Portfolio Diversification between Developed and less Developed Economies: The Case of US and UK Investors in Nigeria

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Abstract

This study examines the hedging effectiveness of portfolio investment diversification between developed and developing economies; with focus on the Nigerian stock asset vis-à-vis the stock assets of the United States (US) and United Kingdom (UK). Its main contribution is in the analysis of optimal portfolio diversification using optimal portfolio weight (OPW) and optimal hedging ratio (OHR). Empirical findings show that the OPW and OHR are low, which indicates impressive potential gains from combining Nigerian stock assets in an investment portfolio with US and UK stock assets. In addition, exchange rate volatility is found to pose stern limitation on the potential benefits of this portfolio diversification arrangement. It is therefore recommended that the monetary authority in Nigeria should pursue policies towards reducing exchange rate volatility to the barest minimum. This will possibly attract more investors from developed economies who might be willing to combine Nigerian stock in their investment portfolio to minimize portfolio risk.

Keywords: Portfolio diversification; Nigeria vis-à-vis US-UK; Structural break; VAR-BEKK-GARCH model; Optimal Hedging strategies

JEL Classification: C4, C52, F21,

1.0 Introduction

Portfolio investment refers to economic transactions in highly liquid financial assets, such as stocks and bonds. It is an investment in the equity of a company made by individuals who have no stake in the running and administration of the company. This type of investment is usually compared with direct investment, which requires the actual mobilization of productive resources by the prospective foreign investors. Meanwhile, as large capital outlay requirement, long gestation period and most importantly the risk averse nature of most investors have been the major deterrents to direct investment, portfolio investment has gained much prominence especially among middle income risk averse investors.

Foreign diversification has long been accepted as a means of improving portfolio efficiency through risk reduction (Ziobriowski and Ziobriowski, 1995). International portfolio diversification occurs when an investor procures financial assets in a foreign country. This activity has been facilitated by the accelerated development in the global financial market occasioned by progressive dismantling of capital and exchange controls among the major industrial countries, a broader-based liberalization, and reform of domestic financial sectors (see Mussa and Goldstein, 1993, Salisu and Oloko, 2015a). By permitting trade in financial assets to take place without regard to either national boundaries or the nationalities of market participants, there is a strong presumption that the efficiency, liquidity, risk-pooling, and disciplinary attributes of capital markets will be enhanced (Mussa and Goldstein, 1993).

Meanwhile, empirical studies have suggested that limited gain is obtainable from portfolio diversification between or among highly correlated assets, such as portfolio of assets of developed vs. developed economies (see Ziobriowski and Ziobriowski, 1995), hence, international diversification is less attractive in highly correlated financial markets (see Miralles-Marcelo et al. 2015). Again, the rational portfolio theory predicts that investors hedge their exposure to domestic risk by holding foreign equities that have low correlation with their own stocks (see Coeurdacier and Guibaud, 2011). Thus, this study attempts to examine the hedging effectiveness of portfolio investment diversification between developed and developing economies; with focus on the Nigerian stock asset vis-à-vis the stock assets of the United States (US) and United Kingdom (UK). The study hypothesized that a US and UK investor with portfolio diversification in Nigeria stock asset would suffer lesser risk in the face of financial crisis emanating from developed economies compared to a US and UK investor with his/her whole investment in the US and UK stock assets respectively. It further uses a structural break detector model by Perron (2006) to identify the financial crisis period endogenously; which naturally coincides with the period of the global economic and financial slowdown of 2007. Existence of significant structural break in investment returns implies that there is a structural change in the dynamics of such an investment return; this may be a drastic positive or negative change (regime shift) or a gradual positive or negative change (trend shift). Failure to modify an empirical model to accommodate structural change effect when in fact it exists and is significant, may cause biasness in the empirical results (see Salisu and Oloko, 2015b).

