VOLATILITY SPILLOVER BETWEEN FOREIGN EXCHANGE AND STOCK MARKETS IN NIGERIA

BY

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DECLARATION

I declare that the work in this dissertation entitled, *"Volatility Spillover between Foreign Exchange and Stock Markets in Nigeria"* has been carried out by me in the Department of Economics under the supervision of Dr. Mohammed Shuaibu and Dr. Aliyu R. Sanusi. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

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CERTIFICATION

This dissertation entitled, "VOLATILITY SPILLOVER BETWEEN FOREIGN EXCHANGE AND STOCK MARKETS IN NIGERIA" by Faridah, Lawal ABUBAKAR meets the regulations governing the award of the degree of M.Sc. Economics of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This Dissertation is dedicated to Almighty Allah by whose unbounded favour and mercy I am able to complete this research work.

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ABSTRACT

Financial market volatility and contagion has been a major concern for policy makers and market participants around the world due to risk and vulnerabilities emanating from exchange rate shocks. Thus, an understanding of the extent of interconnectedness between stock and foreign exchange market is crucial for macroeconomic stability. Therefore, this study "Volatility Spillover between Foreign Exchange and Stock Markets in Nigeria" investigated the magnitude of foreign exchange and stock market integration in Nigeria using weekly time series data from 2000 to 2017 in order to ascertain the extent of volatility in the stock and foreign exchange markets as well as to assess the extent of volatility spillover across the markets. Predicated on a modified version of the portfolio balance approach, the adapted model was estimated using Exponential GARCH, and the VAR-based Forecast Error Variance Decomposition (FEVD) proposed by Diebold and Yilmaz (2012) to establish the extent of foreign exchange and stock market interdependence. The findings reveal that a negative but statistically significant relationship exists between the foreign exchange and stock markets where a percentage change in All Share Index exerts negative (0.1%) impact on exchange rate while a percentage change in exchange rate leads to a 0.6% decline of the All Share Index. This suggests that volatility in the latter is more pronounced. Furthermore, it was observed that volatility spills over from the foreign exchange market to the stock market and this was particularly striking during turbulent periods such as the 2008 global financial crisis and the devaluation of the Naira in the 4th quarter of 2014. This resulted in a spillover index of 2.1% from the foreign exchange to stock market and 0.2% from the stock market to foreign exchange market. The study concludes that exchange rate stability is paramount for a stable asset market in Nigeria, and recommends that monetary authorities should give more priority towards achieving foreign exchange stability.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The level of financial market integration has been on the increase as a result of financial reforms and liberalization of capital accounts in countries around the world. In addition, the advancement in technology has also allowed information to be transmitted freely across global financial markets than ever before. These developments have reduced the isolation of domestic markets and increased their vulnerability to news and shocks thereby causing volatility and possible spillover across asset markets. Most developed and developing economies of the world have experienced high exchange rate volatility, which translates to high degree of uncertainty and obstructs the attainment of government's macro-economic objectives. Volatile exchange rates and stock market prices influence foreign investments. This is because investors are interested in returns as well as the uncertainty of such returns. An excessively volatile stock market weakens consumer confidence and reduces investment spending because it magnifies the risk in equity investment. Volatile exchange rates have made international trade and investment difficult due to underlying uncertainties induced by exchange rate risks. This is expected to have an implication on the stock market (Choi, Fang and Fu, 2006). Thus, a good motive for investors is to possess a good understanding of the origins and drivers of local markets, its volatility, and cross-market correlations.

In Nigeria, the fixed exchange rate regime was adopted shortly after independence in 1960 following the enactment of the Exchange Control Act in 1962 during which the Central Bank of

Nigeria (CBN) was vested with the authority to earn and disburse foreign exchange in the country. Between 1977 and 1981, a tight exchange rate regime was administered to reduce external sector pressure, but failed to achieve the policy objective[1]. Hence, it was replaced with a managed exchange rate regime. Following the economic stabilization Act of 1982, the exchange rate was realigned under a more flexible regime, in order to stem *frivolous* demand for foreign exchange. These measures were sustained until the adoption of the Structural Adjustment Programme (SAP) in 1986. Prior to the adoption of SAP, the naira was overvalued and hence, its consequent liberalization in 1986 with the market forces determining its actual value (Nwude, 2012)[2].

The establishment of the stock market as a formal and specialized capital market institution in Nigeria took place in September 1960 and was referred to as the Lagos Stock Exchange. It was renamed in December 1977 to the Nigerian Stock Exchange (NSE) following the recommendations of the Industrial Enterprise Panel; that branch exchanges should be established. The regulation of the NSE is carried out through the Securities and Exchange Commission (SEC), and thus, the NSE's performance can be viewed through stock market capitalization and/or the All Share Index[3]. Between 1995 and 2000, market capitalization witnessed an increase from ₦101.1 billion to approximately ₦280 billion. In 2003, it hit ₦1.3 trillion and recorded an all-time high of ₦13.3 trillion in 2007[4].

[1] The objective was to attain a favorable Balance of Payment (BOP). This was due to the end of the oil boom period when the Nigerian economy started experiencing fluctuating BOP between the position of surplus and deficit, thus leading to a binding constraint in the realization of her macro objectives.

[2] Yet, the Naira has depreciated persistently against the US Dollar indicated by the data; ₦2.02 in 1986, ₦8.03 in 1990, ₦21.88 in 1996, ₦102.10 in 2000, ₦128.65 in 2006, ₦150.29 in 2010 and ₦197 in 2015.

[3] The NSE stock market capitalization recorded remarkable growth during the period, between 1981 and 2008, as it grew from ₦4.84 billion in 1981 to ₦6.4 billion in 1985 and ₦15.9 billion in 1990.

[4] The stock prices of quoted companies on the NSE are affected either positively or negatively by number of factors within and outside the economic system (company profit, economic performance, etc). Investment in stock is long-

In January 1995, the federal government of Nigeria abrogated the Exchange Control Act of 1989, and effectively internationalized Nigerian stock market, in order to enhance the market's competitiveness and attractiveness in the global market[5], based on the fact that liberalizing capital account would permit financial resources to flow from capital surplus economies to capital deficit countries. A significant change in the Nigerian stock market development was observed in 2004 following the banking consolidation policy of the CBN that required Nigerian banks to increase their minimum capital base to ₦25 billion by the end of December 2005[6]. The banks were encouraged to engage in mergers and acquisition. This exercise affected dealings in the stock market, because most banks had to raise their required minimum capital through the capital market by issuing new securities. This led to a staggering increase in total market capitalization to ₦4.38 trillion.

The 2007-2008 global financial crises had an unprecedented impact on capital and exchange rate as financial market fragility in the United States spread with severe consequence across the globe. Starting with the credit squeeze, reduction in household demand, rising unemployment and falling housing prices in late 2005 to 2006, the bubble finally ruptured, and heralded the sub-prime mortgage crisis with multiplier effects in 2007[7]. Global interconnectedness through the trade and finance channel, in addition to the mono-culture nature of the economy, intensified Nigeria's vulnerability. The shocks were primarily transmitted through the stock market and as foreign investors realized the danger posed by the financial turmoil, they began to withdraw their

term in nature, thus any development that could affect the stability of the economy has serious impact on stock prices. In recent times, the NSE has consistently lost points and the prices of stocks has experienced sharp decline (Business Time, 2015). However, stock prices have a high degree of volatility due to market fluctuations, especially when pressure is being exerted to keep the controlled interest rate closer to market prices.

[5] Security and Exchange Commission Report (1995)

[6] It was meant to strengthen the capital and liquidity base of Deposit Money Banks (DMBs) and reposition them against hard financial times.

[7] The crises caused major business failures, with consumer wealth falling by trillions of dollars, and economic activities dipping considerably, engendering the European sovereign-debt crisis.

funds which in turn negatively affected the stock market. Market capitalization dropped by 28.03% between 2007 (₦13.2 trillion) and 2008 (₦9.5 trillion). As at September 2009, market capitalization was ₦6.96 trillion representing 26.7% decline over its 2008 closing figure. This in turn influenced the exchange rate suggesting the possibility of spillover across the market as the stability experienced in the Foreign Exchange Market (FEM) from 2001 became threatened in the last quarter of 2008 largely due to declining private capital inflows[8].

It is pertinent to note that availability of shale gas in addition to excess supply by the Organization of Petroleum Exporting Countries (OPEC) member country (Saudi Arabia), affected the global crude oil market, and negatively affected the Nigerian economy. This saw the country's crude oil production drop below 2.3mbd (million barrel per day) from 2.44mbd (2014) to 2.15mbd (2015). The impact of the drop became heightened in the third quarter of 2014 when crude oil prices plummeted; forcing the Central Bank of Nigeria (CBN) to devalue the naira by 8% (from ₦154.56 to ₦168.00). Consequently, foreign investors began to withdraw; causing a fall in stock prices by ₦1.73 trillion, due to currency risk, weak economic performance in the emerging markets, fragile recovery of the Euro zone, the effects of the US Federal Reserve tapering of its quantitative easing (QE) policy, and unstable political environment such as the uncertainty that shrouded the 2015 election outcome (MPC Communiqué, 2014).

In a bid to minimize the risks to monetary management occasioned by the dwindling oil prices, the initial policy response of the CBN was the closure of Retail Dutch Auction System (RDAS) window in February 2015. This policy was designed to manage demand for foreign exchange,

[8] Thus, exchange rate has been volatile since then; the official exchange rate showed that the Naira depreciated against the dollar by 20.4% from 2008 as follows; ₦118.56, (2009); ₦148.90, (2011); ₦156.20, (2013); ₦159.05, (2015); ₦168.00 reflecting the demand pressure relative to supply with implications for the foreign exchange reserves.

the sliding exchange rate and foreign reserves owing to the fall in price of crude oil. Consequently, the CBN also introduced additional trade and exchange restrictions, including a ban on access to foreign exchange at the official foreign exchange market for the import of about 41 items[9]. On the other hand, as part of efforts to reverse the drift in the market and restore public confidence, SEC introduced some reforms in the market. This includes the Capital Market Master Plan, the National Investor Protection Fund and the Direct Market Access, among others; and also implemented the electronic dividend payment, de-materialization of share certificates and direct settlement payment, all geared at boosting investor confidence in the market (Nigerian Stock Exchange, 2015).

Although, research have been conducted about the rapid expansion of financial markets integration due to trade and financial market liberalization policies as well as the accelerated investments/business interactions between the stock market and foreign exchange market in Nigeria since both play important roles in influencing the development of the country's economy. However, the markets' financial position are susceptible to volatilities and as a result have cost implications, thus no empirical study has been carried out to affirm the existence of volatility spillover across the markets in Nigeria.

[9] Rice, cement, margarine, palm kernel/palm oil product/vegetable oil, meat and processed meat product, poultry-chicken, private airplanes/jets, Indian incense, tinned fish and sauce/sardines, cold rolled steel sheets, galvanized steel sheets, roofing sheets, wheel barrows, head pans, metal boxes and containers, enamel ware, steel drums, steel pipes, wire rods, iron rods and reinforcing bars, wire mesh, steel nails, security and razor wire, wood particle boards, wood fiber boards, plywood boards, wooden doors, furniture, toothpicks, glass and glassware, kitchen utensils, tableware, tiles-vitrified and ceramics, textiles, woven fabrics, clothes, soap and cosmetics, tomatoes/tomato pastes, plastic and rubber products, Eurobond/foreign currency bond/ share purchases.

1.2 The Research Problem

The global economy is going through a difficult phase of its business cycle. However, the current phase has been primarily driven by continued fall in global oil price, slow growth in the Euro zone, increase in world crude oil supply, declining growth in China and the rising incidence of global terror. This has been exacerbated by rising regional tensions in the Middle East in addition to the Euro migrant crisis[10]. Nigeria like most oil-exporting countries and oil dependent economies is not left out in the global slowdown as the country operates a *pseudo* fixed exchange rate system, allows free capital flows and implements an independent monetary policy (a trilemma)[11]. Thus, currently making the economy vulnerable to both internal and external shocks amidst dwindling foreign reserves, rising government borrowing, tight monetary and fiscal policies, and declining oil price.

The end of second quarter 2014, witnessed a free fall in crude oil price with OPEC (Organization of Petroleum Exporting Countries) reference basket declining from US$105.38/barrel in February 2014 to US$54.06/barrel in February 2015. CBN in reaction to falling oil and de-accumulation of international reserves devalued the Naira from ₦155/$1 to ₦168/$1. The devaluation that followed since November 2014 did not spare the Nigerian Stock market as it created new risks in the form of transaction losses, portfolio outflows and declining stock returns. Thus, financial volatility has been a concern in the financial sector around the world due to unfavorable market risk premium. Therefore, it is important for policy makers to reduce stock market volatility and enhance macro-economic stability in order to improve the effectiveness of asset allocation decisions.

[10] Amid declining growth in China, Russia, Euro zone, Asia and political upheavals in Egypt, Libya, Ukraine, Syria and Brazil has further compounded the demand-supply dynamics of crude oil in the international market

[11] The impossible trinity principle

However, researchers have in the past concentrated on establishing the effects of foreign exchange rate fluctuation on stock return volatility. Mixed findings have emerged indicating that exchange rate fluctuation has an impact on stock return volatility (Olugbenga, 2012; Salihu and Subair, 2013; Moore and Wang, 2014, and Sui and Sun, 2016) while contradictory findings that stock return volatility has an impact on exchange rate fluctuation (Choi et al, 2006; Zhao, 2010; Lin, 2012; Chkili and Nguyen, 2014, and Salisu and Oloko, 2015) have also emerged.

Notwithstanding, recent development in both the capital and the money market clearly shows that the Nigerian economy is experiencing a downturn, as business confidence seems to have fallen by 45.45% during the 2013-2014 (P.MNews, 2014) . Furthermore, there is a widespread contention that volatility of exchange rate is one of the main sources of economic instability around the world (Salisu and Oloko, 2015). The impact of the global economy on developing countries like Nigeria is driven significantly by swings in the currencies of developed economies. In recent years, these swings have been enormous and volatile, and do not conform to the underlying economic fundamentals (Phillips and Perron, 1988).

While the stock market plays a vital role in mobilizing resources and channeling same to investors, the origin of stock market volatility has long been a topic of considerable concern to policy makers and financial analysts. Policy makers have their interest vested in the main determinants of volatility and its spillover effects on real sector activities. Financial analysts on the other hand have focused on the effects of time-varying volatility (Chkili and Nguyen, 2014). The financial position of an economy is determined by the capital market, which is in turn susceptible to foreign exchange volatility (Business Time, 2015). It is against this background that the following research questions emerge; (i) what is the extent of volatility in the foreign

exchange and stock market in Nigeria? (ii) To what extent does volatility spillover across the foreign exchange and stock market in Nigeria?

1.3 Objectives of the Study

The broad objective of the study is to investigate the extent of foreign exchange and stock market integration in Nigeria. Specifically, the study seeks to

i) Ascertain the extent of volatility in the foreign exchange and stock market in Nigeria;
ii) Examine the extent to which volatility spillover across the foreign exchange and stock market in Nigeria.

1.4 Justification of the Study

Foreign exchange and stock market and their volatility can significantly influence economic activities in Nigeria. As asset and credit bubbles form in many countries, stock markets crash and consequently, currencies depreciate. However, the existence of excessive volatility, or "noise," in the stock market undermines the usefulness of stock prices which serves as benchmark for information efficiency of the markets (Karolyi, 2001). Thus, market estimates of volatility are used by policy makers as a tool to measure vulnerability of the economy through the exchange and stock market channel. In view of the importance of volatility, it becomes imperative to understand the spillover of volatility across foreign exchange and stock market volatility.

Various studies carried out in Nigeria on foreign exchange-stock market interaction [Olugbenga (2012), Chigozie and Odionye (2012), Salihu and Subair (2013) and; Salisu and Oloko (2015)] focused on the determinants of volatility in the markets independently, relying on the traditional and portfolio balance approach. However, this study contributed to the existing literature by

introducing a modified portfolio model that accounts for exogenous shocks and considered the interaction in both markets in terms of volatility spillover in doing so, relied on higher frequency data.

In terms of methods, the literature is dominated by the use of unit-root test, granger causality test, co-integration test and error correction model, relying on quarterly and annual data. However, these models are limited because they failed to capture correlation and volatility spillovers across markets. Therefore, the empirical pursuit of this study is two-fold; firstly the Exponential GARCH framework was utilized to capture volatility in the stock and foreign exchange markets. Secondly, Diebold and Yilmaz (DY) framework which is based on forecast error variance decompositions from Vector Autoregressions (VARs) was used to capture volatility spillovers across the markets. This is because it measures spillovers in returns or return volatilities across individual assets, asset portfolios and asset markets both within and across countries, and also conveys useful information and overcomes the limitation associated with the definition and existence of episodes of contagion or herding behavior (Diebold and Yilmaz, 2012).

The empirical outcome of this research is expected to contribute towards the formulation and implementation of monetary policy. Specifically, it will serve as a guide to traders and investors in their portfolio decision making process, as well as inform monetary authorities in formulating appropriate and well-orientated decisions on interest and exchange rate policies. To my knowledge, this is the first study that empirically investigates volatility spillovers between the foreign exchange and stock market in Nigeria using relatively more recent high frequency data set.

1.5 Scope of the Study

This study focused on volatility spillovers between the foreign exchange and stock market in Nigeria using weekly data from 2000 to 2017. The choice of this period provides ample opportunity to show the trend during positive and negative business cycles thereby providing traders, investors and policy makers with adequate estimates of the extent of stock and foreign exchange market integration in Nigeria.

1.6 Organization of the Study

The study is organized into five chapters. Chapter one is the general introduction, while chapter two encompasses conceptualization, theoretical and empirical literature. In chapter three, the research methodology was explored, while chapter four focused on presentation and discussion of results. Chapter five presents the summary, conclusion and recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The relationship between foreign exchange and stock market has attracted significant attention and remains inconclusive. Several studies have linked the inconsistency to; *inter alia,* the exchange rate regime, structural changes, capital restrictions and macroeconomic fundamentals in both developed and developing countries. This section review key concepts, theoretical issues, methodologies used and empirical results with a view to highlighting literature gaps.

