Yang(1999) examine the price and volatility spill-over effects across developed (US, UK and Japan) and emerging markets (Hong Kong and Taiwan) using intra-day data from 1991 to 1992. The univariate GARCH spill-over framework used reveals the existence of volatility spill-over effects from the US to the emerging markets, over and above that exerted by Japan. On a similar subject, Li (2009) using weekly composite indices for the emerging markets of Asia, Latin America, Far East, Europe

The Middle East, and Europeadopt a Multivariate Markov Switching ARCH (MVSWARCH) and multivariate GARCH framework for the period 1988 to 2007. The author finds that the strongest US-emerging market correlations occur when high volatility characterises both sets of markets. The key feature of the MVSWARCH model is that not only is the specification of the variance-covariance matrix time-varying but also state-dependent- varying, depending upon the volatility regime (i.e. whether volatility is high or low). This enables inferences to be made regarding any volatility state-dependent structural changes in the correlation mechanism among variables (Mabvuto, 2011).
A cross review of the empirical literature in both mature and emerging markets on the manner in which volatility of one stock market is transmitted to another point to two main broad conclusions. All these studies typically emphasise (1) the predominance of the US equity market in the global transmission of shocks and (2) the increasing interdependence of world markets across mature and emerging markets.

B. Regional versus Global Interdependence of Stock Markets

Given the above, a major question that springs to mind is whether the interplay of liberalisation policies and the numerous other underlying factors that drive the interdependence of markets have simultaneously strengthened the relative importance of regional and global factors in the stochastic return generating processes and volatility of emerging equity markets. One strand of literature, closely related to one of the objectives of this thesis, has attempted to examine whether regional monetary and economic ties through bilateral trade linkages

and regional economic blocs have meant that capital markets have become integrated more at a regional level than at the global level. This is extremely pertinent to those regions that have implemented deliberate policies to foster deepened economic, monetary and financial integration, such as those in Europe and the Asia Pacific regions.

In Europe, numerous empirical works have attested to the fact that economic integration has also resulted in capital market integration, thereby strengthening the relative importance of the Euro market alongside the US as the dominant market in Europe. For instance, Fratzscher (2002) builds on the Uncovered Interest Parity condition to investigate the role that the European Monetary Union (EMU) has played in the integration of 16 European equity markets, particularly through exchange rate stability. Using a trivariate GARCH framework with time-varying coefficients distinguishing between shocks originating regionally (within the Euro area) and globally (represented by the US market) for the period 1986 to 2000, the author finds that the drive towards the EMU has seen the Euro-regional market gain prominence in world financial markets. At a regional level, the increasing regional equity market integration is attributed to reduced exchange rate uncertainty and monetary policy convergence of interest rates and inflation. Similarly, Baele (2005), using a regime-dependent spill-over framework to examine the extent to which globalisation and regional integration has led to equity market integration in thirteen (13) European markets between 1980 and 2001, finds an increasing influence of the European Union (EU) in regional and global financial markets. Kim, Moshiran and Wu (2005) also examine the effect of the EMU on the integration of fifteen European (twelve EMU members and three non-members) states using a bivariate EGARCH framework. Similar results to those arrived at by Fratzscher (2002) and Baele (2005) are reached by Kim *et al.* (2005) about the strengthening of intra-regional and inter-regional volatility spill-over effects associated with the introduction of the Euro. However, with benefits from a longer post-Euro sample period, a major contrasting result from the arguments made by Fratzscher (2002) and Baele (2005) relates to the role of exchange rate uncertainty in the integration process. Unlike the other authors, Kim *et al.* (2005) find that exchange rate stability has only played a vital role in the integration of three of the twelve smaller markets that adopted the Euro. Nevertheless, a consistent finding amongst all the empirical literature reviewed relates to the fact that economic and monetary integration in Europe has indeed translated into strengthened financial ties amongst European markets. This finding has not been confined to equity markets (Bodart & Redding, 1999; Christiansen, 2007). Furthermore, the increased financial integration of the EU markets has seen an emergence and strengthening role of the EU as a dominant player in the global financial market, a role that previously belonged exclusively to the US market.

With regard to the Asian Pacific Basin region, the findings of the influential work of Chen and Zhang (1997) give credence to the argument that economic integration primarily through regional trade ties has resulted in increased regional and international (global) stock market correlations in this area. The study of Chuang et al. (2007) examines the interdependence of equity variances in six East Asian markets after controlling for the exogenous influence of the

mature markets outside the region, i.e. the US and UK markets. They model the returns in a Vector Autoregressive (VAR)-BEKK framework to obtain the conditional variances for the six markets and then apply a VAR model to examine the dynamic interdependence of the conditional variances. Forecast error variance decompositions and impulse response analyses reveal high levels of volatility interdependence among the Asian markets, with the Japanese market being the most exogenous, as the least susceptible to volatility shocks from the other Asian markets and playing an influential role in transmitting volatility to the other markets. The predominant influence of the Japanese market in East Asia is not new to the empirical literature (see Bekaert and Harvey, 1997; Liu and Pan, 1997; Ng 2000 and Caporale, Pittis, & Spagnolo, 2006). However, the question of whether regional factors (due to regional economic integration) in relation to global factors (due to financial globalisation) are relatively more important in the interdependence of equity market variances in the East Asian/Asia-Pacific regions has not received considerable empirical attention. However, a few methodologically related empirical studies have examined this hypothesis. Examining the magnitude and time-varying nature of global and regional volatility spill-over to six Asia Pacific markets, Ng (2000) proposes a volatility spill-over model that allows the unexpected return of any Asia Pacific market to be driven by a local idiosyncratic shock and two exogenous shocks, one related to the region (proxy by the Japanese market) and the other related to the global market (proxied by the US market). By computing variance ratios with respect to the regional and global factor, the author finds considerable time-variation in the relative importance of global and regional factors for individual Asian-Pacific market volatility. On average, both regional and global factors are important for volatility in the Asia-Pacific region, although the global factors tend to dominate the regional factors.

However, in spite of their relative importance, regional and global factors are found to account jointly for less than ten percent of the conditional volatility in four of the six Pacific basin markets considered (Ng, 2000). These findings compare favourably with that of Bekaert Harvey and Ng(2005) with respect to the relative importance of both factors (regional and global) for volatility in the Asian markets, and in the sense that the global factor tends to dominate the regional factor in accounting for total return variation in the Asian markets considered. The findings, however, differ in the sense that the global and regional shocks on average jointly account for thirty percent (compared to ten percent in Ng, 2000) of the conditional volatility of each Asian market, except Korea and Taiwan in 1997. This conflicting result may be due to the 1997 Asian financial crisis which saw many markets display abnormal behaviour primarily through contagion effects. In support of this contention, Miyakoshi (2003), using a methodology related to that of Ng (2000) and Bekaert *et al.* (2005), omits the period during the Asian crisis and only considers the period from 1998 to 2000. Miyakoshi (2003) argues that in view of the relative magnitude of Asian assets held by Japanese investors, there exists a possibility that Asian markets can drive the return generating process of the Japanese market and therefore, in contrast to Ng (2000) and Bekaert *et al.* (2005), insists on the endogeneity of the regional market (proxied by the Japanese market). The study finds that while regional factors do not affect the Asian market returns, they tend

to be more dominant than global factors in influencing the volatility of those markets in the study.