While most studies and even most recent Miralles-Marcelo et al. 2015 failed to account for structural changes in the application of VAR-GARCH models to the study of portfolio diversification between countries, this study examines this effect by modifying VAR-BEKK-GARCH model by Engle and Kroner (1995). Thus, it compares the results of VAR-BEKK-GARCH

with structural break with that of VAR-BEKK-GARCH without structural break and uses conventional model selection criteria to select the best fit model. Furthermore, this study determines the optimal portfolio management strategies for US stock –Nigeria stock portfolio and in UK stock – Nigerian stock portfolio in the face of financial risk in developed stock markets (i.e. US stock and UK stock) using optimal weight and optimal *hedging ratios. Previous studies on the determination of optimal portfolio diversification have focused on the effect of exchange rate risk on the optimal portfolio decision (see for example, Ziobrowski and Ziobrowski, 1995; Jiang et al. 2013; Caporale et al. 2015). This study distinguishes itself by determining optimal portfolio management in the face of financial risk from developed stock market. The use of optimal weight and optimal hedging ratios in the analysis of optimal portfolio management has been widely employed in the study of the effect of oil price shock on two-asset (oil included) investment portfolio (see Arouri et al. 2011; Salisu and Mobolaji, 2013; Kumar, D., 2014; Salisu and Oloko, 2015b), and its application to international portfolio diversification is unique to this study. Empirical results from this study find support for modeling with structural break and low optimal weight and hedging ratios, which indicates the effectiveness of Nigeria stock – developed economies' stock portfolio in the face of financial risk from developed stock market. Higher exchange rate volatility was also found as a limiting factor to the potential gains from portfolio diversification between Nigeria and US, UK assets.

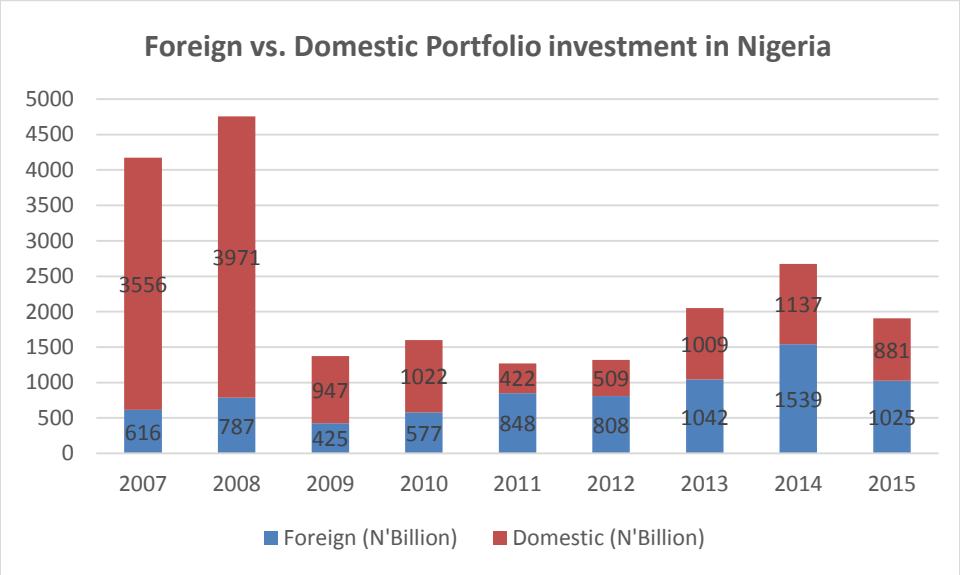
The remainder of the paper is organized as follows. Section 2 provides the background review of Portfolio investment in Nigeria. Section 3 describes data properties and provides preliminary analyses. Estimable econometric model is discussed in Section 4, while result presentation and analysis are described in section 5. Section 6 discusses the optimal portfolio management between Nigeria – US stock portfolio and Nigeria – UK stock portfolio while section 7 concludes the paper.

2.0 Background review of Portfolio Investment in Nigeria

Nigeria is one of the leading recipients of portfolio investment in Africa. Available records from the Nigerian Stock Exchange (NSE) portfolio investment report as displayed in figure 1 below reveals that the share of foreign investment portfolio in the Nigerian stock market has been on an increasing trend since 2011, and only fell relatively in 2015 due to high level of speculations in the market occasioned by political and economic challenges that bedeviled the economy in 2015[1].