2.2 Conceptual Issues

2.2.1 Exchange Rate

Exchange rate is the unit of domestic currency per foreign currency, or the units of a foreign currency in terms of domestic currency (Dwivedi, 2007). It is important because it affects the relative price of domestic and foreign goods. It is a relative price that measures the worth of a domestic currency in terms of another currency (Umar, 2006). The exchange rate between two currencies is defined as the rate at which one currency is exchanged for another. It is composite and its value can be measured in different ways. For example, a currency can be measured in terms of other currencies, or it can be measured in terms of it purchasing power. The rate can be measured through different perspectives as follows:

i. Nominal Exchange Rate: The nominal exchange rate is the number of units of domestic currency that can purchase a unit of a given foreign currency. A decrease in this variable is termed nominal appreciation of the currency (under the fixed exchange rate regime, a

downward adjustment of the nominal exchange rate is termed revaluation) and an increase is termed nominal depreciation of the currency (under the fixed exchange rate regime, an upward adjustment of it is called devaluation).

ii. Real Exchange Rate: Aliyu (2012) defines real exchange rate as the relative price of local goods to foreign goods. It is the nominal exchange rate which has been adjusted for price level between countries (Odusola, 2006). The external real exchange rate is the ratio of aggregate foreign price or cost level to the home countries aggregate price or cost while the internal real exchange rate measures the relative prices of two broad categories of goods; ratio of domestic price of tradable goods to non-tradable goods within a country (Viser, 2004).

iii. Effective Exchange Rate: it is associated with a multilateral exchange rate where a country has multiple trading partners (Aliyu, 2012). In this case, the rate is weighted and incorporates all forms of taxes charged on import and export (Odusola, 2006). However, multilateral real exchange rate is a weighted average of the external real exchange rate index with respect to multiple trading partners (Viser, 2004).

2.2.2 Foreign exchange market

Foreign exchange market is a market in which international currency trade takes place (Krugman, 2003). Currency trading is the world's largest market consisting of almost trillions in daily transactions; and as investors become more interested, the market expands rapidly. Foreign exchange market is a market in which currencies are traded (Chkili, Chaker, Masood and Fry, 2011). For instance, when funds are to be transferred from one country to another, they are first converted from the currency in the country of origin to the currency of the destination country. Thus, the foreign exchange market is where this conversion takes place (Grobys, 2015). That is,

it is a market where transaction and conversion of one country's currency in terms of another takes place at a given rate.

The exchange rate, like commodities, determines its price through it response to the market forces of demand and supply (Krugman, 2003). Consequently, if for some reason demand for a specific currency increases, then the price will rise, and if supply increases, price will decline. In addition, a situation where demand exceeds supply, a depreciation of the currency will occur while a scenario in which supply exceeds demand, an appreciation occurs. A fall in the value of a local currency in the market for foreign exchange relative to other (foreign) currencies is known as currency depreciation whereas an increase in the value of a currency relative to other (foreign) currencies is referred to as an appreciation (David and Scot, 2005).

Exchange Rate Regimes

Fixed or Pegged Regime

This is a system where countries reach an agreement to peg their exchange rate against another currency e.g. United States (US) Dollar and occasionally adjust it until a desired target is attained. This regime evolved after the Second World War and was quite different from the gold standard which had a 100% backing for the domestic currency to be printed by government as they deemed fit (Ogawa 1987). It is a system in which monetary authority announces the buying and selling rates for its currency in terms of a foreign currency and promises to trade at that rate (Aliyu, 2012).

Flexible Exchange Rate Regime

Also known as the floating exchange rate regime, it involves the determination of the exchange rate through the forces of demand for and supply of foreign exchange. It evolved as a result of the global monetary crisis witnessed in 1971 that arose from the decision of some countries to float their currencies against the US Dollar and other currencies (Ogawa 1987).

Under this regime, equilibrium level is sustained without government intervention. That is, exchange rate is allowed to establish it equilibrium path through the interplay of the market forces based on the purchasing power parity (PPP) condition which states that; "homogenous products should maintain equal prices in all countries". Alternatively, it implies that the price of a bundle of goods produced in two countries should be similar when expressed in a common currency. Furthermore, it predicts that exchange rate between two countries will adjust to reflect the price level difference between the two countries in the long-run (Ocheni, 2006).

Managed Float Regime

This exchange rate regime is the regime that blends the features of floating exchange rate with Central Banks' intervention to ensure that governments' objective of stable exchange rate is attained (Lin, 2012). It was embraced when several countries abandoned the fixed and floating regimes (Moore and Wang, 2014). Under this regime, market forces are allowed to determine the exchange rate within defined bounds. The exchange rate regime is an effective instrument used by monetary authorities to discourage imports (Do, Brooks and Sirimon, 2015). Hence, central banks intervene in the market to ensure foreign exchange stability.

2.2.3 Stock Prices

A stock represents share of ownership in a corporation. It is a security (claim) on the earnings and assets of the corporation. Issuing and selling stocks to the public is a means through which corporations raise funds to finance their activities. Dornbusch (1980) viewed stock price as the present value of the future firm's cash flows which reacts to exchange rate changes due to the influence of exchange rate on international competitiveness and invariably, national output.

Because stock prices depend on current and expected future profits as well as on current and expected future interest rates (Blanchard, 2010), it may be defined as the cost of purchasing a security in the market, which can be affected by the state of the company and economic conditions like financial market volatility, economic events, government policies and so on.

2.2.4 Stock Market

Stock market is a market where large and long term capital resources are pooled through issuing of shares and stocks by industries in need of finance for expansion purposes (Olugbenga, 2012). It is a convenient place where trading in securities are conducted in a systematic manner in line with certain rules and regulations. The stock market is an organized corporation designed for the transaction of securities and to serve as an investment intermediary in order to facilitate economic development through long term financing.

Stock market serves as a channel through which surplus funds move from lenders to savers, that is from surplus holders to those with deficit. It is a highly organized market through which businesses can raise financial capital by selling shares and debentures. The stock market serves as a channel through which surplus funds are moved from lender-savers to borrower-spenders who have shortages of funds (Mishkin, 2000). As rightly observed by Alile (1984), the stock

market is a channel through which savings are mobilized and efficiently allocated to achieve economic growth.

2.2.5 Volatility spillover

Volatility may have adverse implications for decisions pertaining to effective allocation of resources and investment (Nnachi, 2008). For instance, volatility makes investors more averse to holding stocks and investors in turn demand a higher risk premium in order to insure against increased uncertainty (Emenike, 2010). Fluctuation of a variable over a period of time is an indication of the variable's volatility, and therefore, the deviation from an expected value is also used to describe volatility. Financial volatility has been influenced by different factors; and they include for instance, increase in inflationary expectations, restrictive monetary policy and removal of interest rate ceiling (Becketti and Sellon, 1989).

According to Milunovich and Thorp (2006), volatility spillover occurs when changes in price volatility in one market produce a lagged impact on volatility in other markets, over and above local effects. Volatility spillover patterns appear to be widespread in financial markets. Volatility may spillover across countries, markets or industries amongst others. The transmission of financial volatilities between countries has been changing, and this has important consequences for investors and policy makers (Schwert, 1983). Investment decisions may be affected by financial volatility spillover as investors equate higher volatility with greater risk. Empirically, volatility is measured in terms of coefficient of variation which is the standard deviation divided by the mean of a series (Obadan, 2006 and Mordi, 2006). Volatility spillover can be defined as the impact derived from the deviations and fluctuations in one market (say foreign exchange

market) to other markets (say stock market) sequel to shocks resulting from an economic event which is usually accompanied by risks and uncertainties.

2.3 Theoretical Issues

Most of the approaches used to investigate the relationship between foreign exchange and stock market are rooted in the traditional, monetary and portfolio balance approaches.

The Traditional Approach

This approach was developed during the era of fixed exchange regimes in 1944 based on the Keynesian economic theory (Harvey, 1996). The approach is also called the Balance of Payment (BOP) view of exchange rate determination. It started with the observation that exchange rate is determined by demand for and supply of foreign exchange, whereby it moves (if free to do so), to bring this demands and supplies in to equality, hence (if no intervention is assumed) to restore equilibrium in the BOP. It considers foreign exchange rates as prices that clear supply of and demand for goods in international transactions, with the foreign exchange markets as a process that simultaneously determines many other variables in the economy (Gandolfo, 1976). The analysis emphasizes the effects of developments in the current account (balance of trade), whereby deteriorating balance of trade or current account deficits are likely to lead to exchange rate depreciation, whereas improving conditions have an opposite effect. Hence, this approach postulates that exchange rate is in equilibrium when the difference between the demand for and the supply of foreign exchange equals zero and predicts that increase in domestic interest rate relative to foreign interest rate, increases the relative supply of foreign currency, which culminates into appreciation of the domestic currency.

The transmission channel runs from exchange rate fluctuations which affect firms' value via changes in competitiveness and changes in the value of firms' asset and liabilities, dominated in foreign currency, hence affecting firms' profits and the value of equity (Gavin, 1989). The approach suggests that real exchange rates affect the competitiveness of the national economy; hence stock markets should exhibit a negative response to national currency appreciation (Dornbusch and Fisher, 1980). On the other hand, Do et al. (2015) argues that currency appreciation negatively (positively) affects stock prices in an export (import) oriented economy. However, the causality may also run from relative domestic productivity shocks to exchange rates in which case the sign of the stock market – currency value association is less obvious.

However, Moore and Wang (2014) combined this approach with portfolio balance approach, suggesting that in countries with a relatively low degree of capital mobility, economic integration is likely to be the main driving force whereas in countries with high capital mobility, financial integration is the main driving force. The dynamic relationship between exchange rates and stock prices in some developed and emerging economy was investigated, and emphasized that trade balance is the main source of the dynamic correlation in the Asian countries whereas the interest differential is a contributory factor for Canada and the United Kingdom (UK). The study focused on examining the correlation between stock price indices and the nominal exchange rates, relative to the United States (US) dollar for the countries under study.

Sui and Sun (2016), in examining the long-run and short-run dynamic linkages among foreign exchange rate, local stock prices, Standard and Poor's (S&P) 500 index and interest differentials in the BRICS (Brazil, Russia, India, China and South Africa) countries, utilized the traditional approach with emphasis that global trade balance can significantly impact a company's performance in major export countries. Globalization is accelerating both trade flow and capital

flow in the world economy, but most emerging countries still strongly intervene their currency's exchange rate and capital flows across their border; which can depress the role of foreign investors. The study focused on two equations; first is the estimation of exchange rate return as a function of local stock return, interest differential and S&P 500 return, for the second estimation; local stock return as the function of exchange rate return, interest differential and S&P 500 return.

The Monetary Approach

The postulates of this approach include among others; Kouri (1976), Dornbusch and Fisher (1980). The Kouri model opined that exchange rate is determined by monetary assets market equilibrium and short-run expectations. The model assumes a small economy which consist of home currency and foreign currency that produces only tradable goods with fixed relative price in the world market. The model was extended by Dornbusch and Fisher (1980) by considering the dynamic relationship between exchange rate and current account. They show that where export price and import price exist, domestic residents are assumed to have perfect foresight in their expectations of the exchange rate to hold domestic money and foreign bonds, with the assumption that current account precedes exchange rate, then as exchange rate begin to depreciate, current account declines.

Some of the assumptions of monetary approach are; (i) Domestic and foreign assets are perfect substitutes, implying that the expected yields in domestic and foreign assets are equal. (ii) Good prices are perfectly flexible. (iii) Relative supplies of domestic and foreign bonds are unimportant. (iv) Demanders are indifferent towards the currency of denomination of the bond as

long as the expected returns are the same. (v) There is uncovered interest rate parity (no risk premium).

The monetary approach assesses a positive relationship between exchange rate and stock prices, and opines that the link is a monetary phenomenon. The mechanism works in such a way that a rise in stock prices raises the rate of return thus making money less attractive since it earns a zero return. The fall in demand for money increases the price level which increases the exchange rate in PPP terms. This predicts positive relationship between the two markets (Groenewold and Paterson, 2011).The fundamental equation in the monetary approach is a conventional money demand function;

$$m = p + \emptyset y - \lambda i$$

Where; ***m*** is log of the domestic money supply, ***p*** is log of the domestic price level, ***y*** is log of domestic real income, ***i*** the domestic short-term interest rate, $\emptyset$ is the money demand elasticity with respect to income and λ is the money demand semi-elasticity with respect to the interest rate.

According to this model, an increase in money supply causes exchange rate to depreciate as a result of inflationary pressure. Therefore, the increase in price level (inflation) consequently leads to the depreciation of the exchange rate and vice versa (Viser, 2004). With the assumption of perfect substitutability of domestic and foreign bonds in the monetary model, investors become indifferent towards the currency of denomination of the bonds to invest as long as the expected returns is the same (Krugman, 2003) .In this case, holders of assets do not require a premium to influence their purchase of asset either in country A or B or, the proportion of their

investment. This implies that relative supplies of domestic and foreign bonds do not influence exchange rate.

However, this approach is not without deficiencies. The Keynesian school with regards to rigid and sticky prices criticized the approach since nothing about the demand side was considered. Because, without considering the behavior of the consumers, it is difficult to interpret how market prices are formed. Hence, the assumption of fixed tradable price in the world market is an unrealistic special form of PPP. Secondly, it lack of micro foundation made it unable to adequately deal with current account and fiscal policy dynamics (or more fundamentally with welfare issues).

The Portfolio Balance Approach

The portfolio balance approach was pioneered during 1970s and 1980s by Black (1973), Kouri (1976), Branson (1977), Girton and Henderson (1977), Porter (1977) among others. The most important dichotomy is whether or not domestic and foreign bonds are assumed to be perfect substitutes in the asset-holders' portfolios. The assumption of perfect substitutability implies that asset holders are indifferent regarding the composition of their bond portfolios as long as the expected rates of return on the two countries' bonds are the same. While the Kouri's (1978) and Dornbusch-Fisher models[12] allow for only domestic money as a domestic asset, Branson (1977) model considers domestic bonds and foreign bonds as assets. Branson (1983) further extended the model to a rational expectation framework, with assumption that there is a small economy whereby available assets in the home country are aggregated into the domestic money stock, the

[12] Dornbusch and Fisher model of exchange rate determination integrates the roles of relative prices, expectations and assets market, and emphasizes the relationship between the behaviour of the exchange rate and the current account. It extends recent approaches by giving an important role to the accumulation of assets over time through the current account. Although the model has the shortcoming of a very restricted menu of assets and of short-run price flexibility and continuous full employment.

holding of domestically issued assets (denominated in the home currency) and the net holdings of foreign issued assets (denominated in foreign currency). Thus, the domestic and foreign bonds are allowed to be held by both the private sector and the central bank.

The portfolio balance approach to exchange rate determination proposes that exchange rate, as the domestic price of foreign currency, is determined as part of the financial market system that brings the demand for an asset in accordance with predetermined stock supplies. Thus, expands the monetary approach by including other financial assets. It postulates that the exchange value is determined by the quantities of domestic money, domestic and foreign financial securities demanded and the quantities supplied.

The basic assumptions of portfolio balance approach are: (i) Individuals earn interest on securities they hold, but not on money; (ii) Households have no incentive to hold the foreign currency. Hence, a domestic household's stock of wealth is valued in the domestic currency, (iii) Investors are risk averse. (iv) Risk premium exists, that is no uncovered interest rate parity.

However, the model assumes that resident distribute their wealth among three forms of assets-monetary base, domestic bonds and foreign bonds. The exchange rate is in equilibrium when these assets are held in their desired proportion. An increase in wealth increase demand for foreign bonds or assets leading to a depreciation of exchange rate as a result of capital outflow so generated (Viser, 2004).

Unlike the monetary approach, the portfolio balance approach allows relative bonds supplies and demands as well as relative money market condition to determine exchange rate. The essential difference between monetary and portfolio balance approach is that the monetary model assumed domestic and foreign bonds to be perfect substitute whereas portfolio balance model assumed imperfect substitutability of local and foreign bonds (Krugman, 2003). However, the model

remains a partial equilibrium representation in two important respects. First, the interaction between financial markets, exchange rate, goods market and the current account was not considered. Secondly, the approach does not allow expectation effect (Dornbusch, 1975).

The portfolio balance model by Branson (1983) and Frankel (1983) supports negative relationship between the two markets (foreign exchange market and stock market), with the proposition that investors are risk averse and they move their investments to country with higher stock returns, which by implication leads to currency appreciation in countries with higher stock returns and depreciation in countries with lower stock returns (Ulku and Demirci, 2012).

Zhao (2010) utilized this approach, to provide additional evidence on the short-run dynamics between exchange rates and stock prices in China. With emphasis that values of relative currency expectation play a considerable role in price movements since the values of financial assets is determined by the present values of the future cash flows. The study focused on Renminbi (RMB) real effective rate and the Shanghai composite stock price index. Salisu and Oloko (2015) also used this approach to capture returns, shocks and volatility spillover between stock and foreign exchange markets in Nigeria.

In order to investigate the co-movement between exchange rates and stock prices in India, Korea, Philippines, Indonesia, Thailand and Taiwan, Lin (2012) utilized portfolio balance approach with emphasis that speculative attack could make the monetary authority increase interest rate with an attempt to reduce capital outflow, however may exert downward pressure on stock prices. The study focuses on foreign exchange rates with respect to the US Dollar for each country, closing stock prices for each stock market indices, interest rate for each country and foreign reserves. Ulku and Demirci (2012) used this approach to investigate the stock market - exchange rate interaction in Hungary, Poland, Turkey, Russia, Ukraine and Croatia. The study focused on

closing values of exchange rates in each country and stock market indices (both local and global). Caporale, Hunter and Ali (2014) also used this approach on the study; linkages between stock prices and exchange rates in the UK, Canada, Japan, Switzerland and the Euro area under the banking crisis period.

2.4 Review of Empirical Results

The review of empirical literature has tried to investigate, examine, capture and assess the relationship and factors that contribute to the volatility spillover between foreign exchange and stock market both within and outside Nigeria through several methods. However, the time varying models and their extensions dominate the literature. Nevertheless, we proceed with the review of time series modeling approach.

2.4.1 Time Series Studies

The argument that currency depreciation might be good news for the stock market due to increased export competitiveness was supported by Cumperayot, Tjeert and Roy (2006) who used the Simultaneous Equation Probit (SEP) model to investigate the linkages between extreme stock market and currency returns in America emerging and developed economies (Argentina and Brazil; Canada and US), Asia and Australia emerging and developed economies (Malaysia and Thailand; Australia, Japan, New Zealand) and Europe emerging and developed economies (Russia and Turkey; Germany, Switzerland and UK) using daily data from 1996 to 2005. He revealed that emerging markets are affected by changes in portfolio flows, and expectations of foreign investors in the equity market also place the local currency under pressure compared to developed markets. Considering the inability of SEP model to capture varying volatility and asymmetric effects while also allowing correlation between security returns to vary overtime,

Lin (2012) adopted the use of Autoregressive Distributed Lag (ARDL) model, for the period of January 1986 to December 2010 to investigate the co-movement between the exchange rate and stock prices in India, Indonesia, Philippines, Thailand and Taiwan. The result reveals that average stock returns emerge negative and the exchange rate changes shows depreciation during the 1997 Asian crisis period, with greater volatility compared to the tranquil period. However, for the global crisis period, the average stock returns remained positive and the exchange rates did not always show depreciation. Moreover, the volatilities of the stock market returns and exchange rate changes during this period were not as great as those during the 1997 Asian crisis period, indicating that global financial crisis had a lesser influence on the stock returns and exchange rate of the Asia emerging markets. The changes in interest rates were negative for both sample periods, with greater volatility during the crisis periods, reflecting the fact that capital inflow in to Asia emerging markets lowers interest rates and government is eager to use this as a policy tool to ease the crisis and stimulate economic growth during such times.