In conclusion, despite the intricate inconsistencies outlined with respect to the findings of the studies that attempt to examine the relative importance of regional and global factors for Asian volatility, a few broad lines of the agreement are worth noting. First, in harmony with the results in Western Europe, regional and global factors both play an important role in volatility in Asian markets. Second, the relative importance of regional and global factors has been time-varying and increasing overtime, and third, while there is no consensus, the majority of the findings lend support to the argument that global factors dominate regional factors in accounting for return volatility of markets in the Asian region.

C. African Frontier and Emerging Markets

While a significant proportion of research has been conducted elsewhere around the globe, the poor level of development of African stock markets has resulted in little emphasis on understanding the dynamic interrelations among these markets with the rest of the world's capital markets. The empirical literature on the second-moment linkages of African stock markets with their global and African counterparts is somewhat inadequate due to the moribund nature of many African markets as well as the paucity of data for numerous African countries. The vast majority of the few studies that have examined the interdependence of African markets have mainly emphasised linkages in the first moment of returns.

The few studies that have examined first moment linkages among African stock markets with their regional and global counterparts include those by Lamba and Otchere (2001), Piesse and Hearn (2002), Collins and Biekpe (2003a), Alhassan (2006) and Chinzara and Aziakpono (2009a). Lamba and Otchere (2001) provide the first comprehensive analysis of dynamic interactions of seven African equity markets with their regional (African) and global counterparts using a multivariate VAR model between 1988 and 2000. The results indicate integration along regional lines, especially among South Africa, Namibia and Zimbabwe. Furthermore, except Namibia and South Africa, there is little evidence of interdependence of African markets with their global counterparts. Similar results for Namibia and South Africa are obtained by Piesse and Hearn (2002) who conduct cointegration tests on the three dominant Southern African Customs Union (SACU) member states, namely South Africa, Botswana and Namibia for the period 1990 to 2000. Collins and Biekpe (2003b) use Granger causality tests to analyse the interdependence among returns of eight African markets and an adjusted correlation coefficient, as in Forbes and Rigobon (2002), to analyse the extent to which these countries were affected by the 1997 Asian crisis. The Granger causality tests reveal linkages among regional lines, specifically for South Africa and Zimbabwe. Except the two largest African markets, Egypt and South Africa. The Forbes and Rigobon (2002) adjusted correlation coefficients suggest no evidence of contagion from the Asian crisis.

A few studies have also examined second-moment linkages among African markets (Pretorius & De Beer, 2004; Piesse& Hearn, 2005; Hamavindu &Floros, 2006). Even fewer studies have examined the second-moment linkages

among African markets and their global counterparts (Samouilhan, 2006 and 2007; Chinzara & Aziakpono, 2009b). In analysing the second-moment linkages among seven African markets, Piesse and Hearn (2005) estimate a group of pair-wise asymmetric univariate volatility spill-over models by augmenting one country's conditional volatility process with the lagged conditional volatilities of another African country to examine volatility spill-over effects between pairs of ten major sub-Saharan African stock markets. The authors find the largest markets of South Africa and Nigeria to be most influential in transmitting volatility to the other African markets, particularly among countries with shared trading mechanisms and shared trade links. Pretorius and De Beer (2004) earlier drew similar conclusions in the foreign exchange market between South Africa and Zimbabwe.

Hamavindu and Floros (2006), using daily data on Namibia and South Africa from the period 1999 to 2003, adopt a GARCH and cointegration framework to assess the extent of Namibia's financial integration with South Africa. They argue that, given the strong economic ties between Namibia and South Africa, there is a strong possibility of there being some volatility spill-over effects, which may have consequences for portfolio diversification opportunities between the two markets. While all the above studies that have examined returns and volatility linkages between South Africa and Namibia have documented strong interdependence between the two countries, Hamavindu and Floros (2006) find contrasting results when they use the local Namibian index which omits stocks with primary listings on the Johannesburg Stock Exchange (JSE), suggesting that the Namibian Stock exchange is an attractive regional portfolio diversification tool in South African. Their findings further suggest that the co-movement found by other researchers like Lamba and Otchere, (2001); Piesse and Hearn (2002) may be induced by those stocks on the Namibian stock exchange that has primary listings on the Johannesburg stock exchange.

While the above studies have considered linkages among African markets, another set of empirical literature has examined the extent to which African markets are linked to other world markets in the second moments of returns. Samouilhan (2006) examines the returns and volatility interaction between the South African equity market and its mature counterpart (UK market) using daily data for the period 1996 to 2004, adopting an autoregressive univariate asymmetric volatility spillover (EGARCH) framework whereby the domestic conditional volatility process is augmented by the lagged conditional volatility of the UK market. Significant volatility spillovers are found between the two markets, with high (low) volatility on the London Stock exchange (LSE) associated with high (low) volatility on the JSE. In a related study, Samouilhan (2007) investigates the link between South African and international markets by examining the extent to which the JSE prices in domestic variance risk and covariance risk with respect to the LSE using a factor-ARCH-in-mean model for the same period. Similar results are found concerning the second-moment linkages and, furthermore, local variance risk is priced at more than foreign covariance risk on the JSE. In other words, local factors are significantly more important relative to global factors in explaining the volatility of the JSE.

In a recent study, Chinzara and Aziakpono (2009b) analyse dynamic returns linkages among South African stock markets with six other world markets within a multivariate VAR framework for the period 1995 to 2007. They also examine the trends and transmission of volatility among these markets by modelling the conditional volatilities of each market using a univariate ARCH set of models, then analysing the volatility propagation mechanism through a VAR framework. Concerning the returns linkages, they find that Australia followed by the US then China exerts the greatest influence on the South African returns. With respect to the second-moment linkages, they find that Australia, followed by the US and China, has the greatest importance for the volatility of the South African market. Of particular interest is that in spite of the dual listing arrangements between South Africa andthe UK market, despite the UK market being the most correlated with the South African market in their sample and contrary to the findings of previous earlier empirical studies (Lamba & Otchere, 2001; Samouilhan, 2006; Samouilhan 2007; Chinzara & Aziakpono 2009a) document an insignificant influence of the UK market on both the returns and volatility linkages with South Africa.