[1] The foreigner's share in the portfolio investment declined during 2015 due to the fear of the re-occurrence of post-election violence experience of post 2011 election and higher systematic exchange rate risk occasioned by falling oil price.

Figure 1: Comparison between Foreign and Domestic Investors' share of Portfolio Investment in Nigeria (2007-2015)



Source: NSE (December, 2015)

Similarly, in the recent report of the African Securities Exchanges Association (ASEA, 2014), Nigeria recorded the second largest Initial Public Offer (IPO) of 23 between 2010 and 2014, after South Africa which recorded 31 IPOs. The third on that ranking was Morocco which recorded 8 IPOs. Also, in terms of money raised in 2014, Nigeria was also second with the sum of $538 Million after South Africa which raised $742 Million, indicating the strength and high level of patronage of the Nigerian Stock Exchange relative to other stock exchanges in Africa. Meanwhile, the 2013 ASEA Fact Book shows that Nigeria has higher foreign investors' participation in her stock market than her South Africa competitor; where it recorded 56/44 ratio for foreign and domestic participation and the Johannesburg Stock Exchange (JSE) recorded 15.35/84.65. Since theoretical literature (see Branson, 1983) and empirical literature (see Bohn and Tesar, 1996) agreed that higher foreign investment tends to flow to countries with higher stock returns, higher foreign participation in Nigeria stock exchange relative to South Africa stock exchange may imply that portfolio diversification with Nigerian stock is more lucrative to foreign investors than portfolio diversification with South African stock.

3.0 Data and Preliminary analysis

This study employed monthly data for stock prices and Naira exchange rate for the period of April 2004 to June 2015. The active variables are the stock prices, which consist of the U.S stock represented by the Standard and Poor Index (S&P 500), the UK stock proxied by the FTSE All Share Index (FTSE-ASI) and the Nigerian stock represented by the Nigerian All Share Index (NSE-ASI) while Naira exchange rate relative to US Dollar ($) and Great Britain Pounds (£) are only used to convert the Naira denominated Nigerian stock to US and UK denominated equivalent prices respectively. The data for Nigerian stock and Nigeria exchange rates were obtained from

the Central Bank of Nigeria (CBN) database while the data for U.S. stock were sourced from Federal Reserve and the data for U.K. stock is from U.K. Yahoo Finance.

The stock prices are converted into continuous compounded monthly stock returns by taking the percentage change in their logarithmic difference, that is; $r_t = 100 * [\Delta \log(P_t)]$. The same formula is also used to compute the rate of appreciation and depreciation in Naira FX rate relative to USD ($) and GBP (£) which are used to convert Naira denominated Nigerian stock prices into U.S. and U.K. denominated stock prices respectively. This action is necessary to account for exchange rate risk attributable to investments in foreign currency denominated assets (see Jiang et al. 2013; Caporale et al. 2015). The dollar denominated rate of return on a foreign asset *i* based in country *j* ($R_{ij\$}$) can be expressed as in equation (1) below[2]:

$$R_{ij\$} = (1 + R_{ij})(1 + X_{j\$}) - 1 \quad (1)$$

where

R_{ij} = rate of return on asset i in the local currency of country j

$X_{j\$}$ = rate of appreciation (or depreciation) of the local currency against the US dollar

Meanwhile, since the cross product of R_{ij} and $X_{j\$}$ are usually very small, equation (1) could be approximated as:

$$R_{ij\$} = R_{ij} + X_{j\$} \quad (2)$$

Thus, equation (2) is used to express Nigeria stock in foreign terms of foreign stock (US and UK) to facilitate easy comparison. Whereas, exchange rate in this case is defined in terms of foreign currency per unit of domestic currency, such that positive movement will imply Naira appreciation and negative movement will signify depreciation.

Preliminary analysis in this study begins with the examination of the market correlation and asset return/risk ratio respectively between the stock prices and stock returns of developed (in this case, US and UK) and developing (Nigeria) economies. We employ simple pairwise correlation analysis between Nigeria and US stock on one hand, and between Nigeria and UK stock on the other hand. Similarly, we compute return/risk ratio as the mean average of a particular return over the period under consideration divided by its corresponding standard deviation.