Ulku and Demirci (2012) relied on the Impulse Response Functions (IRFs) from a co-integrating Structural Vector Autoregressive (SVAR) model, to investigate the stock market – exchange rate interaction in Hungary, Poland, Turkey, Russia, Ukraine and Croatia, using both monthly and daily data for the period of January 2003 to October 2010. He found that a large portion of the national stock market-exchange rate co-movement in emerging external deficit economies is due to global stock market returns. Hence, the interaction between exchange rate and local stock market returns was analyzed after controlling the global returns, and found that the residual connection between the value of the currency and the national stock was positive. Evident that the relative depth of the stock market of a country depends on the strength of the stock market - exchange rate connection. In this respect, countries like Hungary, Poland, Turkey and Russia

with the deepest markets, a shock in national stock market returns have a strong positive relation with the currency value in the contemporaneous period. In contrast, countries with less developed stock markets such as, Ukraine and Croatia, the currency value positively responds to stock market with some lag. However, the IRFs cannot explicitly explain the spillover effects from stock market shocks to foreign exchange market.

Diebold and Yilmaz (2012) relied on the generalized vector autoregressive framework specifically the forecast error variance decomposition to characterize daily volatility spillovers across US stock, bond, foreign exchange and commodities market from January 1999 to January 2010. He found that volatility dynamics appears to be highly persistent. With the bond and stock markets being the most volatile, the commodity and the forex market being comparatively less volatile. In addition, important spillovers were found from the stock market to the other markets after September 2008.

Olugbenga (2012) and Zubair (2013) relied on Johansen co-integration and Granger causality test, where the former examined the long-run and short-run effect of exchange rate on stock market development in Nigeria using quarterly data from January 1984 to April 2004, and the latter investigated the causal relationship between stock market index and exchange rate in Nigeria using monthly data from April 2000 to December 2011. Olugbenga (2012) found a unidirectional relationship running from exchange rate to stock market performance in Nigeria. That variation in the Nigerian stock market is explained by exchange rate volatility. However, Zubair (2013) found absence of causal relationship between all share index and exchange rate, rather a unidirectional causality running from money supply (M2) to all share indices.

Subair and Salihu (2013) relied on unit root test and Error Correction Model (ECM) using annual data from 1981 to 2007, to investigate the effects of exchange rate volatility in the Nigeria Stock Market. They found that short-run change in exchange rate volatility had strong impact on the change in stock market capitalization growth rate. That the effect of net capital flow, degree of freedom and external reserve is felt by the stock market through exchange rate volatility.

In order to examine the exchange rate and stock market returns in a regime switching environment, Chkili and Nguyen (2014) and Kal, Ferhat and Nuran (2015) relied on Markov-Switching Vector Autoregressive (MS-VAR) model, where the former covered the period of March 1997 to February 2013 for the BRICS countries and the latter covered the period from 1972 to 2009 with the use of quarterly data for four developed markets; Australia, Canada, Japan and the UK. Chkili and Nguyen (2014) identified two regimes in their study (a low volatility regime – regime 1; and a high volatility regime – regime 2). It was found that the former was more persistent than the latter. The result showed that the estimated coefficients capturing the impact of exchange rate movement on stock market returns were not significant, owing to the effective hedging strategies against currency risks through available currency derivatives such as currency forward, futures and options. However, Kal et al. (2015) assumed two states depending on the position of change in the exchange rate of the currency related to its fundamentally determined change. If the change of an exchange rate is greater than its fundamentally determined change, it is assumed to be in an overvalued state, and vice versa. For Australian Dollar, the foreign exchange market returns increases the probability of switching between states. However, the returns in the equity market have a different impact on the transition between the states, as during the overvalued state, higher exchange market returns decrease the probability of staying in the undervalued state but the opposite holds in the equity market. For

Canadian Dollar, the only statistically significant effect is the equity market return in an undervalued state. Thus, the probability of transition is increased. For Japanese Yen, the variables were only statistically significant for an overvalued state, thus the probability of staying in the same regime was increased.

On the other hand, Grobys (2015) employed the use of forecast-error variance decomposition framework of a VAR model to capture the dynamic behavior of volatility spillover effects between major foreign exchange market (Europe, Japan and Canada) and the US equity market for the period February 1986 to February 2014. He revealed that interdependences in volatility indices exist between the markets (Europe, Japan and Canada), indicating that volatility spillover effects are high before economically troubled periods but virtually non-existent when the economy is quiet. Specifically, all volatility indices jumped several months before the collapse of Lehman Brothers in September 2008. In 2009-2013 ex-post financial crisis periods, all constructed volatility spillover indices showed that spillover effects are virtually non-existent.

Do et al (2015) relied on the VAR model to examine the linkage between stock and exchange market via realized higher moments and the linkage change under the recent financial crisis in emerging and developed Asia, America and Western Europe using intra-daily data from 2003 to 2009 and found that the realized volatility spillover effect between stock and foreign exchange market is bidirectional and positive in nature both in developed and emerging markets, irrespective of market properties and periods.

Furthermore, Sui and Sun (2016) relied on VAR, Vector Error Correction Mechanism (VECM) and Chow test, for the period 2007 to 2009 where the VAR model was accompanied with the variance decomposition and IRFs to test the short-run dynamic relationship between return of

local stock index, return of exchange rates, return of interest differentials and return of the US S&P 500 index. They found that exchange rate fluctuations exert a significant influence on stock market returns. Evident that exchange rate have structural breaks during financial crisis in Brazil and India, and the stock markets have a significant structural break during financial crisis in Brazil, Russia, China and South Africa.

2.4.2 Time Varying Studies

Milunovich and Thorp (2006) relied on the Asymmetric Dynamic Conditional Correlation (A-DCC) model to value volatility spillover for investors who select mean variance equity portfolios from stock market in London, Frankfurt and Paris with the use of daily data from January 1st 1992 to July 4th 2005. They found that volatility forecasting model is preferred by risk averse investors in order to design favorable hedging strategies, based on the assumption that investors hold mean-variance portfolios allocated among risk-free assets and equities in two of three major European markets; London, Frankfurt and Paris. Significant transmission from Frankfurt to Paris was found, so also Frankfurt and Paris to London. However, Frankfurt was unaffected by lagged volatility shock from the other markets. Although, all volatility spillover coefficients were small but Frankfurt to Paris shocks was greatest in magnitude.

Unlike A-DCC model which is inefficient for addressing short-term relationships between exchange rate and stock prices, and its inability to deal with data involving integrals of different orders; Choi, Fang and Fu (2006) relied on Exponential Generalized Autoregressive Conditional Heteroscedastic (EGARCH) model with the use of daily data from January 1990 to December 2004, to examine volatility spillovers between exchange rate changes and stock market returns; evidence from New Zealand. The study found that conditional variances of the stock returns and

exchange rate changes are significantly impacted by their own standardized innovation in the past. The EGARCH coefficients appear to be statistically significant at 1% level. However, the significant coefficients indicate volatility clustering in both New Zealand stock exchange and the fluctuations of the New Zealand dollar in the international foreign exchange market, thus a significant volatility spillover was found from New Zealand stock market returns to foreign exchange market before the Asian crisis in 1997. Hence, revealed that the New Zealand dollar is adjustable to the international equity flows because her stocks are known to attract international investment.

Mishra, Swain and Malhotra (2007) relied on GARCH and EGARCH model to determine if volatility surprises in the Indian stock market influences the volatility returns in the exchange market for the period January 4th 1993 to December 31st 2003. They found significant volatility spillover parameter in the case of both markets (exchange and stock market in India). Evident that bidirectional volatility exist between the markets. This suggests that the markets move in tandem with each other and there is a long run relation between them. However, Zhao (2010) relied on VAR and Multivariate GARCH (MGARCH) framework to investigate the dynamic relationship between exchange rates and stock prices in China using monthly data from January 1991to June 2009. With the assumption of currency appreciation in the period covered, the result shows statistical significance at 1% level both exchange and stock market. Compared with the exchange market, the time varying and persistence characteristics of the stock market were higher than those of the exchange. Evident that the stock market is more sensitive than the exchange market in reaction to information, and also investment risks of the stock market are higher than the exchange market.

In order to examine volatility spillovers between foreign exchange markets and equity markets in Hong Kong, Singapore, Malaysia and Mexico, Chkili, Chaker, Masood and Fry (2011) relied on EGARCH and MS-EGARCH estimation technique using weekly data for the period 1994 to 2009. They found that volatility shocks in the stock markets for Hong Kong, Singapore, Malaysia and Mexico lasted on the average of 26, 21, 49 and17 weeks respectively. The result shows that the estimated parameters of the variance equation were all significantly different from zero for all the selected stock markets. The mean equation estimated showed that foreign exchange rate changes has a negative sign and it is statistically significant at 1% level for all the markets. This implies that foreign exchange volatility reduces stock market returns; hence any change in the foreign exchange rate may reduce firm's profitability and equity market value.

Whereas Chkili, Chaker and Nguyen (2012) used Uni-variate GARCH, Fractionally Integrated GARCH (FIGARCH) and Fractionally Integrated Power ARCH (FIAPARCH) to investigate volatility interactions between foreign exchange and stock market for three European countries (France, Germany and the UK) from January 1999 to December 2010. The standard GARCH result shows that all estimated parameters were significant for stock and exchange rate returns (Chkili et al, 2012). The magnitude of GARCH coefficients were high and varies between 0.892 (UK - FTSE index), 0.918 (France – CAC40 index), 0.910 (German - DAX index) and 0.984 (USD/EUR), indicating that volatility of stock and exchange rate returns does not disappear overtime. The result for the FIGARCH model successfully captured the long memory property in the volatility processes of both stock and exchange rate returns. The long memory parameters were significant at 1% level for considered cases. For the FIAPARCH model, it was found that the estimates of long memory parameters differ significantly from zero and unity. Similar to GARCH and FIGARCH models, the tail parameter of the FIAPARCH models was also

statistically significant. However, strong evidence of bidirectional relationship was found between the stock and foreign exchange market in France and Germany.

However, Chortareas, Cipollini and Eissa (2012) relied on GARCH framework, to examine the impact of announcing a switching to floating exchange rate and/or currency devaluation on stock market returns and their volatility in three MENA (Middle East and North Africa) countries; Egypt, Morocco and Turkey 9th January 2002 to March 4th 2003 for Egypt, April 6th 2000 to May 30th 2001 for Morocco and February 4th 2000 to March 29th 2001 for Turkey. They found that exchange rate regime switch has an impact on stock market returns in two out of the three countries (except Morocco). For Egypt that practice a free floating exchange rate regime, evidence of event-induced abnormal volatility in their stock returns was found inside the pre-event window. On the event period, no abnormal volatility was found, while in the post event period, a highly significant abnormal volatility emerges reaching the peak. In Morocco, where the Dirham was put under a managed float regime after cutting the link to the French Franc in 1973, the test for event-induced abnormal unsystematic volatility in the stock returns was insignificant for all periods (pre-event, during and post-event periods). Evident that the mild devaluation of the Moroccan Dirham in April, 2001 was overdue and not large enough to have significant effect on the economy. In contrast to the Morocco findings, for Turkey where a floating exchange regime is practiced, the result showed a highly significant event impact in all periods.

Okpara and Odionye (2012) relied on EGARCH to investigate the direction of volatility spillover between exchange rate and stock prices in Nigeria, using quarterly data from 1990 to 2009. They found that the effect of volatility persistence is larger on stock market capitalization than all share indices. This implies that stock market volatility is caused by exchange rate fluctuations

more through stock market capitalization than all share indices. Thus, a unidirectional volatility spillover was found from foreign exchange to stock market in Nigeria.

In order to investigate the linkages between exchange and stock markets in six Asia emerging economies (India, Korea, Malaysia, Pakistan, Philippines and Thailand) and six Latin America emerging economies (Argentina, Brazil, Chile, Columbia, Mexico and Venezuela) Andreous, Matsi and Savvides (2013) relied on VAR-GARCH estimation technique, using weekly data for the period January 6th 1989 to 15th August 2008. They revealed that following the onset of the Asian financial crisis, the experience of the Asia emerging economies is quite different from that of Latin America as regards the volatility transmission. Their result shows that in most cases, volatility spillover between the foreign exchange and stock market decreased in Asia with the opposite in Latin America. Evident that the accumulation of foreign reserves may have helped dampen the volatility transmission mechanism between the foreign exchange and stock market of Asia emerging economies.

Caporale et al. (2014) however, relied on a bivariate VAR-GARCH model specifically the Unrestricted Extended Constant Conditional Correlation GARCH (UECCC-GARCH) to address the interaction between stock and exchange returns in the UK, Japan, the Euro area and Switzerland using weekly data for the period August 2007 to 2010. He found that the co-movement of stock prices and exchange rates in the Euro area, the UK, Japan and Canada broke by the unset of the financial crisis, owing to the assumption that overvaluation of the Yen since 2008 was the case of Japan and the depreciation of the Euro, coupled with the uncertainty surrounding the single currency since the unset of the crisis was the case in the Euro area. The result shows that the stock price – exchange rate process in the two sub-periods (pre-crisis and crisis) displays strong conditional heteroscedaticity; the conditional variances exhibited

persistence in all cases with only one exception that is the UK exchange rates in the pre-crisis period. However, a uni-directional volatility spillover was found from stock returns to exchange rate changes in US and UK, the opposite in Canada and bi-directional volatility spillover in Euro area and Switzerland.

To investigate the dynamic relationship between exchange rates and stock prices, Moore and Wang (2014) Dynamic Conditional Correlation GARCH (DCC-GARCH) model for the period January 1973 to December 2006 for developed markets (UK and Canada) and Asia emerging markets, the start date for each country depended on when a floating or managed float regime was adopted; May 1983 for Indonesia, January 1980 for Korea and Malaysia, February 1986 for Philippines, January 1979 for Singapore and January 1976 for Thailand; to December 2006 for all. They found a negative and bi-directional relationship between relative stock price and real exchange rate being consistent with the model prediction. Which reveals trade balance as the main source of the dynamic correlation for the Asian countries, whereas interest rate differentials as a contributory factor for Australia, Canada and the UK.

Salisu and Oloko (2015) used the Vector Autoregressive Moving Average – Asymmetric Multivariate Generalized Autoregressive Conditional Heteroscedastic (VARMA-AMGARCH) model to capture returns, shocks and volatility spillover between stock market and foreign exchange market in Nigeria, for the period May 1999 to December 2013. Notwithstanding, the VAR-GARCH model was used as a bench mark and found that bidirectional return spillover exists between both markets, with positive significant asymmetric effect that bad news from the stock market increases volatility persistence in the exchange market and vice versa.

In summary, it is important to note that mixed and inconsistent results were found from the literature reviewed; for example Choi et al (2006), Zhao (2010), Lin (2012), Chkili and Nguyen (2014) and Salisu and Oloko (2015) showed that significant and persistent volatility spillover exist from stock market to foreign exchange market, while others showed that the impact is significant from exchange market to stock market; Olugbenga (2012), Salihu and Subair (2013), Moore and Wang (2014) and Sui and Sun (2016). Furthermore, the direction, sign and magnitude of the effect is still inconclusive; while some studies found that it is driven by the dependence on foreign capital and depth of the local stock market and/or the degree of maturity of the financial markets, others argued that the regime system practiced, speculative attack and the prevalent economic situation are factors. The findings from the literature suggest that evidence from other region cannot be generalized; however it is of great concern to note the potential adverse risk of the spillover effects and its impact on the markets.

It is evident that there are very few studies on volatility spillover across the stock and foreign exchange market in Nigeria such as Olugbenga (2012), Opkara and Odionye (2012), Zubair (2013), Salihu and Subair (2013) and Salisu and Oloko (2015). However, they attributed the exchange rate-stock price interaction to; (i) the nature of the economy (an import-oriented or export-oriented), (ii) Maneuvers and insider abuse in the case of the stock market and speculative demand in the case of the exchange market and (iii) Shocks and innovations from the immediate past periods. However, it should be noted that methodologies, time periods and frequencies of observations are different. While they employed unit root test, granger causality test, and co-integration test as their estimating technique, our study rather employed correlation test, descriptive statistics and line plots as a pre-test and rely on two estimation techniques, specifically the Exponential GARCH and forecast-error variance decomposition form Vector

Autoregressions (VARs) framework. Thus, consider the asymmetries in terms of good and bad news occasioned by exogenous factors.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section examines the theoretical framework, model specifications, estimation techniques, and data issues.

3.2 Theoretical Framework

The thrust of this study is to investigate the extent of foreign exchange and stock markets integration. Therefore, the Portfolio Balance Approach (PBA) was anchored on because it provides the platform for analyzing volatility spillovers. The portfolio balance approach is an offshoot of monetary approach. However, both approaches emphasize the role of money and asset trade. While the monetary approach emphasizes on the relationship between money demand and supply, the portfolio balance approach includes other assets to supplement money. In the PB framework, individuals allocate their wealth among three forms; domestic money, domestic asset and foreign asset and allows relative bond supplies and demand as well as relative money-market conditions to determine the exchange rate. The demand for assets is driven by preferences for distributing their portfolio over the assets of different countries. Thus, the PBA revolves around whether to hold wealth as money or as bonds. The market equilibrium is given as;

$$M_s = M_d \quad \ldots \ldots (3.2.1)$$

$$B_s = B_d \quad \ldots \ldots (3.2.2)$$

$$w = M_s + B_s \quad \ldots \ldots (3.2.3)$$

Where M_s represents money supply, M_d is money demand, B_s is bond supply, B_d is bond demand and w is wealth. The demand for money and bonds is a portfolio demand showing the allocation of wealth between money and bond. Given the initial wealth, people decide what amount to hold in form of liquid assets, as money and in form of bonds. Thus, the budget constraint is that wealth must equal the total demand for money and bonds;

$$w = M_d + B_d \quad \text{(3.2.4)}$$

The demand for money and bonds is endogenous depending on the variables determined within the model. The money supply is determined by the government. The bond supply is the total capital stock in the economy plus government debt. Thus, real money supply is the nominal supply divided by the price level;

$$M_s = {}^{M^s}/_{P} \quad \text{(3.2.5)}$$

Likewise, real supply of bonds is;

$$B_s = {}^{B^s}/_{P} \quad \text{(3.2.6)}$$

However, it is expected that portfolio demand depends on real national income (y), the nominal interest rate (R) and real wealth (w);

$$M_d = f(y, R, w) \quad \text{(3.2.7)}$$

$$B_d = f(y, R, w) \quad \text{(3.2.8)}$$

The Portfolio Balance model explains the relationship and/or interaction between foreign exchange and stock market through two channels: Firstly, that an increase in wealth due to a rise

in domestic assets prices will lead to an increase in demand for money by investors, which in turn raises domestic interest rate. This results in an appreciation of the domestic currency thereby attracting foreign capital inflows and prompts an increase in foreign demand for local currency. Another transmission channel of the relationship is the consequent increase in foreign demand for domestic asset as a result of increases in equity prices. This causes the domestic currency to appreciate. Thus, the PBA fails to account for asymmetric shocks that might influence the exchange rate stock price interaction.