In general, while acknowledging some of the conflicting findings among the empirical literature on the interdependence of African markets with their global counterparts, a few broad lines of agreement can be drawn. Firstly, a cross-reading of the previous literature lends support to the argument that African markets remain largely segmented, except for those regions that have common trading mechanisms and strong trade links, especially in Southern Africa, and particularly between South Africa and Namibia. Secondly, with respect to the interdependence of African equity markets with their overseas counterparts, the consensus is that most African states are largely segmented from the rest of the global markets, with the exception of South Africa.

From our review of the African empirical literature, in relation with that of other regions earlier discussed, one notices certain weaknesses and deficiencies. Amongst all the empirical literature that was reviewed on the propagation of volatility among African stock markets and the world's stock markets, none of the studies, at least to the researcher's knowledge, examines these linkages through multivariate GARCH models with Nigeria as the focal point of the study. They mostly use univariate GARCH models (and their numerous symmetric and asymmetric variants), and studies focussing on African bourses that have utilised multivariate techniques in the empirical literature are few and far in between. Owing to the fact that the volatilities of stock returns are time-varying and the generally accepted findings in the vast financial literature that the volatilities of stock returns tend to move together in opposition to, or in response to other markets volatilities, should in itself warrant the use of multivariate GARCH models in addition to the very popular univariate GARCH models. The advantage of using multivariate GARCH models is that, in addition to specifying how the conditional volatilities vary over time, they also specify the dynamics of the conditional covariances of the variables within the system.

Table I: Summary of Studies in the Empirical Literature on Stock Market linkages, with a primary focus on Mature Economies (Developed Stock Markets) in America, Europe and Asia.

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings
Gannon and Au-Yeung (2005)	2 Countries, US and Hong Kong Sport And Futures Market	1994-2001 Daily	Bivariate GARCH (BEKK) with multiple switching points in variance equations	Switch points capture changes in volatility structure due to regulatory events on HSI and HSIF.	US SE found in the HSI and HSIF. Evidence of structural changes in volatility found when US is Excluded
Bodart and Reding (1999)	6 European Counties: EMS andnon EMS	1989-1994, Daily	Multivariate/Univariate GARCH models	Bivariate GARCH models that are used to analyse how exchange rate regime affects conditional correlations among countries.	Unlike on the bond market, there is little significant evidence that stock correlations among the countries reviewed are affected or influenced by the degree of exchange rate variability.
Cifarelli and Paladino (2005)	3 Countries: US, UK and Germany	1992-2000, Daily	Symmetric and asymmetric multivariate GARCH models	Model allows analysis of extent to which stock market volatility diffusion causes stock market exuberance transmission	Volatility SE arelargely accounted for by stock market Exuberance. Markets tend to be more interlinked during bouts of crises.
Fratzscher (2002)	16 OECD countries	1986-2000, Daily	Multivariate volatility model	Through a tri-variate GARCH specification regional and global shocks are	European equity markets have become integrated with Euro area market experiencing an increasingly dominant role in

				distinguished and analysed.	Europe over that of the US.
In (2007)	3 countries, US, UK and Japan	1996-2001, Daily	Multivariate VAR-GARCH	Model enables testing asymmetry in the volatility SE.	Unidirectional SE from the US to UK and Japan Significant reciprocal SE between UK and Japan.
Isakov and Pérignon (2000)	5 countries, and Switzerland	1988-1998, Daily	Multivariate volatility model (GARCH-BEKK)	Inferences are made by modelling a series of bivariate GARCH-BEKK with the 5 markets.	Asymmetric volatility SE to Switzerland are mainly from European countries, and not significantly from the US.
Kim *et al.* (2005)	12 EMU countries, 3-non-EMU states, Japan and US	1989-2003, Daily	Multivariate volatility model (ARMA-EGARCH)	This model specification used eliminates the assumption of constant correlation between stock returns.	Time varying conditional correlations found with persistent effects among countries with similar industrial structures. Volatility SE among EMU States indicates increased integration.
Koutmos and Booth (1995)	3 countries, US, UK and Japan	1986-1993, Daily	Multivariate volatility model (MEGARCH) With constant correlations	Jointly examines the interdependencies, however fails to account for overlapping trading in UK and US.	SE found from US to UK and Japanese markets.SE found from Japan to UK. SE are pronounced during periods of negative news
Aragó-Manzana and Fernández-Izquierdo (2007)	5 countries: Europe	1995-2004, Daily	Multivariate GARCH-BEKK Framework	SE are modelled using a series of bbivariate GARCH-BEKK specifications of the local with the foreign stock market.	Indistinguishable asymmetric information SE are detected among all the countries EMU and non-EMU countries.
Bae and Karolyi (1994)	2 Countries: US and Japan	1988-1992, Daily	Univariate GARCH, EGARCH Models	Day time and overnight asymmetric news transmission between the two markets is analysed using intraday opening	Volatility SE are evident. SE originating from the US to Japan are significantly understated in magnitude and persistence if asymmetry in their transmission is not taken into consideration.

				and closing stock prices.	
Baele (2005)	8 EMU, 3 EU, 2 Non-EU Countries and US.	1980-2001, Weekly	Multivariate/Univariate regime switching Volatility Spillover Model	Spillover model allows volatility to be driven by local, regional and global factors. Regime Switching model accounts for shock sensitivities to change over time.	SE intensity have increased since the 1980s Regional and US shocks have increased (8%-23% and 15%-27% respectively) in explaining local volatility. Trade integration, equity market development & low inflation contribute to increasing EU regional integration.
Christiansen (2007)	US, Europe, 6 EMU States and3 non-EMU member states	1988-2002, Weekly	Univariate AR-GARCH Implemented as in Ng (2000)	Spillover model allows volatility to be driven by local, regional and global factors.	Stronger regional than global SE on EMU states than on non-EMU. Weaker US SE than Aggregate European SE.
Hamao *et al.* (1990)	3 countries: Japan, US, UK	1985-1988, Daily	Univariate GARCH-M models	Conditional variance in close-to-open and open-to-close returns of local market is approximated by a MA-GARCH-M process.	Unidirectional volatility SE from the US to UK (weaker) and Japan (stronger), UK to Japan (weak) after the 1987 crash. There is no significant SE prior to the 1987 crash.
Koch and Koch (1991)	8 countries: US, UK, Germany, Japan, Hong Kong, Australia, Singapore & Switzerland	1972-1987, Daily	Dynamic Simultaneous Equations	Simultaneous equation model is estimated to describe contemporaneous and lead-lag first moment relationships among 8 markets.	Increased interdependence of markets over time especially among countries in similar geographical locations with overlapping trading hours.

Source: Adapted from Mabvuto, M. (2011). "Analysis of Volatility Spillover Effects between the South African, Regional and World Equity Markets". Unpublished M.Sc. Thesis, Rhodes University, Grahamstown, South Africa.