Liberalized capital flows, financial integration and sustained international diversification has led stock and foreign exchange market to become increasingly interdependent. For instance, stocks from a given country are bought on the local currency of that country, which fluctuates in value based on market forces. When the outlook for a particular stock market is highly positive, international funds flow in and when that stock market struggles, international investors seek alternative measures and withdraw their funds (Harvey, 1996). Conceptually, response to asymmetries may arise from different sources.

However, market returns could be attributed to; the returns expectation investors might have regarding domestic returns with respect to changes in foreign market returns, and /or investors' psychology about market upturns and downturns due to inherent risk aversion. Accordingly, a stronger stock market may cause local currency to increase in value (currency appreciation) and a weaker stock market may have opposite effect (currency depreciation) since exchange rate volatility creates cash flow uncertainty for local firms. This uncertainty leads to increased stock market volatility as investors' process information regarding expected returns. Likewise, volatile stock prices affect exchange rate as the market return uncertainty for investors induces trading activities and capital outflows.

3.3 Model Specification

In order to ascertain the extent of volatility in each market (objective (i)), an EGARCH (p,q) model proposed by Nelson (1991) would be adopted from the study of Choi et al, (2006) who used the model to capture volatility between stock market returns and exchange rate changes in the New Zealand. The EGARCH model differs from GARCH model because it uses the logged conditional variance to relax the positiveness constraint of coefficients[13] and allows one to examine the asymmetric effects of volatility impacts. The models are specified as follows;

$$\Delta ASI_t = \beta_{1,0} + \sum_{i=1}^{p} \alpha_{1,i} \Delta ASI_{t-i} + \sum_{j=1}^{q} \beta_{1,j}\, \Delta EXR_{t-j} + \varepsilon_t^{ASI} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

$$\sigma_t^2 = w + \sum_{i=1}^{p} \beta_i\, \Delta ASI_{t-i} \sigma_{t-i}^2 + \sum_{j=1}^{q} \alpha_j\, \sigma_{t-j}^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1.1)$$

$$\Delta EXR_t = \beta_{2,0} + \sum_{i=1}^{p} \alpha_{2,i} \Delta ASI_{t-i} + \sum_{j=1}^{q} \beta_{2,j}\, \Delta EXR_{t-j} + \varepsilon_t^{EXR} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

$$\sigma_t^2 = w + \sum_{i=1}^{p} \beta_i\, \Delta EXR_{t-i} \sigma_{t-i}^2 + \sum_{j=1}^{q} \alpha_j\, \sigma_{t-j}^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2.1)$$

Where; equation 3.1 and 3.2 represent the mean equations, equation 3.1.1 and 3.2.1 represent the variance equations, ASI_t represents all share index, EXR_t represents official exchange rate, $\beta_{1,j}$ $\beta_{2,j}$ represents the coefficients showing the effect of exchange rate changes to stock market returns and the reverse effect respectively and ε_t represents the error terms.

[13] No parameter restriction

Furthermore, to examine the extent to which volatility spillover across the markets (objective (ii)), the forecast-error variance decomposition[14] framework of the VAR model proposed by Diebold and Yilmaz (2012) was modified to account for two asset markets compared to the four asset markets they considered (stock, bond, forex and commodity). Thus, we present the generalized VAR framework as;

$$X_t = \emptyset_0 + \sum_{i=1}^{p} \emptyset_i X_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4)$$

Where X_t is the vector with elements; EXR_t and ASI_t, $\emptyset_0$ is a n-dimensional column vector of the terms, $\emptyset_i$ is a parameter matrix and $\varepsilon_t \sim (0, \Omega)$ is a vector disturbance or vector of serially uncorrelated error term.

The moving average representation of the VAR is given by;

$$X_t = \sum_{i=0}^{\infty} A_i \, \varepsilon_{t-i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.5)$$

$$Q_i = \emptyset_1 A_{i-1} + \emptyset_2 A_{i=2} + \ldots\ldots + \emptyset_p A_{i-p} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.6)$$

Where A_0 being an N x N identity matrix and with $A_i = 0$ for $i = 0$. However, the N-variable VAR variance decomposition introduced by Sims(1980), allows for each variable X_i to be added to the shares of H-step ahead error forecasting variance coming from shocks of variable X_j (where $\forall i \neq j$ for each observation).

The spillover index to be estimated for this study is expressed as;

[14] The variance decomposition allows us to parse the forecast variances of each variable into parts which are attributable to the various system shocks.

$$S = \frac{a_{0,12}^2 + a_{0,21}^2}{trace\ (A_0 A_0^{'})} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.7)$$

Where; S represents the spillover index, $a_{0,12}^2 + a_{0,21}^2$ represents the total spillover from EXR_t and ASI_t, $trace(A_0 A_0^{'}) = a_{0,11}^2 + a_{0,12}^2 + a_{0,21}^2 + a_{0,22}^2$ represents the total forecast error variation. $a_{0,11}^2 + a_{0,12}^2$ represent the variance of the one step-ahead error in forecasting EXR_t and $a_{0,21}^2 + a_{0,22}^2$ represents the variance of the one step-ahead error in forecasting ASI_t.

Note; there are two possible spillovers; EXR_t shocks that affect the forecast error variance of ASI_t which can be interpreted as the spillover effect from foreign exchange market to the stock market and ASI_t shocks that affect the forecast error variance of EXR_twhich means the spillover effect from stock market to exchange rate.

3.4 Estimation Techniques

To achieve the objectives of this study, two models were utilized. The EGARCH (p,q) model[15] as follows;

$$\ln \sigma_t^2 = w + \sum_{i=1}^{p} \beta_i g(z_{t-i}) + \sum_{j=1}^{q} \alpha_j \ln \sigma_{t-j}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.1)$$

$$\sigma_t^2 = w + \sum_{i=1}^{p} \beta_i Z_{t-i}^2 \sigma_{t-i}^2 + \sum_{j=1}^{q} \alpha_j \sigma_{t-j}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.2)$$

Where;

$g(z_t) = \theta z_t + \lambda(/\ z_t\ / - E(/\ z_t\ /))\sigma_t^2$ is the conditional variance $w, \beta, \alpha, \theta\ and\ \lambda$ are coefficients and z_t is a standard normal variable. The formulation for $g(z_t)$ allows the sign and the magnitude to z_t to have separate effects on the volatility. Since $\ln \sigma_t^2$ may be negative, there are no restrictions on the parameters.

[15] This is particularly useful in an asset pricing context.

Secondly, the forecast-error variance decomposition framework of the VAR model proposed by Diebold and Yilmaz (2012) which focused on the total spillover in a simple VAR framework, and then progressed by measuring the directional spillovers in generalized VAR framework. The study extended the Diebold and Yilmaz spillover index which follows directly from the familiar notion of variance decomposition with N-variable vector autoregression. However, the calculation of variance decompositions requires orthogonal innovations[16], whereas the VAR innovations are generally contemporaneously correlated, thus the problem was circumvented by exploiting the generalized VAR framework of Koop, Pesaran and Potter (1996), and Pesaran and Shin (1998), hereafter KPPS[17] which produces variance decompositions which are invariant to the ordering. The model is further explored in the following directions;

Variance shares

The variance shares includes the own variance shares[18] and the cross variance shares. The fractions of the H-step ahead error variances in forecasting x_i that is due to shocks to x_j for i, j = 1, 2,….., N such that i≠j is cross variance shares or spillovers. Denoting the KPPS H-step ahead forecast variance decompositions as $\theta_{ij}^{g}(H)$, for H = 1, 2,……., yields;

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj}^{-1}\sum_{h=0}^{H-1}\left(e_i' A_h \sum e_j\right)^2}{\sum_{h=0}^{H-1}(e_i' A_h \sum A_h' e_i)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.2)$$

Where; $\sum$ is the variance matrix for the error vectorε, σ_{jj} is the standard deviation of the error term for the jth equation and $\varepsilon_i$is the selection vector, with one as the ith element and zeros otherwise. Note that$\sum_{j=1}^{N}\theta_{ij}^{g}(H) \neq 1$, therefore in order to use the information available in the

[16] A situation where the dependent and independent variables are uncorrelated
[17] A Kwiatkowski-Phillip-Schmidt-Shin test was developed in 1992, for testing that an observable time series is stationary around a deterministic trend.
[18] It is the fraction of the H-step ahead error variances in forecasting x_i that are due to shock in x_i, for i = 1,2,….,N

variance decomposition matrix in the calculation of the spillover index, we normalize each entry of the variance decomposition matrix by the row sum as;

$$\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.3)$$

Note that, by construction, $\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(H) = 1$ and $\sum_{ij=1}^{N} \tilde{\theta}_{ij}^{g}(H) = N$.

Total spillovers

The total volatility spillover index[19] was studied so as to understand how much of shocks the volatility spillover across major asset markets;

$$S^{g}(H) = \frac{\sum_{ij=1}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{ij}^{N} \tilde{\theta}_{ij}^{g}(H)} \bullet 100 = \frac{\sum_{ij=1}^{N} \tilde{\theta}_{ij}^{g}(H)}{N} \bullet 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.4)$$

Note, $i \neq j \; and \; j \neq i \; for \; all$

Directional spillovers

The generalized VAR framework helps to understand the direction of the volatility spillovers across major asset markets. The directional spillover[20] will be calculated using the normalized elements of the generalized variance decomposition matrix. The directional spillovers received by market i from all other market j is calculated as;

$$S_{i.}^{g}(H) = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{ij=1}^{N} \tilde{\theta}_{ij}^{g}(H)} \bullet 100 = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(H)}{N} \bullet 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.5)$$

[19] The total volatility spillover index measures the contribution of spillovers of volatility shocks across asset classes to the total forecast error variance.

[20] The set of directional spillovers can be thought as providing a decomposition of the total spillover to those coming from (or to) a particular source.

In a similar way, the directional volatility spillovers transmitted by market i to all other markets j as;

$$S_{.i}^{g}(H) = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ji}^{g}(H)}{\sum_{ij=1}^{N} \tilde{\theta}_{ji}^{g}(H)} \bullet 100 = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ji}^{g}(H)}{N} \bullet 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.6)$$

Net spillovers

The net spillover[21] is the difference between the gross volatility shocks transmitted to and those received from all other markets. It was obtained from market i to all other markets j as;

$$S_{i}^{g}(H) = S_{.i}^{g}(H) - S_{i.}^{g}(H) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4.7)$$

3.5 Preliminary Test

Prior to undertaking the estimation techniques, our preliminary tests were entailed in assessing the level of integration of the series. In addition, correlation analysis was conducted; to ascertain the degree of association between the two variables, while descriptive statistics will be used to understand the behavior of the data in order to guarantee us on our estimation techniques. Finally, line plots were used to show the trend of the series.

3.6 Data and Data Sources

For this study, we considered weekly data for the period 2000-2017 first quarter in order to overcome the shortcomings of monthly (inability to capture the timing of events) and daily data (affected by noise and anomalies such as day of the week effects) (Caporale et al. 2014). This yields a sample of 904 observations. As a proxy for foreign exchange market, we relied on the Official Exchange Rate (EXR_t); for stock market, the All Share Index (ASI_t) which is obtainable

[21] The net volatility spillover provides summary information about how much each market contributes to the volatility in other markets.

from the Central Bank of Nigeria (CBN) online database and the Nigerian Stock Market official website. Closing price data for both markets was considered in order to avoid timing conflicts and to precisely capture volatility spillover in both markets.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULT

4.1 Introduction

This chapter presents the empirical results of the study based on the methodology developed. The chapter is organized into sections. Starting with the line plots, descriptive statistics, unit root test, correlation test and lastly the estimation techniques.

4.2 Line Plots

The graphical analysis in Figure 4.1.1a and b present the trend of the series, indicating key periods. Evidently, volatility appear to be more persistent in stock market, displaying bigger and higher jumps; notably in 2004, 2006, 2008, 2014 and 2015 reflecting the dynamics of key events, and the foreign exchange market volatility appears to be very low but increased slightly over time, especially over the periods 2008-2010 global financial crisis and more recently in 2014-2016 following the devaluation of the Naira in 2015. The banking consolidation period (2004) affected dealings in the stock market. This policy required banks to raise their minimum capital through the capital market and this led to a staggering increase in the all share index. On the other hand, the foreign exchange market witnessed an unprecedented boost as the value of naira appreciated; due to increased investment inflows. The effect of the global financial crisis during the 2007-2008 periods depicts a decline in the capital and foreign exchange markets largely due to the sharp decline of capital inflows. As investors realized the danger posed by the financial crisis, they began to withdraw their funds. Hence, the negative signal influenced the stock and foreign exchange market.

In addition, the fall in the price of crude oil and uncertainty that shrouded the 2015 election outcome (2014-2015) negatively affected both markets as there was a drop in all share index and depreciation of the naira.

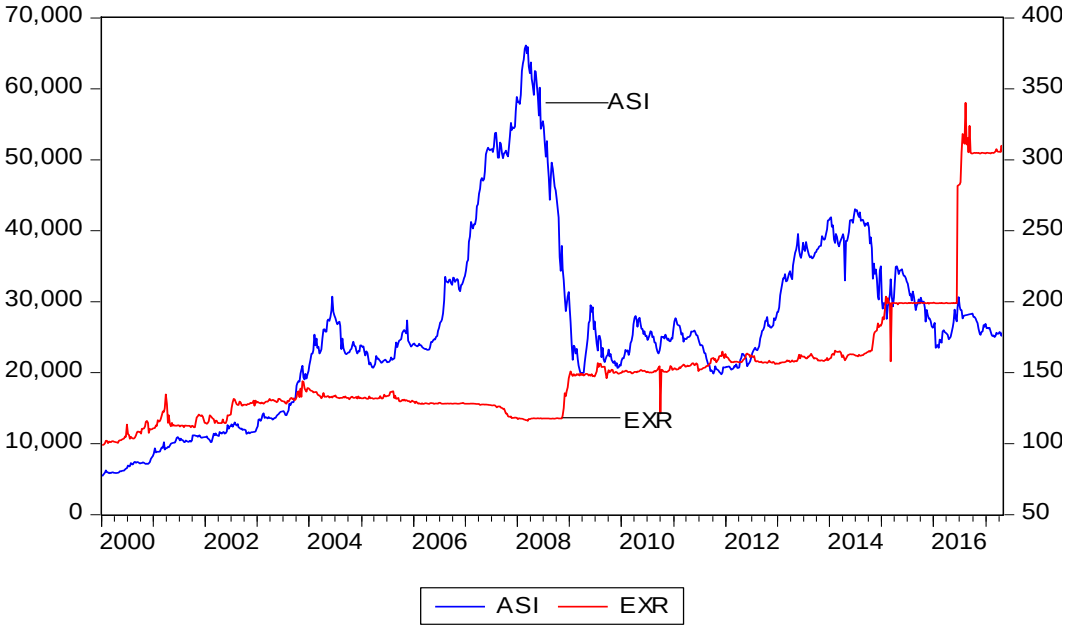


Figure 4.1.1a; Trend of All Share Index and Exchange Rate

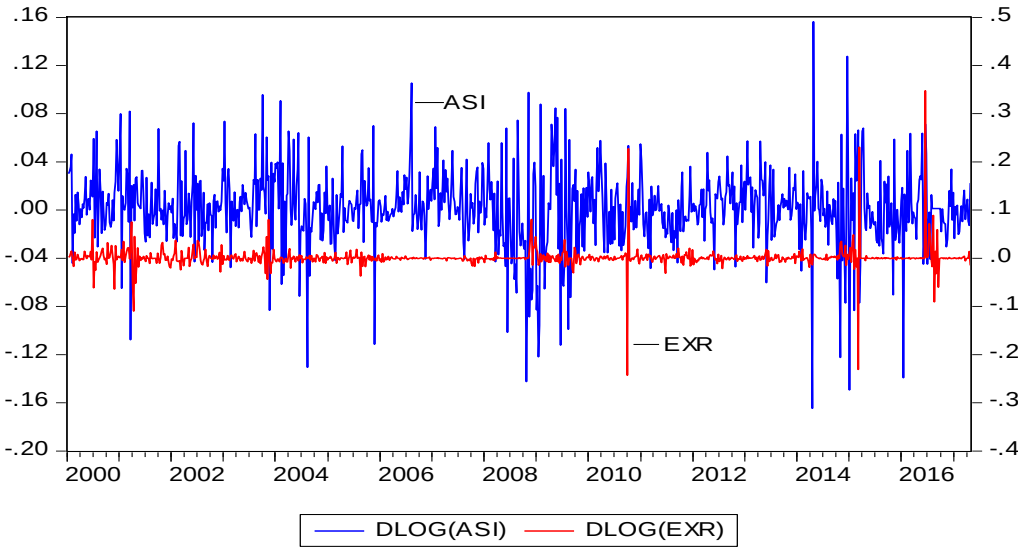


Figure 4.1.1b; First Difference of their Logs

4.3 Descriptive Statistics of the Variables of Study

Having presented the graphical trend of the variables of study, the descriptive statistics is employed in order to understand the behavior of the series.