Another weakness of most studies focusing on the interdependence of African bourses with their global counterparts is that methodologically they fail to jointly examine the relative importance of regional and global factors in

explaining the volatility of African equity markets by quantifying the proportion of the volatility driven by regional and global factors, and whether these proportions have remained stable over time (Bekaert & Harvey 1997; Bekaert *et al.*, 2005; Ng, 2000; Christiansen, 2007).Furthermore, while many studies have attested to the increasing predominance of global factors in the South African equity market, none of the studies have attempted to empirically link this time-varying interdependence to certain economic fundamentals so as to analyse beyond conjecture the actual drivers of the second moment linkages of the South African market as guided by the theoretical literature on the fundamental driving forces of stock market volatility linkages. It is the researcher's fervent view that an analysis of stock market linkages is inadequate without an attempt at understanding the driving forces behind those linkages. This is of particular importance for policy, and if one desires to assess whether there has been progress towards integration among African markets, especially in view of the recent efforts that have been put forward by the numerous African governments in trying to foster economic cooperation and integration at the regional level; not to mention the current increase in the demands for the consolidation of African stock exchanges along regional lines (Bob-Osaze, 2007).In addition to complementing the few existing African literature on volatility transmission (spill-over) analysis, and in view of the inconsistent and often conflicting results of the past empirical literature, this study attempts to wade into the controversy in the current literature to offer a better understanding of the Nigerian (and other African frontier and emerging) equity market in relation to its global counterparts.Adapted from Mabvuto (2011), and Todorov (2012); as shown in Tables I, II and III are a summary of some of the recent state of the art empirical works on second moment stock market linkages, interdependence, volatility transmission, spill-over and contagion effects in mature, emerging and frontier stock markets.

NOTES:
SE: Spill-over Effect HSI: Hang Seng Index ** Daily Closing Pseudo prices are used to avoid non-synchronous closing times
EMU: European Monetary Union HSIF: Hang Seng Futures LRMH: Linear Regression Model with Heteroskedasticity
LRM: Linear Regression Model GBM: Geometric Brownian Motion

*** This findings contrasts that of Forbes and Rigobon (2002), who show that most correlation coefficients used in the vast empirical literature to document inter-market linkages during turbulent times (usually referred to as contagion or spill-over), are biased measures of dependence. When these biases are accounted for, there is no evidence of contagion in the 1987 US crisis, 1994 Mexican crisis or 1997 Asian crisis.

Table II: Summary of Studies in the Empirical Literature on Stock Market linkages, with a primary focus on Mature and/or Emerging

Market Economies (Emerging Stock Markets) in Europe, Asia and Latin America.

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings
Beirne *et al.* (2008)	41 EMEs , 6 Mature Markets.	1993,1996-2008, Weekly.	Multivariate Volatility Models: Trivariate GARCH-BEKK models [Local, Regional and Global markets].	Changes in volatility transmission are examined during turbulent periods in mature markets.	Volatility SE from mature markets are found in most EMEs, and from regional to local markets, with the spillover parameters changing during turbulent times (in mature markets) – contagion.
Bekaert *et al.* (2005)	22 countries: Asia, Europe and Latin America.	1980-1998,	Asymmetric GARCH with the mean equation implemented is a two-factor asset pricing model.	As in Ng (2000), Spillover model allows volatility to be driven by local, regional and global factors.	No additional contagion documented after Mexican crisis, but increased integration in Asia during Asian crisis.
Caporale *et al.* (2006)	8 East Asian Countries.	1990-1995, Weekly.	Conditional Correlation Analysis, Univariate GARCH	This framework is adopted to analyse "contagion" which the authors define as increased cross-market linkages in response to a shock on	Contagion began in late 1997 at the time of the Hong Kong crash or onset of the Korean crisis, with the source of the crisis (Thailand) affecting the rest of the countries in the region.

				another country.	
Caporale *et al.* (2006)	US, Japan, Europe (4), and South East Asian (8) Countries.	1986-2000, Daily.	Multivariate Volatility models [GARCH-BEKK], Bootstrapping	A series of bivariate GARCH models are estimated to measure volatility SE before and after the 1997 Asian crisis.	Bi-directional volatility SE in the pre-crisis and whole sample. However, causality in variance links runs from country in turmoil to others following the onset of the crisis.
Chuang *et al.* (2007)	6 East Asian (Emerging) Markets	1992-2006, Weekly	Multivariate VAR-GARCH (BEKK) and VAR	Volatility transmission is examined through a VAR system of 6 conditional variances.	SE are recorded, with a larger proportion coming from Japan to the rest of the East Asian states. Volatilities have increased post-Asian crisis period.
Darrat and Benkato (2003)	5 countries: Turkey, US, UK, Japan and Germany.	1986-2000, Monthly.	Johansen-Juselius Cointegration, Univariate GARCH model.	Volatility SE are analysed by expressing the conditional volatility of ISE, as a function of the lagged conditional variances of the other four markets.	Volatility SE between the ISE and the other four matured markets are found to have strengthened after liberalisation, with the US and UK being the main drivers of ISE volatility.
Ng (2000)	6 Pacific Basin states (emerging markets) , US and Japan.	1980-1996, Weekly.	Univariate and Multivariate GARCH models	Spillover model allows volatility to be driven by local, regional and global factors.	Volatility SE effects from US and Japan found. Global and regional factors account for less than 10% of Pacific basin volatility.
Wei *et al.* (1995)	3 Developed and 2 Emerging markets	1991-1992, Daily	Univariate GARCH models	Problems associated with non-synchronous trading are overcome by	Volatility SE are found from the US to the emerging countries over that exerted by Japan.

				the use of Intraday, open-to-close and close-to-open prices.	
Bekaert and Harvey (1997)	20 Emerging markets, US	1976-1992, Monthly	Univariate volatility models	EM volatility dynamics and what drives them are analysed by distinguishing world and local factors.	World factors drive less than 10% of volatility in 16 out of 20 EM surveyed, but increases after liberalisation and crises for 12 of the 17 countries that underwent liberalisation.
Li (2009)	US and 5 Emerging market Groups	1988-2007, Weekly	Multivariate Markov Switching ARCH, Multivariate GARCH Models	US-EM co-movements when both markets are in HV/LV states/regimes and the USEM portfolio diversification implications are investigated.	The author finds that US-EME correlations vary depending on the volatility states of the two market groups.Strongest US-EM correlations result when both US-EM markets are simultaneously characterised by high volatility.
Miyakoshi (2003)	7 Asian countries, US and Japan	1998-2000, Daily	Multivariate EGARCH model	Spillover model allows volatility to be driven by local (endogenous), regional and global (exogenous) factors.	Mean return SE from US (and not Japan) to the Asian markets. Volatility SE from Japan (more than from the US) affects Asian market volatility in contrast to Ng (2000).
Tse *et al.* (2003)	2 US and Poland	1994-2003, Daily	Multivariate Asymmetric Volatility models, Cointegration	Study implements a bivariate EGARCH that allows for both mean and volatility SE between the	There is weak evidence of mean SE from the US, but no evidence of volatility SE. Cointegration tests reveal no evidence of a longrun

			Tests	two markets.***	relationship between US and Polish markets.
Kim and Rogers (1994)	3 Countries: US, Japan and Korea	1985-1992, Daily (intraday)	Univariate GARCH models	The effect of liberalisation on volatility transmission is assessed by examining the full sample and a post liberalisation sub period.	Volatility SEs have intensified since liberalisation especially for close-to-open returns, showing that information from the major mature markets has become pertinent for the opening price in. Korea.