Table 4.1 Descriptive Statistics of ASI and EXR

STATISTICS	EXR	ASI
Mean	150.6985	26294.18
Median	136.5175	24866.27
Maximum	340.2500	66121.93
Minimum	98.90000	5395.180
Std. Dev.	43.19999	12388.86
Skewness	2.309718	0.752659
Kurtosis	8.861785	3.662871
Jarque-Bera	2098.022	101.9026
Probability	0.000000	0.000000
Sum	136231.5	23769935
Sum Sq. Dev.	1685214	I.39E+11
Observations	904	904

Source: Authors Computation Using E-views 9

The result from Table 4.1 shows that the mean value of exchange rate is 150.7 to a dollar and the median value is 136.52. The series ranges from a minimum value of 98.9 to a maximum value of 340.25. The mean value of the all share index is 26294.18, the median value is 24866.27 and the series ranges from a minimum value of 5395.18 to a maximum value of 66121.93. The standard deviation values compared their means'; for exchange rate is lower than that of the All Share

Index indicate that the stock market is more volatile compared to foreign exchange market[22]. The result reveals the presence of Ske1wness and leptokurtosis in the data. The variables are all positively skewed (EXR; 2.31 and ASI; 0.75) meaning the distribution has long right tail. The kurtosis shows that the variables are leptokurtic. This is evident, because their kurtosis is greater than 3. In addition, a symmetric distribution is expected to have a very high probability value for the Jarque-Bera test, but in our case the series probability is very low. Thus, the series are typical to ARCH disturbances.

4.4 Unit Root Test

In order to assess the level of integration of the variables, a stationarity test was carried out using the Augmented Dickey Fuller (ADF) test. The test is necessitated in order to avoid spurious results. Sequel to the test, the analysis of the time series showed that all the variables are non-stationary at levels [I(0)], meaning that the null hypothesis (H_0) cannot be rejected 1%, 5% and 10% level of significance of the variable. However, the test was conducted at first difference {I(1)}, which indicated that all the variables are stationary at 1%, 5% and 10% level of significance. Therefore we reject the null hypothesis that there is a unit root.

Table 4.2 Augmented Dickey Fuller Test and Level of Integration

	At Level				At First Diff				Remark
Variables	ADF stat	1%	5%	10%	ADF stat	1%	5%	10%	
EXR	0.72856	-3.43740	-2.86454	-2.56842	-13.32052	-3.43740	-2.86454	-2.56842	I(1)
ASI	-1.78382	-3.43736	-2.86452	-2.56841	-10.46289	-3.43740	-2.86454	-2.56842	I(1)

Source: Authors Computation Using E-views 9

[22] Low SD value indicate low spread out in the data from the mean (closer to the mean); hence less volatility. High SD value indicate greater spread out in the data from the mean (far from the mean); hence, high volatility.

4.4 Correlation Analysis

Correlation test was used to measure the degree of association between the variables and the direction of the relationship. The result reveals that the relationship between exchange rate (EXR) and all share index (ASI) is weak and negatively related since the value is -0.02 (see Appendix D). This implies that depreciation in EXR will lead to decrease in stock market returns (ASI). This conforms to the proposition that investors are risk averse and they move their investments to countries with higher stock returns, which by implication leads to currency appreciation in countries with higher stock returns and depreciation in countries with lower stock returns (Ulku and Demirci, 2012).

4.6 Estimation Techniques

4.6.1 Model Selection Criteria

Models are chosen based on the following criteria: Akaike's Information Criterion (AIC), Schwarz's Criterion (SC), Hannan Quinn Criterion (HQC), Standard Error (S.E) of Regression, Sum Squared Residuals (SSR) and Log Likelihood (LL). The decision rule is that the model with the lowest value of AIC, SIC, HQC, S.E of Reg and SSR, and biggest value of LL is the preferred model among others. The EGARCH (1,1) is found to be the preferred model for DLOG(ASI) compared to EGARCH (2,2) and EGARCH (3,3), while EGARCH (3,3) is found to be the preferred model for DLOG(EXR) compared to EGARCH (1,1) and EGARCH(2,2). The table below illustrates the outcome of the model selection criteria.

Table 4.3 Model Selection Criteria

	DLOG(ASI)			DLOG(EXR)		
	EGARCH(1,1)	EGARCH(2,2)	EGARCH(3,3)	EGARCH(1,1)	EGARCH(2,2)	EGARCH(3,3,)
S.E of Reg	0.031820	0.031861	0.031845	0.024043	0.024056	0.023820
SSR	0.911249	0.913585	0.912677	0.520278	0.520825	0.510649
AIC	-4.262084	-4.275888	-4.274440	-5.038717	-5.255023	-6.056641
SC	-4.224831	-4.227990	-4.225899	-5.001463	-5.207126	-5.998099
HQC	-4.247856	-4.257594	-4.252080	-5.024488	-5.236729	-6.034281
LL	1931.331	1939.563	1940.910	2281.981	2381.643	2745.573

Source: Author's Computation Using E-views 9

4.6.2 EGARCH Estimation

In order to ascertain the extent of volatility in the markets, the EGARCH is used and our result is reported in two models as specified in chapter 3(in 3.2). The result of an estimated EGARCH (1,1) is reported for model 1a as ASI and model 1b is the result of the estimated EGARCH (3,3) for EXR. The models were chosen based on the selection criteria in table 4.3. Furthermore, diagnostic tests are carried out to ensure that there is no serial correlation, no misspecification and the residuals are normally distributed. If the variance equation is well specified, there should be no ARCH in the standardized residuals. The result for the model 1a is presented in table 4.4a

Table 4.4a EGARCH(1,1) Result for DLOG(ASI)

VARIABLES	**MEAN**	**VARIANCE**
CONSTANT	0.047967**	-1.429355*
	(0.020790)	(0.198178)
DLOG(EXR)	-0.006351***	
	(0.003807)	
DLOG(ASI(-1))	0.998563*	
	(0.001239)	
ARCH(1)		0.459631*
		(0.047496)
GARCH(1)		0.039701***
		(0.024011)
Lev. Effect		0.845492*
		(0.025489)

** indicates the level of significance of the variables at 1%, **5% and ***10%.*
( ) indicates the Standard Error of the variables.
Source: Author's Computation Using E-views 9

Table 4.4a presents the result for All Share Index (DLOG(ASI)) . The result reveals that the coefficient of exchange rate is statistically significant at 10% and negative (-0.06). This means that a negative relationship exists between the Nigerian stock and foreign exchange markets that is an increase in exchange rate (depreciation) will cause decline in stock market returns (ASI), hence the stock market is responsive to both bad and good news that emanates from the foreign exchange market because most investments are portfolio, thus a fall in the value of exchange rate will pose to undervalue their investments. The leverage effect term is positive, indicating that the extent of volatility in the stock market is low, meaning that volatility responds first to larger changes in the market value.

Table 4.4b EGARCH(3,3) Result for DLOG(EXR)

VARIABLES	MEAN	VARIANCE
CONSTANT	-0.081777****	-2.988968*
	(0.001788)	(0.206607)
DLOG(ASI)	-0.000529*****	
	(0.000172)	
DLOG(EXR(-1))	1.017568*	
	(5.82E-07)	
ARCH(1)		1.079289*
		(0.027720)
ARCH(2)		0.885370*
		(0.025052)
ARCH(3)		0.737050*
		(0.031263)
GARCH(1)		-0.162652*
		(0.009804)
GARCH(2)		0.166047*
		(0.008299)
GARCH(3)		-0.186154*
		(0.006022)
Lev. Effect		0.894764*
		(0.007958)

** indicates the level of significance of the variables at 1%, **5% and ***10%.*
( ) indicates the Standard Error of the variables.
Source: Author's Computation Using E-views 9

Table 4.4b presents the result for Exchange rate (DLOG (EXR)). The result shows that the coefficient of ASI is statistically significant at 10% level and negative (-0.005). This implies that

exchange rate also reacts to information from stock prices, thus a negative relationship exist between the foreign exchange and stock exchange market in Nigeria. This could be attributed to the nature of the stock market (long-term) hence investors could be less concerned with the behavior of the market. The result conforms with the portfolio balance approach of exchange rate determination that significant volatility transmits from the stock market to the foreign exchange market. Meaning higher cross-border financial assets flows between domestic and foreign stock markets, may results in the changes of demand for and supply of currencies in which the international equities are priced and exchange rate has to be adjusted according to the international equity flows (Branson, 1983; and Frankel, 1983). Our findings is in tandem with the findings of Choi et.al (2006) that volatility changes in stock returns have an impact on the movements of foreign currency in New Zealand. In other words, the New Zealand Dollar is adjustable to the international equity flows because the country's stocks are known to attract international investment. The leverage effect term is also positive and implies that volatility in the foreign exchange market reacts more to larger changes in the market value[23].

4.6.3 Diagnostic Test

The diagnostic test below illustrates that the model has been specified correctly and as well has no additional ARCH effect in the standardized residuals. More so, the Q-statistics reveals that there is no serial correlation in the residuals and Jarque-Bera statistics for normal distribution shows that the residuals in the model are normally distributed.

[23] For the purpose of completeness and robustness, inflation rate was added to our model in order to improve our results. However, the results gotten were statistically in significant. See Appendices H

Table 4.5 Diagnostic test

Diagnostic test	ARCH LM Obs*R	Prob	Jarque-Bera Coeff	Prob	Q-statistics 1st Coeff	Prob
EGARCH (1,1)	0.2085	0.6479	1013.120	0.0000	0.2095	0.647
EGARCH (3,3)	0.3330	0.5639	2951.416	0.0000	0.3344	0.563

Source: Author's Computation Using E-views 9

4.6.4 Forecast Error Variance Decomposition Estimation (FEVD)

In order to examine the extent to which volatility spillover across the foreign exchange and stock market in Nigeria, the FEVD is used. The VAR result is presented in table 4.6.

Table 4.6 Vector Autoregression Estimates

	ASI	**EXR**
ASI(-1)	0.987836 (0.03348)	-0.027436 (0.02375)
ASI(-2)	0.027109 (0.04704)	0.023920 (0.03337)
ASI(-3)	0.002366 (0.04703)	0.022334 (0.03336)
ASI(-4)	0.049761 (0.04704)	0.001100 (0.03337)
ASI(-5)	- 0.013684 (0.04705)	-0.028134 (0.03338)
ASI(-6)	-0.058914 (0.03331)	0.007803 (0.02363)
EXR(-1)	-0.045316 (0.04738)	0.699691 (0.03361)
EXR(-2)	-0.026562 (0.05773)	0.243773 (0.04095)
EXR(-3)	0.039220 (0.05868)	0.067562 (0.04162)
EXR(-4)	-0.012943 (0.05868)	0.099141 (0.04162)
EXR(-5)	-0.029950 (0.05773)	-0.068358 (0.04095)
EXR(-6)	0.075624 (0.04762)	-0.040149 (0.03378)
C	0.056915 (0.02670)	-0.002645 (0.01894)
S.D. Dependent	0.517340	0.235325
AIC	-8.793103	
SIC	-8.654123	

Standard Errors in Parenthesis.
Source: Author's Computation Using E-views 9

The variance errors were decomposed; using 6 lags and 10 forecast horizons to enable splitting the forecast error variance of each variable into parts which are attributable to the various system shocks. This makes it easy to determine how much of the forecast error variance of each of the variable can be explained by exogenous shocks to the other variable.

Descriptive statistics for the volatility series are presented in Table 4.7. It is observed that the stock market has been the most volatile series with the average volatility being the largest coupled with the marginal disparities in the heights of the volatility between the markets.

Table 4.7 Descriptive Statistics for volatility series

	Mean	Maximum	Minimum	Standard Error
Stock market	10.05328	11.09925	8.59326	0.52796
Foreign exchange market	4.98387	5.82968	4.59410	0.23654

Source: Author's Computation Using RATS 9.20

Table 4.8 Volatility Spillover Table

To (i)	From (j)		
	Stock (ASI)	Foreign Exchange (EXR)	Contribution 'From' the other market
Stock (ASI)	97.91	2.09	2.1
Foreign Exchange (EXR)	0.19	99.81	0.2
Contribution 'To' the other market	0.2	2.1	2.3
Net Contribution	-1.9	1.9	
Contribution including own	98.11	101.90	Total Spillover Index = 11.5%

Source: Author's Computation Using RATS 9.20

The financial markets are continually evolving and known to exhibit great variation over time as different events unfolds. Thus, this is largely due to markets interdependency and linkages. Table 4.8 provides an appropriate input-output decomposition of the volatility spillover. The ijth entry is the estimated contributions to the forecast error variance of market i coming from innovations in market j.

The total volatility spillover is effectively a distillation of the various directional volatility spillovers into a single index. It appears in the lower right corner of the table 4.8. It is approximately the grand off-diagonal column sum (or row sum) relative to the grand column

sum including diagonals (or row sum including diagonals), expressed as a percentage. It is calculated as;

Directional from others ÷ Directional to others × 100

The total spillover index for volatilities shows that on an average across our samples, over 11% of the forecast error variance in the markets comes from spillovers. This suggests that the interdependence amongst the markets is marginal compared to the 46% findings of Grobys (2015)[24]. The stock market volatility spillover to the foreign exchange market shows a smaller level (0.2%) of interdependency and receives 2.1% from the foreign exchange market. This is consistent with the findings of Ulku and Demirci (2012) who observed that the relative depth of the stock market of a country depends on the strength stock market-exchange rate connection. Hence, developing economies experience significant and low interdependency between the stock and foreign exchange market. Likewise Subair and Salihu (2013) noted that volatility spillover exist due to short-run changes in the markets.

Figure 4.6.1 reveals upswings and downswings over time with volatility spillovers fluctuating between 0.5% and 20%. At the beginning of our sample the volatility spillovers were about 7.5% and fell to about 0.5% in mid 2007. In 2008, a sharp rise in volatility spillover was observed, recording 2.5% as a result of the onset of the global financial crisis. It remained relatively stable until the end of 2008 when it spiked up to 14%. A drastic rise to 20% was observed in mid 2010, followed by a sharp fall in 2013-2014 (1.5%-0.5%). These swings in volatility spillovers rose in mid 2014 and 2016 due to the devaluation of naira. This implies that as exchange rate depreciation rises, the spillover appears to be rising too.

[24] Study on volatility spillover between currency and capital markets. Evidence from the US economy.

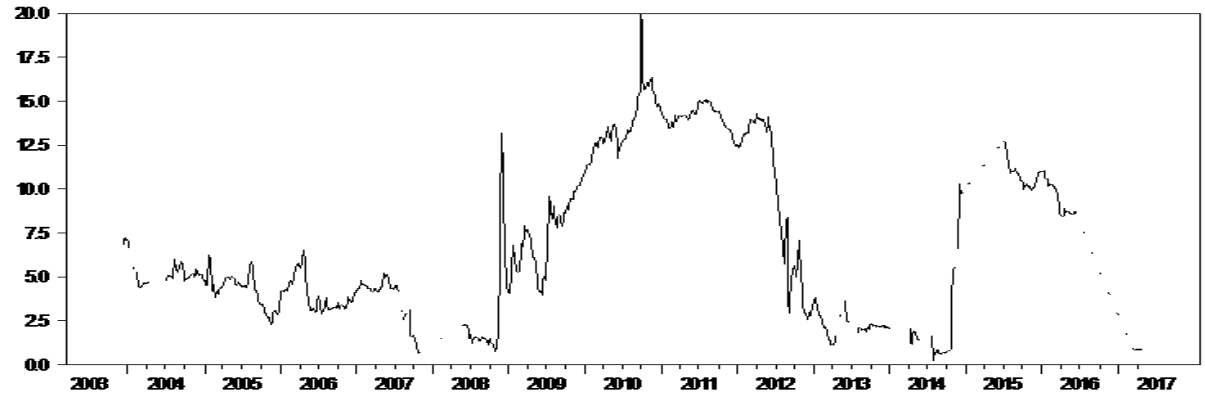


Figure 4.6.1 Total Volatility Spillovers of the Stock market and Foreign exchange market

The directional spillovers provides a decomposition of the total spillover to those coming from (or to) a particular source. It can be seen on the spillover table labeled as 'contribution to others' and 'contribution from others'. This implies that the directional spillover from foreign exchange to stock exchange market is relatively higher (2.1%) compared to stock market spillovers to foreign exchange market explaining 0.2% of the forecast error variance.

The directional spillover plots in Figure 4.6.2a and 4.6.2b vary over time, and reveal that the direction of spillover is more from foreign exchange market to stock market in Nigeria. It is observed that during tranquil times the spillovers from each market are below 5% and increases to 20% during volatile periods.

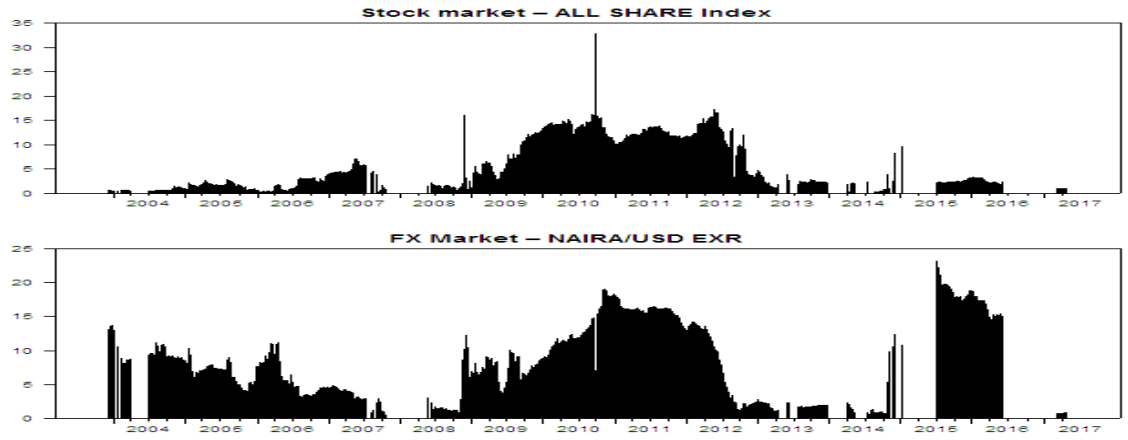


Figure 4.6.2a Directional volatility spillover from the stock market to foreign exchange market

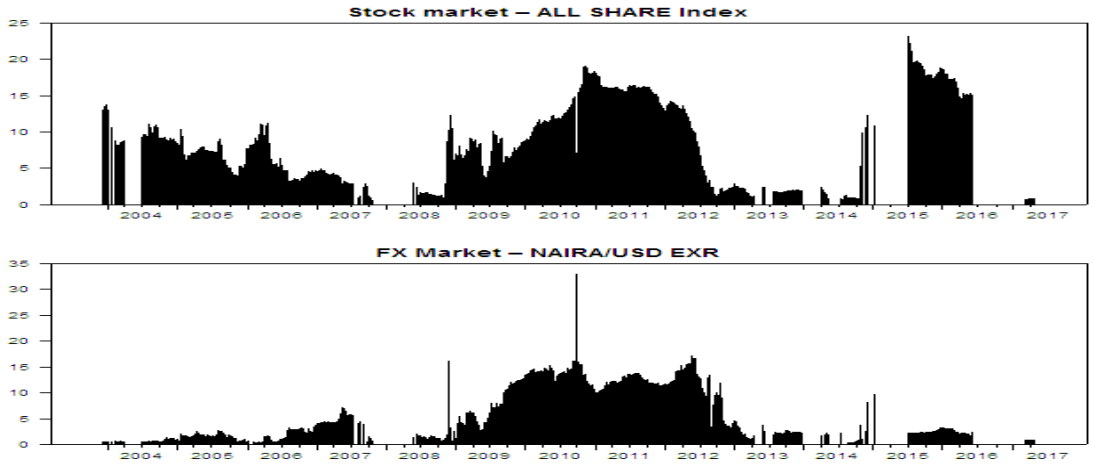


Figure 4.6.2b Directional volatility spillover to stock market from the foreign exchange market

The net volatility spillovers reveal that the largest spillover is from foreign exchange market at 1.9% to the stock exchange market. From Figure 4.6.3 it is observed that the bulk of the spillovers are received by the stock market and positive throughout the sample periods, reaching as high as 20% after the depreciation of the Naira in 2015.