Source: Adapted from Mabvuto, M. (2011). "Analysis of Volatility Spillover Effects between the South African, Regional and World Equity Markets". Unpublished M.Sc. Thesis, Rhodes University, Grahamstown, South Africa.

NOTES:
EME: Emerging Market Economy ISE: Instanbul Stock Exchange SE: Spill-over Effect
EMS: European Monetary System LV: Low Volatility State HV: High Volatility State
*** Non Synchronous trading between the two markets is accounted for by introducing a first order moving average term in the mean return equations.

Table 111: Summary of Studies in the Empirical Literature on Stock Market linkages, with a primary focus on Emerging and Frontier African Markets.

Study	Countries Covered	Period Covered and Frequency	Estimation Method	Methodological Issues	Summary of Findings
Alhassan (2006)	9 counties: Ghana and major world markets	1990-2003, Weekly.	Cointegration and Error correction analysis.	First moment return associations are modelled using cointegration and error correction analysis.	Preliminary results show Ghana is not co-integrated with any of the markets except Japan. However, an error correction model fails to

					validate this finding.
Hamavindu and Floros (2006)	2 countries: RSA and Namibia	1999-2003,Daily.	Unit root tests, Johansen Cointegration tests and Univariate GARCH models.	The returns are adjusted for thin trading to eliminate spurious serial correlation in index returns.	First moments of returns exhibit low correlations and with weak evidence of long run relationship. No evidence of volatility SE between Namibia and RSA.
Lamba and Otchere (2001)	9 developed countries, 7 African countries	1988-2000, Weekly.	Vector Autoregressive (VAR) Model, Cointegration.	The study analyses South Africa‟s return co-movements with several developed markets prior to and after the apartheid regime.	With the exception of RSA and Namibia, the authors record weak evidence of co-movement of African countries with overseas markets.
Piesse and Hearn (2002)	3 Countries: RSA, Namibia and Botswana	1990-2000, Monthly.	Cointegration and Autoregressive Distributed Lag (ADL) extension.	First moment return co-movements are examined among the 3 markets to test the hypothesis of market integration.	There is significant evidence of a common stochastic trend driving the returns of Namibia and South Africa, which is stronger in Namibia, and „spills over‟ into the more open RSA.
Piesse and Hearn	10 Sub-Saharan Countries	1993-2000,Daily.	Univariate EGARCH spillover	SE‟s are mapped by	SE mainly between countries with

(2005)			model.	augmenting a single county"s conditional volatility captured by an EGARCH model with another county"s conditional volatility.	strong trade links or sharing mechanisms for trade and settlement SE are mainly transmitted by RSA and Nigeria (largest markets) to other regional markets.
Pretorius and De Beer (2004)	2 Countries: RSA and Zimbabwe (currencies)	1996-1999,Daily.	Univariate ARCH Models , Correlation Analysis.	ARCH and correlation coefficients are used to examine contagion Rand and Zimbabwean Dollar volatility.	Significant volatility SE effects are detected in support of the contagion hypothesis through financial linkages, but not through bilateral trade linkages between the South African Rand and the Zimbabwean Dollar.
Samouilhan (2006)	2 Countries: RSA and UK	1996-2004, Daily.	Univariate asymmetric volatility models (EGARCH).	First and second moment return associations are investigated between UK and RSA at broad and sector levels.	Significant volatility SE effects recorded with high/lower volatility in foreign markets associated with high/low domestic volatility. Causality in the SE was not addressed.

Samouilhan (2007)	2 countries: RSA and UK	1996-2004, Daily.	Univariate volatility Models (GARCH).	An ICAPM that takes into account variance and covariance risk is used to determine the price of these two risks.	Significant volatility SE are detected such that increases in LSE volatility is associated with increased JSE volatility. Domestic (RSA) risk is priced more than foreign risk.
Mabvuto (2011)	10 countries: RSA, Egypt, Nigeria, Botswana, Mauritius, Namibia and mature economies.	1995-2010, Weekly.	Univariate as well as multivariate GARCH methodology within the BEKK and VEC model framework.	The returns used in the study are continuously compounded log returns. The approach proposed is basically a two factor model in which the unexpected return in the sampled African stock markets are influenced not only by news originating from within the local markets but also	the empirical findings show no evidence of contagion during either the east Asian currency crisis (of 1997) or 2007/2008 global financial crisis for RSA, while some markets such as Egypt, Mauritius and Botswana, exhibit contagion effects from either crisis. Overall the study findings support the view that African bourses are largely segmented both at the regional and global levels as domestic volatility is more influenced by local idiosyncratic

				by two foreign sources: a regional shock from within the African region and a global shock from other mature (world) markets.	shocks (the proportion not attributable to either global and regional factors).
Todorov (2012)	22 countries MENA, Latin America Asia, Africa and USA.	2005-2010 Daily.	Univariate GARCH (1,1) models that specifies market returns as a function of own past values as well as bivariate models that accounts for the impact of returns and volatility from the US market.	To demonstrate the presence of substantial deviations from normality and considerable leptokurtosis in the country data series utilised, ARCH type models was utilised to account for the influence of changing volatility in the time series used. Also daily data was used in the analysis	The results show the presence of significant systemic risk emanating from the covariance of the Frontier markets (studied) stock index returns with world returns. Both the systematic risk and risk premium are time varying. Overall the empirical findings suggest statistically significant impact of both world and own country risk in explaining Frontier country returns. While time-variation in the world risk premium was found to be statistically significant for most Frontier

	on the assumption that it will better capture or account for the stock market dynamics as well as provide greater insight on cross market interactions.	market returns, own country risk, on the other hand, is found to be quantitatively more important.

Source: Adapted from Mabvuto, M. (2011). "Analysis of Volatility Spillover Effects between the South African, Regional and World Equity Markets". Unpublished M.Sc. Thesis, Rhodes University, Grahamstown, South Africa.

NOTES: MENA Middle East and North Africa GCC Gulf Cooperation Council

BEKK: The acronym (BEKK) comes from synthesized work on multivariate models by Baba, Engle, Kraft and Kroner. Engle and Kroner (1995) as well as Gourieroux (1997) gives sufficient conditions for multivariate analysis using the BEKK framework

D. Summary of the Review of Empirical Literature

Section three reviews the existing theoretical and empirical literature on the interdependence of financial markets, primarily focusing on the transmission mechanism of volatility shocks among equity markets. The section broadly discussed several issues from a theoretical disposition. At first, the motivation for why it is of importance to understand inter-market linkages in finance was addressed. It concludes that such an understanding would help investors to identify international diversification opportunities, and help regulators to implement policies aimed at amplifying potential gains from integration, while assisting them to evaluate policy proposals aimed at mitigating the potential financial vulnerability that international financial interdependence may bring. Factors driving equity market linkages are discussed and identified to typically include exchange rate regime, macroeconomic linkages, bilateral trade ties, and policies aimed at liberalising the financial system. In addition, some of the common approaches to studying equity market linkages are also briefly discussed.