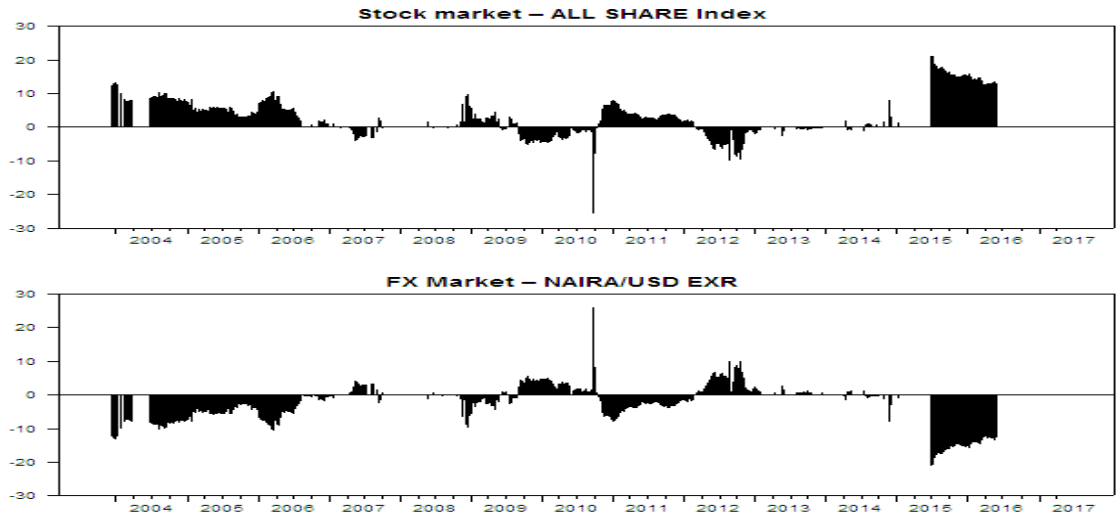


Figure 4.6.3 Net Volatility Spillover

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This study was carried out to investigate the extent of foreign exchange market and stock market integration in Nigeria. To this effect, two models are estimated, the Exponential GARCH and Forecast Error Variance Decomposition. Preliminary tests were conducted in order to assess the order of integration of the series. It was found that all the series were stationary at first difference I(1), using the Augmented Dickey Fuller test. Preliminary analysis, using correlation tests, reveals that fluctuations in the two markets may indeed be negatively associated. A more formal model, the Exponential GARCH was then employed in order to ascertain the extent of volatilities in the markets. The results reveal that all the variables are statistically significant in the mean equations and the coefficients have the expected sign (negative) which corroborates with the portfolio balance theory. The second model is employed to examine the extent to which volatility spillover across the foreign exchange market and stock market. However, it was found that volatility appears to be more persistent in the stock market (0.06%) compared to the foreign exchange market (0.005%). The total volatility spillover reveals that the interdependence amongst the market is marginal (11.5%) which is attributed to the 'emerging' nature of the economy. The directional spillover index computed also indicated that spillover basically occurs more from the foreign exchange market to the stock market, noting that it occurs during turbulent periods. Finally, the net volatility spillover appears to be consistent with the directional spillover showing that the largest spillover is from the foreign exchange market to the stock market in Nigeria. One implication of this finding is that the stability of foreign exchange market could be

a useful means of reducing the excessive volatilities of the Nigeria's stock market. This therefore, highlights the importance of exchange rate as a means of achieving not only price stability, but also a means of achieving financial stability.

5.2 Conclusion

This study is carried out in order to investigate the extent of foreign exchange and stock market integration in Nigeria. Specifically, to ascertain the extent of volatility in the market as well as examine the extent of volatility spillover across the markets. Based on our first objective, a negative but statistically significant relationship exists between the stock market and foreign exchange market with the former evidently being the most volatile especially during the periods of global financial crisis and devaluation of the naira. Secondly, it is revealed that volatility spillover occurs from foreign exchange market to the stock market owing to the fact that 'news' emanating from the foreign exchange market has impact on the stock market in Nigeria. Therefore, this study concludes that connection between both markets should be strengthened for a better anticipation of potential currency risks that could be associated with the arrival of future economic and/or markets disruptions. Secondly, stability of the foreign exchange market is of preponderant importance for achieving effective asset market stability in Nigeria.

5.3 Recommendations

The recommendations from this study are as follows;

i. The monetary authorities should continue to focus on achieving foreign exchange market stability, given its potential for helping achieve asset market stability.
ii. The finding that the direction of the spillover reveals that it runs from foreign exchange market to stock market and that the bulk occurs during turbulent periods

implies that the Securities and Exchange Commission (SEC) should view foreign exchange crisis as early warning signals, and take pre-emptive measures to reduce the impending volatilities.

iii. This study suggests that hedgers should consider the victims of exchange rate volatilities in their portfolio.

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Appendix A

SUMMARY OF EMPIRICAL FINDINGS

DEVELOPED MARKETS

S/No	AUTHOR	STUDY	SCOPE	OBJECTIVE	THEORY	VARIABLES	ESTIM PROC
1	Choi, D.F.S., Fang, V. and Fu, T.Y (2006)	Volatility spillover between stock market returns and exchange rate changes; the New Zealand case.	January 1990 to December 2004	To analyze the volatility spillover between stock and foreign exchange market in New Zealand.	Portfolio balance approach	Daily data; exchange rate NZD/USD and the TWI index	EGAR
2	Milunovich George and Thorp Susan (2006)	Valuing volatility spillovers; London, Paris and Frankfurt.	1st January 1992 to 4th July 2005	To value volatility spillover for investors who select mean variance equity portfolios from stock markets in London, Frankfurt and Paris.		Daily data; European stock market indices valued in US Dollars, FTSE 100 (London), DAX 30 (Frankfurt) and CAC 40 (Paris)	A-DC
3	Chkili Walid, Chaker Aloui and Nguyen Duc Khuong (2012)	Asymmetric effects and long memory in dynamic volatility relationship between stock returns and exchange rates.	January 1999 to December 2010	To investigate volatility interactions between foreign exchange and stock market for three European countries; France, Germany and the UK.	Traditional and portfolio balance approach		GARC FIGAR FIAPA
4	Caporale Guglielmo Maria, Hunter John and Ali Faek Menla (2014)	The linkage between stock prices and exchange rates	August 2007 to 2010	To address the interaction between stock and foreign exchange returns in the UK, Japan, the Euro area and Switzerland.	Portfolio balance approach	Weekly data; the log of stock prices and the log of exchange rates.	UECC GARC
5	Grobys Klaus	Are volatility	February 1986	To capture the		CRSP index	Foreca

	(2015)	spillovers between currency and capital markets driven by economic states? Evidence from the US economy	to February 2014	dynamic behavior of volatility spillover effects between major foreign exchange market (Europe, Japan and Canada) and the US equity market.		and exchange rate of other countries vis-à-vis US Dollar.	varianc decomp framew VAR m
6	Kal Hilmi Suleyman, Ferhat Arslaner and Nuran Arslaner (2015)	The dynamic relationship between stock and foreign exchange market (Australia, Japan, Canada and the UK)	1972 to 2009	To examine the exchange rate and stock market returns in a regime switching environment.		Percentage change in each currency, growth rate between each country, differential in GDP growth rate, differential in short term treasury rates, differential in inflation rates and stock market yield differentials	MS-VA model
7	Diebold X. Francis and Yilmaz Kamil (2012)	Better to give than to receive: Predictive directional measurement of volatility spillovers	January 1999 – January 2010	to characterize daily volatility spillovers across US stock, bond, forex and commodities market		S&P 500 index, the 10-year treasury bond yield, the New York Board of Trade US dollar index futures and the Dow-Jones/UBS commodity	forecas varianc decomp model

EMERGING MARKETS

7	Mishra Alok Kumar, Swain Niranga and Malhotra, D.K. (2007)	Volatility spillover between stock and foreign exchange markets; evidence from India	January 4th 1993 to December 31st 2003	To investigate if volatility surprises in the Indian stock market influences the volatility return in the exchange market		Stock market; SENSEX, BSE 100, S&P CNX NIFTY-50 and S&P CNX 500. Exchange rate of Indian rupees per US Dollar	GARC EGAR model

8	Zhao Hua (2010)	Dynamic relationship between exchange rate and stock prices; evidence from India	January 1991 to June 2009	To investigate the dynamic relationship between exchange rates and stock prices in China	Portfolio balance approach	Monthly data; Renminbi exchange rate and Shanghai composite stock price	VAR a MGAR framew
9	Chkili Walid, Chaker Aloui, Omar Masood and Fry John (2011)	Stock market volatility and exchange rates in emerging countries	1994 to 2009	to examine volatility spillovers between foreign exchange markets and equity markets in Hong Kong, Singapore, Malaysia and Mexico	Markov switching approach	Weekly data; exchange rates expressed in US Dollar and stock price index	EGAR MS-EC framew
10	Chortareas Georgios, Cipollini Andrea and Eissa Abdelaziz Mohammed (2012)	Switching to floating exchange rates, devaluation and stock returns in MENA countries	2000-2003	to examine the impact of announcing a switching to floating exchange rate and/or currency devaluation on stock market returns and their volatility in three MENA (Middle East and North Africa) countries; Morocco, Turkey and Egypt		Egypt Hermes financial price index, Morocco SE.CFG price index and Turkey ISE national all share index	GARC framew
11	Lin Chen-Hsiu (2012)	The co-movement between exchange rates and stock prices in Asia emerging markets	January 1986 to December 2010	to investigate the co-movement between the exchange rate and stock prices in India, Indonesia, Philippines, Thailand and Taiwan	Traditional and portfolio balance approach	Monthly data; exchange rates, stock prices, interest rate and foreign reserve for each country	ARDL

12	Ulku Numan and Ebru Demirci (2012)	Joint dynamics of foreign exchange and stock markets in emerging Europe	January 2003 to October 2010	To investigate the stock market – exchange rate interaction in Hungary, Poland, Turkey, Russia, Ukraine and Croatia	Traditional and portfolio balance approach	Monthly and daily data; closing values of exchange rates, national stock market indices (expressed in local currency) and global market indices	IRFs fr co-inte Structu Vector Autore (SVAR
13	Andreous Elena, Matsi Elena and Savvides Andreas (2013)	Stock and foreign exchange market linkages in 12 emerging economies	January 6th 1989 to August 15th 2008	To investigate the linkages between exchange and stock markets in six Asia emerging economies (India, Korea, Malaysia, Pakistan, Philippines and Thailand) and six Latin America emerging economies (Argentina, Brazil, Chile, Columbia, Mexico and Venezuela)	Traditional and portfolio balance approach	Local (emerging) stock market returns, exchange rate of each country vis-à-vis the US Dollar and global stock market return	VAR-C model
14	Chkili Walid and Nguyen Duc Khuong (2014)	Exchange rate movements and stock market returns in a regime switching environment; evidence from BRICS countries	March 1997 to February 2013	To examine the exchange rate and stock market returns in a regime switching environment; Brazil, Russia, India, China and South Africa	Portfolio balance approach	Weekly stock prices and US Dollar exchange rates for the BRICS	MS-VA model
15	Sui Lu and Sun Lijuan (2016)	Spillover effects between exchange rates and stock prices; evidence from BRICS around the global financial crisis period	2007 to 2009	To examine the short run and long run dynamic linkages among foreign exchange rate, local stock return, S&P 500 and interest differential	Traditional approach	US Dollar denominated exchange rates, stock prices and 3 month interest rates for the BRICS, US 3 month interest rates and S&P 500 index	VAR, and Ch

EMERGING AND DEVELOPED MARKETS

16	Cumperayot Phornchanok, Tjeert Keijzer, and Roy	Linkages between extreme stock	1996 to 2005	To investigate the linkages		Daily data; local stock	Simultaneous equation probit model	Found that emerging markets are affected by

	Kouwenberg (2006)	market and currency returns		between extreme stock market and currency returns in America emerging and developed economies (Argentina and Brazil; Canada and US), Asia and Australia emerging and developed economies (Malaysia and Thailand; Australia, Japan, New Zealand) and Europe emerging and developed economies (Russia and Turkey; Germany, Switzerland and UK)		index returns and exchange rate vis-à-vis the US Dollar		changes in portfolio flows, and expectations of foreign investors in the equity market also place the local currency under pressure compared to developed markets
17	Moore Toomoe and Wang Ping (2014)	Dynamic linkage between real exchange rates and stock prices	January 1973 to December 2006	To investigate the dynamic relationship between exchange rate and stock prices in developed markets (UK and Canada) and Asia emerging markets	Traditional approach	Monthly closing stock price indices and end of period nominal exchange rates relative to the US Dollar	DCC-GARCH	A negative and bidirectional relationship was found between relative stock price and real exchange rate

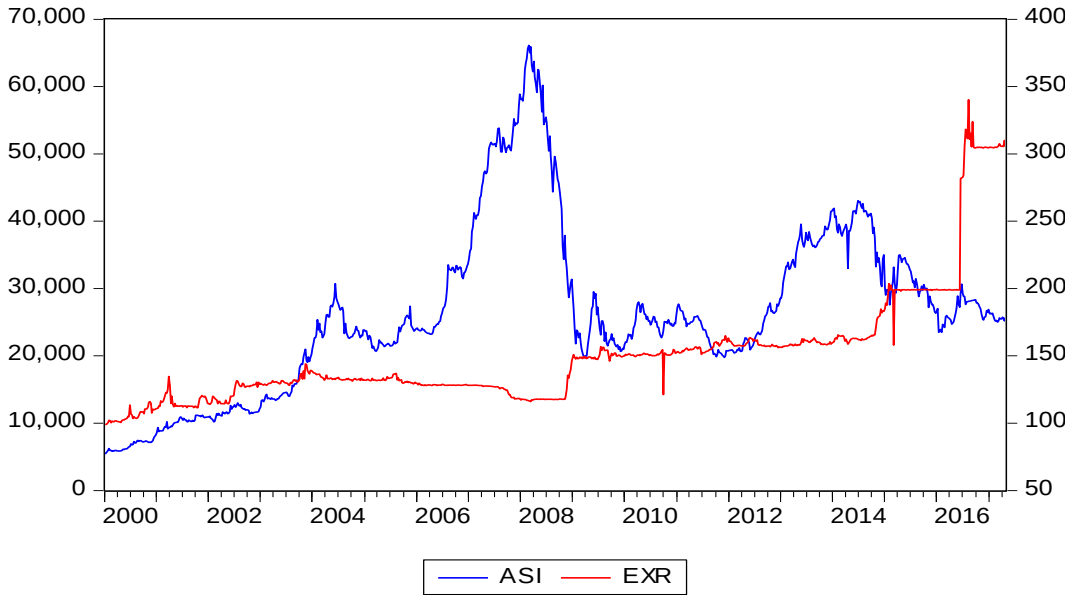
				(Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand)				
18	Do Xuan Hung, Brooks Robert and Sirimon Treepongkarun a (2015)	Realized spillover effects between stock and foreign exchang e market; Evidenc e from regional analysis	2003 to2009	To examine the linkage between stock and exchange market via realized higher moments and the linkage change under the recent financial crisis in emerging and developed Asia, America and Western Europe	Traditiona l and portfolio approach	Intra-daily data of stock price indices and foreign exchang e prices	VAR framework	Found positive and bidirectiona l realized volatility spillover effect between the stock and foreign exchange market studied