Furthermore, a comprehensive overview of the empirical literature documenting interdependence and volatility transmission in mature, emerging and developing markets is given. With regard to the literature on emerging and mature markets, the broad issues relates firstly to the predominance of the US market in the global transmission of volatility. Secondly, in both Europe and East Asia and the Pacific, the interplay of both regional and global factors is seen to be critical for the volatility of those markets. Thirdly, while there is no consensus in both European and East Asia and Pacific markets regarding which factors between global and regional are more important for the volatility in those markets, the empirical findings generally point to increasing interdependence both at the regional and global level in those markets.

With respect to the literature in the African markets, the majority of the findings on the linkages in both the first and second moments of returns support the view that African markets are largely segmented both at the regional level (except where strong trade ties and common trading mechanisms are existent) and at the global level.The next section presents the concluding remarks and recommendations..

4.0. CONCLUDING REMARK

From the extant literature, we observe that volatility transmission from the world stock markets to the African markets could be harmful during periods of financial crises. If such harmful volatility is transmitted into the African stock markets, it could, in turn, be transmitted into other domestic markets like the money market and foreign exchange markets, which could in turn threaten the stability of the domestic financial system as a whole. Therefore, there is a need for policy makers to keep a watchful eye on the behaviour of volatility, especially in other African and major world equity markets in order to prevent or at best curtail negative investors sentiment that often plague frontier and emerging markets during periods of financial crises. While it is often difficult to prevent incidences of volatility transmission, spill-over and contagion, one way of minimising its effect is to ensure that the government of African countries create a stable domestic macroeconomic and political environment by further entrenching democracy, building enduring institutions that outlive current administration, curbing corruption in business and non-business related organisations, and, establishing much needed physical and nonphysical infrastructure.

5.0. RECOMMENDATIONS

On the basis of the research findings, we recommend the following measures, as veritable means through which the negative consequences of volatility transmission, spill-over and contagion among the sampled African markets could be mitigated; and the positive aspects further enhanced for the benefit of Nigeria and other regional African markets.

African countries should strive to develop and implement detailed capital market master plans and country-specific reforms, to reduce their vulnerability to external financial crises in the future. In particular, such reforms should be

guided by the adoption of international best practices, and standards covering issues such as banking system regulation and supervision, data dissemination, corporate governance, transparency in monetary policies, capital market trading activities, and accounting standards. Adherence to these standards could help strengthen macroeconomic policies, the general financial system, and the institutional environment in which capital flows take place. This could reduce the risk of a financial crisis both within and among African markets.A real means of ensuring this is to strengthen the existing financial infrastructure in the money and capital market like the capital market Administrative Proceedings Committee (APC) and the Investment and Securities Tribunal (IST). Moreover, the Economic and Financial Crimes Commission (EFCC) could be further strengthened to help curb risks that arise due to financial market malfeasance.

There is a need for African markets to focus more seriously on their capital markets as possible channels for volatility transmission, spill-over and contagion. In particular, there is still minimal comprehension of the financial channels through which volatility is transmitted among African markets and the actors involved in these financial channels. For example, African capital market regulators need to consider the role of different groups of local and foreign investors and the financial intermediaries operating in their markets. They also should strive to understand the actions of particular classes of investors and the rationality or irrationality of their trading patterns and how important is the incentive framework under which the different groups of investors operate. For instance, hedge funds are one group of investors that are often blamed in the empirical literature for large speculative attacks or market swings since they often take large positions contrary to market sentiments. Since most hedge funds are private, they are not subject to the same reporting standards as many publicly-owned investment companies and their actions could be shrouded in mystery.

Furthermore, the repositioning of the capital market as a pivot for domestic investment growth is critical in order to balance the investment climate in African countries. For instance, during periods of international economic crises, Nigeria's investment climate is often among those that are seriously hit because of her heavy dependence on foreign investment in the choice sectors of her economy. The rapid outflow of capital from the banking sector during the recent financial crises, for instance, had far-reaching effects on the Nigerian banking sector and a strong ripple effect on the entire capital market in general. A well-developed capital market that is domestically sound and oriented can step up to fully accommodate such investment gap in the event of a similar crisis or external turbulence in international capital markets.

We, therefore, advocate that policymakers in their bid to formulate and execute policies aimed at stabilising the domestic financial markets in Nigeria should also take into consideration global factors emanating from foreign external markets such as those in the US or UK.The recent downturn in the international price of crude oil and some related commodities, as well as, the much recent sub-prime crisis in the United States of America that led to the recent global financial crisis are veritable examples of important external global factors. Indeed this recommendation still holds for the other African markets as well.

We also recommend that investors should take advantage of the segmentation of the African markets by including other frontier and emerging markets stocks in their domestic portfolio holdings. This would minimise unsystematic risk. While the findings in this study purely motivate this recommendation, the practical implementation of such an investment strategy would have to take into consideration far much more than just the degree of integration of the African markets, such as political risk, legal and institutional factors, all of which are beyond the scope of the study.These could, however, be the basis for further studies.

The general theme of our recommendations harps on the need for more integration among the world equity markets; while at the same time capitalising on any advantage of segmentation that currently exists in international financial markets. However, there are cost-returns benefits associated with the integration or merger of capital markets worldwide. We, therefore, recommend that regulatory authorities worldwide should strive to achieve regional integration among African and World markets. Given the way the world is currently headed, it is our sincere opinion that as a result of the need for some form of competition in international markets; regionalisation of markets is what we will have as the future new market realities, rather than just one single world market as many researchers anticipate. After all, yesterday the world was said to be a global city, today it is a global village; and who knows, tomorrow it just might be a global family!

Finally, African banks and related financial institutions must be wary of providing short and medium term funds or credit facilities to foreign and domestic investors whose focus is simply to speculate with such funds in the capital market rather than on developing other critical sectors of the economy to achieve economic diversification. Such high-frequency speculations could lead to massive volatility persistence in such markets as stock prices and returns fluctuate without corresponding changes in market fundamentals. Regulatory authorities in African countries are therefore advised, to put in place appropriate policies that will encourage banking institutions and investors to act in a manner that is consistent with the broad objectives of the government.

REFERENCES

Aït-Sahalia, Y., Andritzky, J., Jobst, A., Nowak, S., & Tamirisa, N. (2009). *How to stop a herd of running bears? Market response to policy initiatives during the global financial crisis.* IMF(Working Paper No. WP/09/204). Washington D.C., USA: International Monetary Fund (IMF).