EVIDENCE FROM NIGERIA

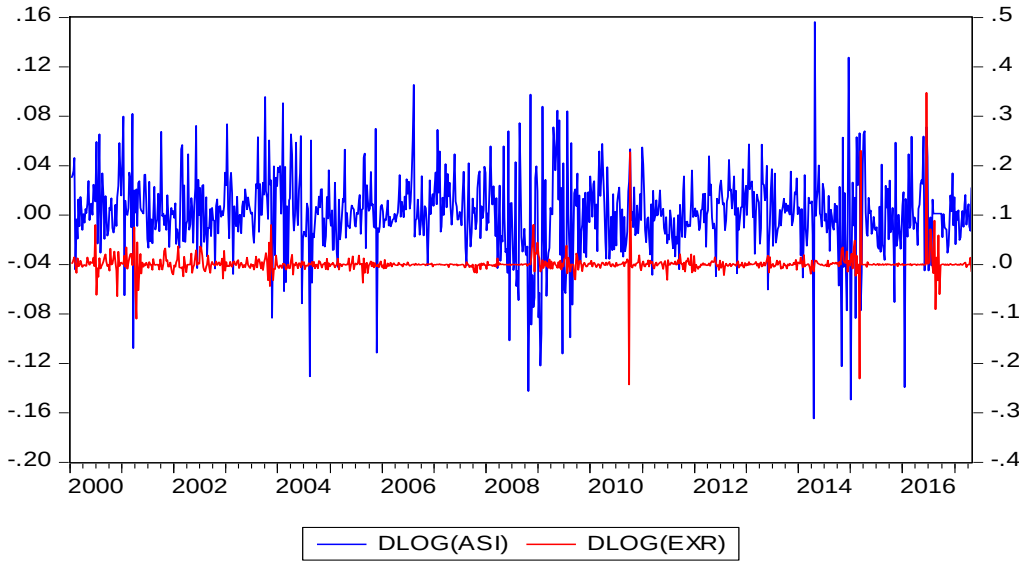
19	Olugbenga Anthony Adamola (2012)	Exchange rate volatility and stock market behavior; the Nigerian	January 1984 to April 2004	To examine the long-run and short-run effect of exchange rate on stock market development	Traditional approach	Quarterly data; official exchange rate and all share index	Johansen co-integration and granger causality test	A unidirectional relationship running from exchange rate to stock market performance

		experience		in Nigeria				was found
20	Chigozie Okpara Godwin and Odionye Chukwudi Joseph (2012)	The direction of volatility spillover between stock prices and exchange rate; evidence from Nigeria	1990 to 2009	To investigate the direction of volatility spillover between exchange rate and stock prices in Nigeria	Traditional approach	Quarterly data; nominal exchange rate, all share index and stock market capitalization	EGARCH framework	Found a unidirectional volatility spillover from foreign exchange to stock market in Nigeria
21	Zubair Abdulrasheed (2013)	Causal relationship between stock market index and exchange rate, evidence from Nigeria	April 2000 to December 2011	To investigate the causal relationship between stock market index and exchange rate in Nigeria	Traditional and portfolio balance approach	Monthly data; official exchange rate, all share index and money supply	Johansen co-integration and granger causality test	No causal relationship was found between all share index and exchange rate
22	Subair Kolawole and Salihu Musa Olalekan (2013)	Exchange rate volatility and the stock market; the Nigerian experience	1981 to 2007	To investigate the effects of exchange rate volatility in the Nigerian stock market	Traditional approach	Annual data; stock market capitalization, official exchange rate, interest rate, inflation rate and GDP	Unit root test and ECM	found that short-run change in exchange rate volatility had strong impact on the change in stock market capitalization growth rate
23	Salisu A. Afees and Oloko F. Tirimisiyu (2015)	Modeling spillovers between stock market and foreign exchange market in Nigeria	May 1999 to December 2013	To capture returns, shocks and volatility spillover between stock market and foreign exchange market in Nigeria	Portfolio balance approach	WDAS exchange rate and all share index	VARMA-AMGARCH	Found a bidirectional return spillover between the markets

Appendix B1: ***Graph for ASI and EXR***



Appendix B2: ***First Difference of their Graph***



Appendix C1: ***Descriptive Statistics Result***

Date: 10/15/17
Time: 09:33
Sample: 1/07/2000 4/28/2017

	ASI	EXR
Mean	26294.18	150.6985
Median	24866.27	136.5175
Maximum	66121.93	340.2500
Minimum	5395.180	98.90000
Std. Dev.	12388.86	43.19999
Skewness	0.752659	2.309718
Kurtosis	3.662871	8.861784
Jarque-Bera	101.9026	2098.022
Probability	0.000000	0.000000
Sum	23769935	136231.5
Sum Sq. Dev.	1.39E+11	1685214.
Observations	904	904

Appendix C2: *Unit Root Result at First Difference for ASI*

Null Hypothesis: D(ASI) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.46289	0.0000
Test critical values:	1% level	-3.437409	
	5% level	-2.864546	
	10% level	-2.568424	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ASI,2)
Method: Least Squares
Date: 10/15/17 Time: 09:40
Sample (adjusted): 2/18/2000 4/28/2017
Included observations: 898 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ASI(-1))	-0.751722	0.071847	-10.46289	0.0000
D(ASI(-1),2)	-0.260892	0.065696	-3.971235	0.0001
D(ASI(-2),2)	-0.272529	0.057161	-4.767760	0.0000
D(ASI(-3),2)	-0.250032	0.046638	-5.361144	0.0000
D(ASI(-4),2)	-0.151666	0.033101	-4.581969	0.0000
C	16.48501	32.12901	0.513088	0.6080

R-squared	0.514419	Mean dependent var	0.933597
Adjusted R-squared	0.511697	S.D. dependent var	1376.153
S.E. of regression	961.6372	Akaike info criterion	16.58181
Sum squared resid	8.25E+08	Schwarz criterion	16.61388
Log likelihood	-7439.233	Hannan-Quinn criter.	16.59406
F-statistic	188.9952	Durbin-Watson stat	2.014356
Prob(F-statistic)	0.000000		

Appendix C3: *Unit Root Result at First Difference for EXR*

Null Hypothesis: D(EXR) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.32052	0.0000
Test critical values:	1% level	-3.437401	
	5% level	-2.864542	
	10% level	-2.568422	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXR,2)
Method: Least Squares
Date: 10/15/17 Time: 09:44
Sample (adjusted): 2/11/2000 4/28/2017
Included observations: 899 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXR(-1))	-1.051486	0.078937	-13.32052	0.0000
D(EXR(-1),2)	-0.196780	0.067161	-2.929962	0.0035
D(EXR(-2),2)	-0.210588	0.052661	-3.998943	0.0001
D(EXR(-3),2)	-0.190383	0.032862	-5.793419	0.0000
C	0.238706	0.142148	1.679271	0.0934

R-squared	0.638987	Mean dependent var	-0.006774
Adjusted R-squared	0.637371	S.D. dependent var	7.019520
S.E. of regression	4.227061	Akaike info criterion	5.726437
Sum squared resid	15974.03	Schwarz criterion	5.753141
Log likelihood	-2569.033	Hannan-Quinn criter.	5.736639
F-statistic	395.5907	Durbin-Watson stat	2.025878
Prob(F-statistic)	0.000000		

Appendix D: *Result for Correlation Test*

DLOG(ASI)		DLOG(EXR)
1.000000	DLOG(ASI)	-0.019916
-0.019916	DLOG(EXR)	1.000000

Appendix E1: *EGARCH (1,1)Result for Model 1*

Dependent Variable: DLOG(ASI)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 09/29/17 Time: 15:36
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Convergence achieved after 50 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.047967	0.020790	2.307204	0.0210
DLOG(EXR)	-0.006351	0.003807	-1.668122	0.0953
DLOG(ASI(-1))	0.998563	0.001239	805.7882	0.0000
Variance Equation				
C(4)	-1.429355	0.198178	-7.212490	0.0000
C(5)	0.459631	0.047496	9.677178	0.0000
C(6)	0.039701	0.024011	1.653456	0.0982
C(7)	0.845492	0.025489	33.17063	0.0000

R-squared	0.996349	Mean dependent var	10.05490
Adjusted R-squared	0.996341	S.D. dependent var	0.526017
S.E. of regression	0.031820	Akaike info criterion	-4.262084
Sum squared resid	0.911249	Schwarz criterion	-4.224831
Log likelihood	1931.331	Hannan-Quinn criter.	-4.247856
Durbin-Watson stat	1.992215		

Appendix E2: *EGARCH (2,2)Result for Model 1a*

Dependent Variable: DLOG(ASI)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 09/29/17 Time: 15:34
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902
Failure to improve likelihood (non-zero gradients) after 51 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(7)*RESID(-1)
/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1)) + C(9)*LOG(GARCH(
-2))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.036799	0.018854	1.951755	0.0510
DLOG(EXR)	-0.006109	0.003855	-1.584543	0.1131
DLOG(ASI(-1))	0.999586	0.000986	1014.225	0.0000
Variance Equation				
C(4)	-2.592988	0.370635	-6.996060	0.0000
C(5)	0.528385	0.051012	10.35811	0.0000
C(6)	0.369545	0.050315	7.344584	0.0000
C(7)	0.071104	0.021545	3.300296	0.0010
C(8)	-0.062354	0.033767	-1.846586	0.0648
C(9)	0.789925	0.028401	27.81331	0.0000

R-squared	0.996339	Mean dependent var	10.05490
Adjusted R-squared	0.996331	S.D. dependent var	0.526017
S.E. of regression	0.031861	Akaike info criterion	-4.275888
Sum squared resid	0.913585	Schwarz criterion	-4.227990
Log likelihood	1939.563	Hannan-Quinn criter.	-4.257594
Durbin-Watson stat	1.989151		

Appendix E3: *EGARCH (3,3)Result for Model 1a*

Dependent Variable: DLOG(ASI)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 09/29/17 Time: 15:37
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902
Failure to improve likelihood (non-zero gradients) after 68 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(7)*ABS(RESID(-3)
/@SQRT(GARCH(-3))) + C(8)*RESID(-1)/@SQRT(GARCH(-1)) + C(9)
*LOG(GARCH(-1)) + C(10)*LOG(GARCH(-2)) + C(11)*LOG(GARCH(-3))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.043102	0.020016	2.153352	0.0313
DLOG(EXR)	-0.006818	0.003916	-1.740756	0.0817
DLOG(ASI(-1))	0.999288	0.001134	880.9446	0.0000
Variance Equation				
C(4)	-4.325809	0.672386	-6.433525	0.0000
C(5)	0.514301	0.047781	10.76376	0.0000
C(6)	0.563871	0.073783	7.642280	0.0000
C(7)	0.349068	0.061604	5.666357	0.0000
C(8)	0.089429	0.018249	4.900498	0.0000
C(9)	-0.422930	0.042259	-10.00799	0.0000
C(10)	0.201257	0.032682	6.158002	0.0000
C(11)	0.760128	0.030327	25.06406	0.0000

R-squared	0.996343	Mean dependent var	10.05490
Adjusted R-squared	0.996335	S.D. dependent var	0.526017
S.E. of regression	0.031845	Akaike info criterion	-4.274440
Sum squared resid	0.912677	Schwarz criterion	-4.215899
Log likelihood	1940.910	Hannan-Quinn criter.	-4.252080
Durbin-Watson stat	1.990552		

Appendix E4: *EGARCH (1,1) Result for Model 1b*

Dependent Variable: DLOG(EXR)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 09/29/17 Time: 14:48
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Failure to improve likelihood (non-zero gradients) after 66 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.118333	0.012504	-9.463833	0.0000
DLOG(ASI)	0.001857	0.001118	1.660852	0.0967
DLOG(EXR(-1))	1.020219	0.000806	1265.817	0.0000
Variance Equation				
C(4)	-2.574428	0.132435	-19.43913	0.0000
C(5)	0.890675	0.061262	14.53889	0.0000
C(6)	-0.090318	0.045690	-1.976776	0.0481
C(7)	0.721631	0.014386	50.16274	0.0000

R-squared	0.989672	Mean dependent var	4.984312
Adjusted R-squared	0.989649	S.D. dependent var	0.236321
S.E. of regression	0.024043	Akaike info criterion	-5.038717
Sum squared resid	0.520278	Schwarz criterion	-5.001463
Log likelihood	2281.981	Hannan-Quinn criter.	-5.024488
Durbin-Watson stat	2.476176		

Appendix E5: *EGARCH (2,2) Result for Model 1b*

Dependent Variable: DLOG(EXR)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 09/29/17 Time: 14:49
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Failure to improve likelihood (non-zero gradients) after 110 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(7)*RESID(-1)
/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1)) + C(9)*LOG(GARCH(
-2))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.107496	0.003639	-29.54063	0.0000
DLOG(ASI)	-6.71E-05	0.000353	-0.190281	0.8491
DLOG(EXR(-1))	1.022125	0.000160	6378.673	0.0000
Variance Equation				
C(4)	-10.03365	0.080223	-125.0723	0.0000
C(5)	2.129497	0.047571	44.76465	0.0000
C(6)	2.278093	0.056443	40.36105	0.0000
C(7)	-0.373459	0.056387	-6.623144	0.0000
C(8)	-0.087629	0.018238	-4.804670	0.0000
C(9)	0.124512	0.016298	7.639482	0.0000

R-squared	0.989661	Mean dependent var	4.984312
Adjusted R-squared	0.989638	S.D. dependent var	0.236321
S.E. of regression	0.024056	Akaike info criterion	-5.255023
Sum squared resid	0.520825	Schwarz criterion	-5.207126
Log likelihood	2381.643	Hannan-Quinn criter.	-5.236729
Durbin-Watson stat	2.478272		

Appendix E6: *EGARCH (3,3) Result for Model 1b*

Dependent Variable: DLOG(EXR)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 09/29/17 Time: 14:50
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Failure to improve likelihood (non-zero gradients) after 177 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(7)*ABS(RESID(-3)
/@SQRT(GARCH(-3))) + C(8)*RESID(-1)/@SQRT(GARCH(-1)) + C(9)
*LOG(GARCH(-1)) + C(10)*LOG(GARCH(-2)) + C(11)*LOG(GARCH(-3))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.081777	0.001788	-45.72475	0.0000
DLOG(ASI)	-0.000529	0.000172	-3.075424	0.0021
DLOG(EXR(-1))	1.017568	5.82E-07	1748553.	0.0000
Variance Equation				
C(4)	-2.988968	0.206607	-14.46691	0.0000
C(5)	1.079289	0.027720	38.93570	0.0000
C(6)	0.885370	0.025052	35.34119	0.0000
C(7)	0.737050	0.031263	23.57565	0.0000
C(8)	-0.162652	0.009804	-16.59087	0.0000
C(9)	0.166047	0.008299	20.00904	0.0000
C(10)	-0.186154	0.006022	-30.91414	0.0000
C(11)	0.894764	0.007958	112.4316	0.0000

R-squared	0.989863	Mean dependent var	4.984312
Adjusted R-squared	0.989840	S.D. dependent var	0.236321
S.E. of regression	0.023820	Akaike info criterion	-6.056641
Sum squared resid	0.510649	Schwarz criterion	-5.998099
Log likelihood	2745.573	Hannan-Quinn criter.	-6.034281
Durbin-Watson stat	2.516223		

Appendix F1: *Heteroskedasticity Test Result for Model 1a*

Heteroskedasticity Test: ARCH

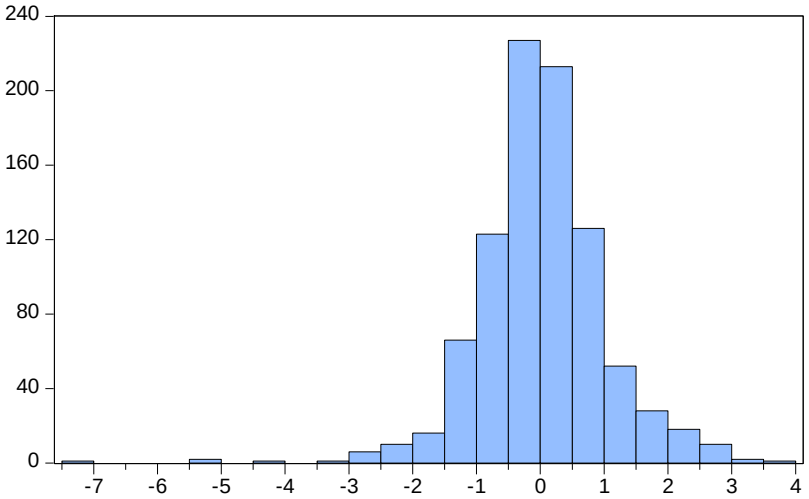
F-statistic	0.208173	Prob. F(1,900)	0.6483
Obs*R-squared	0.208587	Prob. Chi-Square(1)	0.6479

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 09/30/17 Time: 21:16
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.984747	0.094424	10.42898	0.0000
WGT_RESID^2(-1)	0.015207	0.033330	0.456260	0.6483

R-squared	0.000231	Mean dependent var	0.999936
Adjusted R-squared	-0.000880	S.D. dependent var	2.652600
S.E. of regression	2.653766	Akaike info criterion	4.792052
Sum squared resid	6338.228	Schwarz criterion	4.802705
Log likelihood	-2159.215	Hannan-Quinn criter.	4.796121
F-statistic	0.208173	Durbin-Watson stat	1.999341
Prob(F-statistic)	0.648313		

Appendix F2: *Normal Distribution Test Result for Model 1a*



Series: Standardized Residuals
Sample 1/14/2000 4/28/2017
Observations 903

Mean	0.014128
Median	-0.003860
Maximum	3.553520
Minimum	-7.077973
Std. Dev.	1.000238
Skewness	-0.572354
Kurtosis	8.061266
Jarque-Bera	1013.120
Probability	0.000000

Appendix F3: *Q-statistics Test Result for Model 1a*

Date: 09/30/17 Time: 21:17
Sample: 1/07/2000 4/28/2017
Included observations: 902

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.| |	.| |	1	0.015	0.015	0.2095	0.647
.| |	.| |	2	-0.020	-0.020	0.5554	0.758
.| |	.| |	3	-0.024	-0.024	1.0825	0.781
.| |	.| |	4	-0.026	-0.026	1.7182	0.787
.| |	.| |	5	-0.015	-0.016	1.9331	0.858
.| |	.| |	6	-0.034	-0.035	2.9859	0.811
.| |	.| |	7	0.020	0.019	3.3493	0.851
.| |	.| |	8	-0.007	-0.011	3.3990	0.907
.| |	.| |	9	0.022	0.021	3.8570	0.921
.| |	.| |	10	0.031	0.029	4.7569	0.907
.| |	.| |	11	0.016	0.016	4.9909	0.932
.| |	.| |	12	0.013	0.014	5.1580	0.952
.| |	.| |	13	0.020	0.024	5.5385	0.961
.| |	.| |	14	0.001	0.003	5.5392	0.977
.| |	.| |	15	-0.022	-0.017	5.9702	0.980
.| |	.| |	16	-0.021	-0.017	6.3889	0.983
.| |	.| |	17	-0.017	-0.016	6.6683	0.987
.| |	.| |	18	-0.015	-0.015	6.8640	0.991
.| |	.| |	19	0.043	0.041	8.5735	0.980
.| |	.| |	20	-0.022	-0.028	9.0172	0.983
.| |	.| |	21	-0.038	-0.041	10.381	0.974
.| |	.| |	22	-0.016	-0.018	10.623	0.980
.| |	.| |	23	0.025	0.022	11.204	0.981
.| |	.| |	24	-0.001	-0.005	11.205	0.987
.| |	.| |	25	0.054	0.057	13.914	0.963
.| |	.| |	26	-0.014	-0.018	14.089	0.972
.| |	.| |	27	0.041	0.047	15.638	0.960
.| |	.| |	28	0.068	0.072	20.015	0.864
.| |	.| |	29	-0.007	-0.002	20.057	0.891
.| |	.| |	30	-0.030	-0.023	20.900	0.891
.| |	.| |	31	0.012	0.025	21.030	0.911
.| |	.| |	32	-0.021	-0.023	21.435	0.922
.| |	.| |	33	-0.002	0.004	21.437	0.939
.| |	.| |	34	-0.021	-0.020	21.836	0.947
.| |	.| |	35	0.055	0.051	24.726	0.902
.| |	.| |	36	-0.011	-0.020	24.832	0.920

*Probabilities may not be valid for this equation specification.