Alhassan, A. (2006). Prospects for international portfolio diversification: Linkages between the Ghanaian Equity Market and the World's Major Markets. *African Finance Journal,* 8(1), 1-13.

Aragó-Manzana, V., & Fernández-Izquierdo, M.A. (2007). Influence of structural changes in transmission of information between Stock

Markets: A European Empirical Study. *Journal of Multinational Financial Management,* 17(2), 112-124.

Bae, K., & Karolyi, A.G. (1994). Good news, bad news and international spillovers of stock market Return Volatility between Japan and the US. *Pacific-Basin Finance Journal,* 2(4), 405-438.

Baele, L. (2005). Volatility Spillover Effects in European Equity Markets. *Journal of Financial*
andQuantitative Analysis, 40(2), 373-401.

Bekaert, G., & Harvey, C.R. (1997). Emerging Equity Market Volatility. *Journal of Financial Economics*, 43(1), 29-77.

Bekaert, G., & Harvey, C.R. (2000). Foreign speculators and emerging equity markets. *Journal of Finance*, 55(2), 565-613.

Bekaert, G., & Harvey, C.R. (2003). Emerging markets finance. *Journal of Empirical Finance*, 10 (1), 3-56.

Bekaert, G., Harvey, C.R., & Ng, A. (2005). Market integration and contagion. *Journal of Business*, 78(1), 39-69.

Bob-Osaze, E. (2007). *Capital Markets: African and Global*. Lagos: The Book House Company.

Bob-Osaze, E. (2011). The specificities of value melt-down in the Nigerian Stock Exchange 2008-2010: Some Parallax snaps. *First Professorial Endowed Lecture Series*, University of Benin, Benin City.

Bob-Osaze, E. (2011). *Writing theses and dissertations.* Benin: Ambik Press.

Bodart, V., & Redding, P. (1999). Exchange rate regime, volatility and international correlations on bond and stock markets. *Journal of International Money & Finance.* 18(1), 133-151.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of*
Econometrics, 31(3), 307-327.

Calderon, C.A., Chong, A.E., & Stein, E.H. (2002). Trade intensity and business cycle synchronization: Are developing countries any different? Unpublished Manuscript, Inter-American Development Bank. Washington DC.

Calvo, G. (2004). Contagion in emerging markets: When Wall Street is a carrier. *IEA Conference Volume Series*, 136(1), 81-94.

Campbell, J. (1996). Consumption and the Stock Market: Interpreting International Experience. *NBER Working Paper*, 5610.

Caporale, G.M., Cipollini, A., & Spagnolo, N. (2006). Testing for Contagion; a Conditional Correlation analysis. *Journal of Empirical Finance,* 12(3), 476-489.

Caporale, G.M., Pittis, N., & Spagnolo, N. (2006). Volatility Transmission and Financial crisis. *Journal of Economics and Finance,* 30(3), 376-390.

Chen, N.F., & Zhang, F. (1997). Correlations, trades and stock returns of the Pacific Rim Markets. *Pacific Basin Finance Journal,* 5(5), 59-77.

Chinzara, Z., & Aziakpono, M. (2009a). Integration of the South African equity market into the world major stock markets: implication for portfolio diversification. *AfricanFinance Journal* Special Issue, 8(1), 412-421.

Chinzara, Z., &Aziakpono, M. (2009b). Dynamic returns linkages and volatility transmission between South African and World Major Stock Markets. *Studies inEconomics & Econometrics.* 33(3), 69-94.

Christiansen, C. (2007). Volatility-spillover effects in European bond markets. *European Financial Management,* 13(5), 923-948.

Chuang, I., Lu, J., & Tswei, K. (2007). Interdependence of international equity variances: Evidence from the East Asian Markets. *Emerging Markets Review,* 8 (4), 311-327.

Cifarelli, G., & Paladino, G. (2005). Volatility linkages across three major equity markets: A financial arbitrage approach. *Journal of International Money & Finance,* 24(3), 413-439.

Clare, A., & Lekkos, I. (2000). An analysis of the relationship between international bond markets. Working Paper. Bank of England. Retrieved on 10th November 2013 from: Http://ssrn.com/abstract=258021 or DOI: 10.2139/ssrn.258021.

Cole, H.L., &Obstfeld, M. (1991). Commodity trade and international risk sharing: How much do financial markets matter? *Journal of Monetary Economics.* 28(1), 3-24.

Collins, D., & Biekpe, N. (2003a). "Contagion and interdependence of African stock Markets". *South African Journal of Economics.* 71 (1), 181-194.

Collins, D., & Biekpe, N. (2003b). Contagion: a fear for African equity markets. *Journal of*
Economics and Business, 55 (3), 285-297.

Eguavoen, J. O. (2012). Stock return and volatility in an emerging stock market: evidence from Nigeria(Unpublished Master's Thesis). University of Benin, Benin City, Nigeria.

Eichengreen, B. (1999). *Towards a new international financial architecture: A practical post-Asia agenda*. Washington D.C.: Institute for International Economics.

Engle, R.F. (1982). Autoregressive conditional heterosceticity with estimates of the variance of United Kingdom inflation. *Econometrics*. 50(4), 987-1008.

Engle, R., & Kroner, F.K. (1995). Multivariate simultaneous generalized ARCH. *Econometric Theory,* 11(1), 122-150.

Eriki, P.O.,& Idolor, E.J. (2010). The behaviour of stock prices in the Nigerian Capital Market: A Markovian analysis. *Indian Journal of Economics and Business (IJEB).* 9(4), 675 – 694.

Errunza, V. (1977). Gains from portfolio diversification into less developed countries securities. *Journal of International Business*, 8(2), 83-99.

Eun, C.S., & Shim, S. (1989). International transmission of stock market movements. *Journal of Financial & Quantitative Analysis,* 24(2), 241-256.

Francis, B.B., Hasan, I., & Hunter, D.M. (2002). Emerging market liberalisation and the impact on the uncovered interest rate parity. *Journal of International Money andFinance.* 2(6) 931-956.

Fratzscher, M. (2002). Financial Market Integration in Europe: On the effects of the EMU on Stock Markets. *International Journal of Finance and Economics*, 7(3), 165-193.

Gannon, G., & Au-Yeung, P.S. (2005). Structural effects and spillovers in the HSIF, HIS and S&P 500 volatility. *Research in International Business and Finance,*18(3), 305-317.

Gourieroux, C. (1997). *ARCH Models and Financial Applications*. New York: Springer-Verlag.

Grossman, G.M., & Helpman, E. (1991). *Innovation and Growth in the Global Economy.* Cambridge, MA: MIT Press.

Grubel, H.G. (1968). Internationally diversified portfolios: Welfare gains and capital flows. *American Economic Review*, 58(5), 1299-1314.