Appendix F4: *Heteroskedasticity Test Result for Model 1b*

Heteroskedasticity Test: ARCH

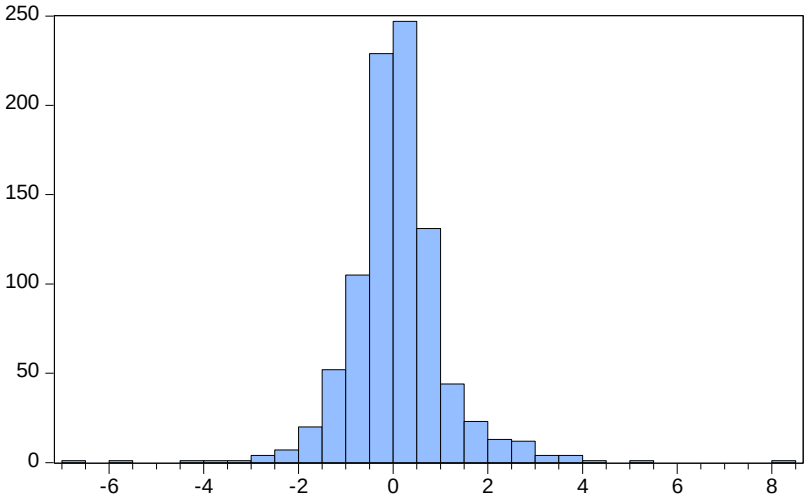
F-statistic	0.332394	Prob. F(1,900)	0.5644
Obs*R-squared	0.333010	Prob. Chi-Square(1)	0.5639

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 09/30/17 Time: 21:03
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.127145	0.126669	8.898364	0.0000
WGT_RESID^2(-1)	-0.019215	0.033329	-0.576536	0.5644

R-squared	0.000369	Mean dependent var	1.105940
Adjusted R-squared	-0.000742	S.D. dependent var	3.639030
S.E. of regression	3.640379	Akaike info criterion	5.424268
Sum squared resid	11927.12	Schwarz criterion	5.434921
Log likelihood	-2444.345	Hannan-Quinn criter.	5.428337
F-statistic	0.332394	Durbin-Watson stat	1.999933
Prob(F-statistic)	0.564397		

Appendix F5: *Normal Distribution Test Result for Model 1b*



Series: Standardized Residuals
Sample 1/14/2000 4/28/2017
Observations 903

Mean	0.094727
Median	0.051354
Maximum	8.208997
Minimum	-6.696332
Std. Dev.	1.047525
Skewness	0.402497
Kurtosis	11.82014
Jarque-Bera	2951.416
Probability	0.000000

Appendix F6: *Q-statistics Test Result for Model 1b*

Date: 09/30/17 Time: 21:08
Sample: 1/07/2000 4/28/2017
Included observations: 902

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.| |	.| |	1	-0.019	-0.019	0.3344	0.563
.| |	.| |	2	-0.001	-0.001	0.3348	0.846
.| |	.| |	3	-0.005	-0.006	0.3621	0.948
.| |	.| |	4	-0.035	-0.036	1.5026	0.826
.| |	.| |	5	-0.007	-0.008	1.5443	0.908
.| |	.| |	6	-0.010	-0.010	1.6300	0.950
.| |	.| |	7	-0.027	-0.028	2.3155	0.940
.| |	.| |	8	0.012	0.010	2.4509	0.964
.| |	.| |	9	-0.014	-0.014	2.6334	0.977
.| |	.| |	10	0.006	0.004	2.6620	0.988
.| |	.| |	11	-0.036	-0.038	3.8207	0.975
.| |	.| |	12	-0.002	-0.004	3.8255	0.986
.| |	.| |	13	0.020	0.019	4.1990	0.989
.| |	.| |	14	-0.013	-0.013	4.3525	0.993
.| |	.| |	15	-0.021	-0.024	4.7683	0.994
.| |	.| |	16	-0.015	-0.018	4.9850	0.996
.| |	.| |	17	-0.027	-0.027	5.6405	0.995
.|* |	.| |	18	0.076	0.072	10.933	0.897
.| |	.| |	19	0.017	0.019	11.204	0.917
.| |	.| |	20	-0.027	-0.029	11.898	0.920
.| |	.| |	21	-0.027	-0.031	12.586	0.922
.| |	.| |	22	0.027	0.029	13.254	0.926
.| |	.| |	23	-0.009	-0.007	13.326	0.945
.| |	.| |	24	-0.024	-0.026	13.870	0.950
.| |	.| |	25	0.002	0.002	13.873	0.964
.| |	.| |	26	-0.026	-0.029	14.513	0.966
.| |	.| |	27	-0.029	-0.032	15.316	0.965
.| |	.| |	28	0.000	-0.004	15.317	0.975
.| |	.| |	29	-0.002	0.004	15.321	0.982
.| |	.| |	30	-0.020	-0.023	15.680	0.985
.| |	.| |	31	0.006	-0.005	15.709	0.990
.| |	.| |	32	-0.002	-0.006	15.712	0.993
.| |	.| |	33	-0.012	-0.010	15.853	0.995
.| |	.| |	34	-0.016	-0.017	16.104	0.996
.| |	.| |	35	0.005	0.004	16.130	0.997
.| |	.| |	36	-0.007	-0.015	16.180	0.998

*Probabilities may not be valid for this equation specification.

Appendix G1: *VAR Result for Model 2*

Vector Autoregression Estimates
Date: 10/02/17 Time: 14:48
Sample (adjusted): 2/18/2000 4/28/2017
Included observations: 898 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LOG(ASI)	LOG(EXR)
LOG(ASI(-1))	0.987836	-0.027436
	(0.03348)	(0.02375)
	[29.5090]	[-1.15540]
LOG(ASI(-2))	0.027109	0.023920
	(0.04704)	(0.03337)
	[0.57634]	[0.71690]
LOG(ASI(-3))	0.002366	0.022334
	(0.04703)	(0.03336)
	[0.05032]	[0.66942]
LOG(ASI(-4))	0.049761	0.001100
	(0.04704)	(0.03337)
	[1.05794]	[0.03298]
LOG(ASI(-5))	-0.013684	-0.028134
	(0.04705)	(0.03338)
	[-0.29082]	[-0.84290]
LOG(ASI(-6))	-0.058914	0.007803
	(0.03331)	(0.02363)
	[-1.76877]	[0.33024]
LOG(EXR(-1))	-0.045316	0.699691
	(0.04738)	(0.03361)
	[-0.95640]	[20.8175]
LOG(EXR(-2))	-0.026562	0.243773
	(0.05773)	(0.04095)
	[-0.46013]	[5.95300]
LOG(EXR(-3))	0.039220	0.067562
	(0.05868)	(0.04162)
	[0.66840]	[1.62319]
LOG(EXR(-4))	-0.012943	0.099141
	(0.05868)	(0.04162)
	[-0.22057]	[2.38179]
LOG(EXR(-5))	-0.029950	-0.068358
	(0.05773)	(0.04095)
	[-0.51877]	[-1.66919]
LOG(EXR(-6))	0.075624	-0.040149
	(0.04762)	(0.03378)
	[1.58815]	[-1.18863]

C	0.056915	-0.002645
	(0.02670)	(0.01894)
	[2.13148]	[-0.13965]
R-squared	0.996303	0.991010
Adj. R-squared	0.996253	0.990888
Sum sq. Resids	0.887493	0.446570
S.E. equation	0.031667	0.022463
F-statistic	19876.22	8129.778
Log likelihood	1832.660	2141.035
Akaike AIC	-4.052694	-4.739498
Schwarz SC	-3.983204	-4.670008
Mean dependent	10.06255	4.986389
S.D. dependent	0.517340	0.235325

Determinant resid covariance (dof adj.)	5.06E-07
Determinant resid covariance	4.91E-07
Log likelihood	3974.103
Akaike information criterion	-8.793103
Schwarz criterion	-8.654123

Appendix G2: *Result for Lag Selection*

VAR Lag Order Selection Criteria
Endogenous variables: LOG(ASI) LOG(EXR)
Exogenous variables: C
Date: 10/01/17 Time: 00:09
Sample: 1/07/2000 4/28/2017
Included observations: 896

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-14345.68	NA	2.78e+11	32.02606	32.03677	32.03016
1	-10044.59	8573.377	18974206	22.43435	22.46647	22.44662
2	-10014.33	60.17577	17894115	22.37574	22.42928*	22.39620
3	-10013.63	1.395966	18026278	22.38309	22.45806	22.41174
4	-10012.86	1.513018	18156962	22.39032	22.48670	22.42715
5	-9991.595	42.01231	17470474	22.35177	22.46958	22.39679
6	-9977.396	27.98609*	17077266*	22.32901*	22.46823	22.38221*
7	-9975.891	2.959464	17172678	22.33458	22.49522	22.39596
8	-9975.404	0.955518	17307917	22.34242	22.52448	22.41198

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix G3: ***Variance Decomposition Result for Model 2***

Variance Decomposition of LOG(ASI):			
Period	S.E.	LOG(ASI)	LOG(EXR)
1	0.031667	100.0000	0.000000
2	0.044546	99.94783	0.052173
3	0.054821	99.78747	0.212532
4	0.063768	99.67706	0.322939
5	0.072637	99.51759	0.482412
6	0.081358	99.21632	0.783675
7	0.089176	99.03893	0.961074
8	0.096355	98.88670	1.113297
9	0.103036	98.75246	1.247537
10	0.109335	98.62064	1.379357

Variance Decomposition of LOG(EXR):			
Period	S.E.	LOG(ASI)	LOG(EXR)
1	0.022463	0.091074	99.90893
2	0.027445	0.300531	99.69947
3	0.032042	0.362297	99.63770
4	0.036244	0.313929	99.68607
5	0.040990	0.250482	99.74952
6	0.045037	0.242654	99.75735
7	0.048709	0.230964	99.76904
8	0.052185	0.216404	99.78360
9	0.055510	0.201737	99.79826
10	0.058640	0.192748	99.80725

Cholesky Ordering: LOG(ASI) LOG(EXR)

Appendix H1: *EGARCH (1,1) Result for ASI with Inflation*

Dependent Variable: DLOG(ASI)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 10/11/17 Time: 03:50
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Failure to improve likelihood (singular hessian) after 43 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001206	0.000886	1.361162	0.1735
DLOG(EXR)	6.34E-05	0.029321	0.002164	0.9983
D(INF)	0.001426	0.000713	2.000337	0.0455
DLOG(ASI(-1))	0.060752	0.038557	1.575614	0.1151
Variance Equation				
C(5)	-1.553785	0.204392	-7.601992	0.0000
C(6)	0.489479	0.048785	10.03332	0.0000
C(7)	0.040015	0.025322	1.580251	0.1140
C(8)	0.830838	0.026226	31.67966	0.0000

R-squared	-0.002660	Mean dependent var	0.001700
Adjusted R-squared	-0.006009	S.D. dependent var	0.031899
S.E. of regression	0.031995	Akaike info criterion	-4.257998
Sum squared resid	0.919256	Schwarz criterion	-4.215385
Log likelihood	1928.357	Hannan-Quinn criter.	-4.241721
Durbin-Watson stat	2.104583		

Appendix H2: *EGARCH (2,2) Result for ASI with Inflation*

Dependent Variable: DLOG(ASI)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 10/11/17 Time: 03:53
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Convergence not achieved after 500 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(8)*RESID(-1)
/@SQRT(GARCH(-1)) + C(9)*LOG(GARCH(-1)) + C(10)*LOG(GARCH(
-2))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001607	0.000884	1.817499	0.0691
DLOG(EXR)	0.004036	0.030367	0.132894	0.8943
D(INF)	0.001480	0.000713	2.075274	0.0380
DLOG(ASI(-1))	0.035840	0.038436	0.932460	0.3511
Variance Equation				
C(5)	-2.838332	0.395784	-7.171410	0.0000
C(6)	0.558588	0.052690	10.60140	0.0000
C(7)	0.395667	0.050673	7.808186	0.0000
C(8)	0.067493	0.020715	3.258135	0.0011
C(9)	-0.078465	0.034582	-2.268940	0.0233
C(10)	0.777085	0.030396	25.56505	0.0000

R-squared	-0.000725	Mean dependent var	0.001700
Adjusted R-squared	-0.004068	S.D. dependent var	0.031899
S.E. of regression	0.031964	Akaike info criterion	-4.272478
Sum squared resid	0.917481	Schwarz criterion	-4.219211
Log likelihood	1936.887	Hannan-Quinn criter.	-4.252132
Durbin-Watson stat	2.053199		

Appendix H3: *EGARCH (3,3) Result for ASI with Inflation*

Dependent Variable: DLOG(ASI)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 10/11/17 Time: 03:54
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Convergence achieved after 81 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(8)*ABS(RESID(-3)
/@SQRT(GARCH(-3))) + C(9)*RESID(-1)/@SQRT(GARCH(-1)) + C(10)
*LOG(GARCH(-1)) + C(11)*LOG(GARCH(-2)) + C(12)*LOG(GARCH(-3))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001331	0.000876	1.518399	0.1289
DLOG(EXR)	-0.001433	0.028095	-0.051007	0.9593
D(INF)	0.001334	0.000717	1.858954	0.0630
DLOG(ASI(-1))	0.066226	0.040907	1.618942	0.1055
Variance Equation				
C(5)	-4.629581	0.670306	-6.906667	0.0000
C(6)	0.537009	0.047795	11.23564	0.0000
C(7)	0.598992	0.074018	8.092510	0.0000
C(8)	0.379064	0.058486	6.481273	0.0000
C(9)	0.091560	0.018051	5.072308	0.0000
C(10)	-0.436597	0.041691	-10.47230	0.0000
C(11)	0.189091	0.032550	5.809246	0.0000
C(12)	0.751212	0.030164	24.90394	0.0000

R-squared	-0.003041	Mean dependent var	0.001700
Adjusted R-squared	-0.006392	S.D. dependent var	0.031899
S.E. of regression	0.032001	Akaike info criterion	-4.270673
Sum squared resid	0.919605	Schwarz criterion	-4.206754
Log likelihood	1938.074	Hannan-Quinn criter.	-4.246258
Durbin-Watson stat	2.116278		

Appendix H4: *EGARCH (1,1) Result for EXR with Inflation*

Dependent Variable: DLOG(EXR)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 10/11/17 Time: 03:24
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Convergence achieved after 62 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001755	0.000645	2.719514	0.0065
DLOG(ASI)	0.002920	0.035043	0.083325	0.9336
D(INF)	0.000355	0.001399	0.254021	0.7995
DLOG(EXR(-1))	-0.257864	0.072065	-3.578206	0.0003
Variance Equation				
C(5)	-3.231251	0.205712	-15.70762	0.0000
C(6)	0.413105	0.041388	9.981327	0.0000
C(7)	0.145887	0.038161	3.822943	0.0001
C(8)	0.605159	0.025606	23.63366	0.0000

R-squared	0.077000	Mean dependent var	0.001247
Adjusted R-squared	0.073917	S.D. dependent var	0.023406
S.E. of regression	0.022525	Akaike info criterion	-4.963772
Sum squared resid	0.455609	Schwarz criterion	-4.921159
Log likelihood	2246.661	Hannan-Quinn criter.	-4.947496
Durbin-Watson stat	2.070913		

Appendix H5: *EGARCH (2,2) Result for EXR with Inflation*

Dependent Variable: DLOG(EXR)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 10/11/17 Time: 03:21
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Failure to improve likelihood (non-zero gradients) after 82 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(8)*RESID(-1)
/@SQRT(GARCH(-1)) + C(9)*LOG(GARCH(-1)) + C(10)*LOG(GARCH(
-2))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.002611	9.97E-05	26.19482	0.0000
DLOG(ASI)	-0.057593	0.001417	-40.64091	0.0000
D(INF)	0.001295	7.37E-05	17.57020	0.0000
DLOG(EXR(-1))	0.006008	0.011403	0.526837	0.5983
Variance Equation				
C(5)	-9.822196	0.070082	-140.1537	0.0000
C(6)	2.078673	0.039956	52.02427	0.0000
C(7)	2.442995	0.028300	86.32587	0.0000
C(8)	0.396071	0.046019	8.606624	0.0000
C(9)	0.001814	0.009706	0.186876	0.8518
C(10)	0.147663	0.006393	23.09665	0.0000

R-squared	-0.013205	Mean dependent var	0.001247
Adjusted R-squared	-0.016590	S.D. dependent var	0.023406
S.E. of regression	0.023600	Akaike info criterion	-5.627415
Sum squared resid	0.500136	Schwarz criterion	-5.574148
Log likelihood	2547.964	Hannan-Quinn criter.	-5.607069
Durbin-Watson stat	2.565730		

Appendix H6: *EGARCH (3,3) Result for EXR with Inflation*

Dependent Variable: DLOG(EXR)
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 10/11/17 Time: 03:23
Sample (adjusted): 1/21/2000 4/28/2017
Included observations: 902 after adjustments
Failure to improve likelihood (non-zero gradients) after 0 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*ABS(RESID(-2)/@SQRT(GARCH(-2))) + C(8)*ABS(RESID(-3)
/@SQRT(GARCH(-3))) + C(9)*RESID(-1)/@SQRT(GARCH(-1)) + C(10)
*LOG(GARCH(-1)) + C(11)*LOG(GARCH(-2)) + C(12)*LOG(GARCH(-3))

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001634	0.001004	1.626519	0.1038
DLOG(ASI)	-0.019152	0.020860	-0.918118	0.3586
D(INF)	3.07E-05	0.001315	0.023324	0.9814
DLOG(EXR(-1))	-0.279924	0.029746	-9.410562	0.0000
Variance Equation				
C(5)	-7.592530	6.924914	-1.096408	0.2729
C(6)	0.010000	0.004129	2.421922	0.0154
C(7)	0.010000	0.021578	0.463440	0.6430
C(8)	0.010000	0.041441	0.241309	0.8093
C(9)	0.010000	0.010284	0.972431	0.3308
C(10)	0.010000	0.841039	0.011890	0.9905
C(11)	0.010000	1.123592	0.008900	0.9929
C(12)	0.010000	1.069561	0.009350	0.9925

R-squared	0.078655	Mean dependent var	0.001247
Adjusted R-squared	0.075577	S.D. dependent var	0.023406
S.E. of regression	0.022504	Akaike info criterion	-4.719174
Sum squared resid	0.454792	Schwarz criterion	-4.655254
Log likelihood	2140.347	Hannan-Quinn criter.	-4.694758
Durbin-Watson stat	2.033042		