Hamavindu, H.M., & Floros, C. (2006). Integration and volatility spillovers in African equity markets: evidence from Namibia and South Africa. *African Finance Journal,* 8(2), 31-50.

Harvey, C.R. (1997). Predictable risk and returns in emerging markets. *Review of Financial Studies,*8(3), 773–816.

Hilliard, J.E. (1979). The Relationship between Equity Indices on World Exchanges. *Journal of Finance*, 34(1), 103-114.

Idolor, E.J. & Braimah, A. (2015). A Test of Fama's Efficient Capital Market's II Position in the Nigerian Bourse. *Indian Journal of Economics and Business (IJEB)*, 14(3), 375 – 398.

Idolor, E.J. (2014). *Volatility transmissions among Nigeria, selected African and World equity markets* (unpublished doctoral dissertation). University of Benin, Benin City, Nigeria.

Ikponmwosa, N. (2013). Foreign Private Investment and Stock Market Volatility in Nigeria. Unpublished M.Sc. Thesis, University of Benin, Benin City, Nigeria.

In, F. (2007). Volatility Spill-overs across International Swap Markets: The US, Japan, and the UK. *International Money and Finance,* 26(3), 329-341.

Isakov, D., & Pérignon, C. (2000). On the dynamic interdependence of international stock markets: A Swiss perspective. *Swiss Journal of Economics & Statistics*, 136(2), 123-146.

Investopedia (2013). Emerging Markets Defined. Retrieved on 10th September 2013 from: http://www.investopedia.com/terms/e/emerging.

Kaminsky, G., & Reinhart, C. (2002). Financial Markets in times of stress. *Journal of Development Economics, 69(2), 451-470.*

Kim, S.W., & Rogers, J.H. (1994). International stock price and market liberalisation: Evidence from Korea, Japan and the United States. *Journal of Empirical Finance,* 2(2), 117- 133.

Kim, S.J., Moshiran, F., & Wu, E. (2005). Dynamic stock market integration driven by the European Monetary Union: An empirical analysis. *Journal of Banking & Finance*, 29(10), 2475-2502.

Koch, P.D., & Koch, W.T. (1991). Evolution in dynamic linkages across daily national stock Indexes. *Journal of International Money and Finance,* 10(2), 231-251.

Kodres, L.E., & Pritsker, M. (2002). A rational expectations model of financial contagion. *Journal of Finance*, 57(2), 769-799.

Koutmos, G., & Booth, G.B. (1995). Asymmetric volatility transmission in international

stock markets. *Journal of International Money & Finance*, 14(6), 747-762.

Lamba, A.S., & Otchere, I. (2001). An analysis of the linkages among African and World
Equity Markets. *The African Finance Journal*, 3(2), 1-25.

Levy, H., & Sarnat, M. (1970). International diversification of investment portfolios. *American Economic Review*, 60(4), 668-675.

Li, L.M. (2009). Change in volatility regimes and diversification in emerging Stock Markets.
South African Journal of Economics, 77(1), 59-80.

Liu, Y.A., & Pan, M. (1997). Mean and volatility spillover effects in the U.S. and Pacific-Basin
stock markets. *Multinational Finance Journal*, 1(1), 47-62.

Ludrigson, S., & C. Steindel (1999). How important is the Stock Market effect on consumption. *Federal Reserve Bank of New York Economic Policy Review*, 5(1), 29-51.

Mabvuto, M. (2011). *Analysis of Volatility Spillover Effects between the South African, Regional and World Equity Markets*(Unpublished Master's Thesis). Rhodes University, Graham's town, South Africa. .

Miyakoshi, T. (2003). Spillovers of stock return volatility to Asian equity markets from Japan and the US. *Journal of International Financial Markets, Institutions & Money*, 13(4), 383-399.

Mollah, S.A. (2009). Stock return and volatility in the emerging Stock Market of Bangladesh. *Journal of the Academy of Business and Economics*, 43(21), 29-78.

Ng, A. (2000). Volatility spillover effects from Japan and the U.S. to the Pacific-Basin. *Journal of*
International Money and Finance, 19(2), 207-233.

Olowe, R. A. (2009). Stock Return, Volatility and the global financial crisis in an emerging market: the Nigerian case.*International Review of Business Research Papers*,5(4), 426-447.

Piesse, J., & Hearn, B. (2005). Integration and the Asymmetric Transmission of Volatility: A
Study of Equity Markets in Sub Saharan Africa. *South African Journal of Economics*, 73(1),36-53.

Piesse, J., & Hearn, B. (2002). Equity markets integration versus segmentation in the three dominant markets of the Southern African customs union: Cointegration and causality tests. *Applied Economics*, 34(14), 1711-1722.

Porterba, J.M. (2000). Stock Market Wealth and Consumption. *Journal of Economic Perspectives*, 14(2), 99-118.

Pretorius, A., & De Beer, J. (2004). Contagion in Africa: South Africa and a troubled neighbour, Zimbabwe. *Economic Modelling*, 21(4), 703-717.

Rajni, M., & Mahendra, R. (2007). Measuring Stock Market Volatility in an Emerging Economy. *International Research Journal of Finance and Economics*, 8(1), 126-130.

Rogoff, K. (1999). International institutions for reducing global financial instability. *Journal of Economic Perspective*s, 13(4), 21-42.

Ripley, D.M. (1973). Systematic Elements in the Linkage of National Stock Market Indices. *Review of Economics and Statistics.* 55(3), 356-361.

Samouilhan, N.L. (2006). The Relationship between International Equity Market Behaviour and the
JSE. *South African Journal of Economics,* 74(2), 249-260.

Samouilhan, N.L. (2007). "The Price of Risk in the South African Equity Market". *South African Journal of Economics.* 75 (3), 442-458.

Schollhamer, H., & Sand, O.C. (1987). Lead-lag relationships among national equity markets: An empirical investigation. In Khoury, S.J. and Ghosh, A. (Eds). *RecentDevelopments in International Banking & Finance,* Vol. 1. Lexington: Lexington Books.

Solnik, B.H. (1974). Why not diversify internationally? *Financial Analyst Journal,* 30(4), 48-54.

Starr-McCluer, M. (1998). Stock Market Wealth and Consumer Spending. Board of Governors of the Federal Reserve System. Finance and Economics Discussion Paper Series, 98/20.

Todorov, G.K. (2012). *A Study of Stock Market Linkages between the US and Frontier Markets* (Unpublished Doctoral Dissertation). Florida International University, Miami, USA.

Von-Furstenberg, G.M., & Jeon, B.N. (1989). International stock price movements: links and messages. *Brookings Papers on Economic Activity. 20*(1), 125-179.

Wei, K.C.J., Liu, Y., & Yang, C. (1995). Volatility and Price Change Spillover Effects across the Developed and Emerging Markets. *Pacific-Basin Finance Journal*, 3(1), 113-136.