Table 1: Market correlation and asset return/risk ratio

Statistics	US Stock		UK Stock		Nigeria Stock	
	P_t	r_t	P_t	r_t	P_t	r_t
Mean	1367.983	0.439	2944.618	0.358	31424.560	0.283
Median	1307.075	1.100	2978.650	0.975	26442.060	0.023
Maximum	2107.390	10.231	3797.120	9.094	65652.380	32.352

[2] see also, Ziobriowski and Ziobriowski (1995)

Minimum	735.090	-18.564	1929.750	-14.412	19851.890	-36.588
Std. Dev.	310.209	4.117	460.289	3.902	10820.180	7.716
Return/Risk Ratio & Unconditional Correlation						
US Stock	[1.0000]	0.107	[0.9102]	-	[0.4304]	(0.002)
UK Stock	[0.9102]	-	[1.0000]	0.092	[0.4845]	(0.016)
Nigeria Stock	[0.4304]	-	[0.4845]	-	[1.0000]	0.037
Obs.	137	136	137	136	137	136

Source: Computed by the author

Note: Return risk ratio is computed for stock returns and while unconditional correlation is computed for pair of stock prices and presented in square bracket [.]. Also, values in round bracket (.) represents the return risk ratio of Nigeria stock after accounting for exchange rate risk, that is, when Nigeria stock is denominated in foreign currency.

Table 1 above reveals that the return risk-ratio of the US stock is 10.7 percent, for UK stock is 9.2 percent while for Nigeria stock is 3.7 percent. This suggests that risk adjusted stock returns in US and UK is greater than that of Nigeria. The result is worse for Nigerian stock if cross border investment is considered. Suppose we incorporate exchange rate risk by expressing Nigerian stock in USD ($) and GBP (£), as presented in parenthesis, the risk adjusted return for Nigeria stock denominated in USD ($) is 0.2 percent while the Nigeria stock denominated in GBP (£) is 1.6 percent. This suggests that the Naira exchange rate volatility could possibly reap off larger percentage of foreign investment returns in Nigeria, but does this mean it is worthless for US and UK investors to invest in Nigerian stock? Certainly not, because exchange rate volatility does not ordinarily translate to volatility in portfolio investment – which is largely influenced by shocks to financial market.

The result of unconditional correlation in Table 1 above reveals high correlation between stocks of developed economies (0.91 for US-UK stocks) and low correlation between developed and developing economies (0.43 for Nigeria-US stocks and 0.48 for Nigeria-UK stocks). This suggest a strong association between stock assets of developed economies and weak association between stock assets of developed vs. developing economies, hence, a financial shock that originates from financial markets of developed economies may not have spontaneous effect on the financial markets of developing economies. Meanwhile, as major financial crisis usually originates from financial markets in developed economies, it may be logical to say that the US and UK investors are mostly prone to major loss in portfolio investment and may require a less correlated stock such as Nigerian stock to effectively hedge against possible investment risk.

Assuming the possibility that investors in developed economies invest in less developed economies to minimize investment risk, the trend review was carried out to analyze the net average returns gains or losses accrued to a US and a UK investor during the Global Financial Crisis, by considering the condition of two basic types of investors in developed economies. The first investor diversifies by having equal units of investment in domestic and Nigerian stocks while the second investor does not diversify with Nigerian stock but have double the units of the investment of the first investor in domestic stocks.

Figures 2a and 2b below show the relationship between Nigerian and US stocks, and between the Nigerian and UK stocks, respectively. The shaded portion indicates the period of the global

financial crisis, with the light-shaded portion showing the initial stage (October, 2007 to January, 2008) of the crisis and the fairly deep shaded portion (February, 2008 to February, 2009) indicating the advanced stage of the financial crisis. Obviously, the graphical presentation reveals that Nigerian stock is not affected in the initial stage of the financial crisis.

Figure 2a: Relationship between US stock and Nigerian stock expressed in USD($)

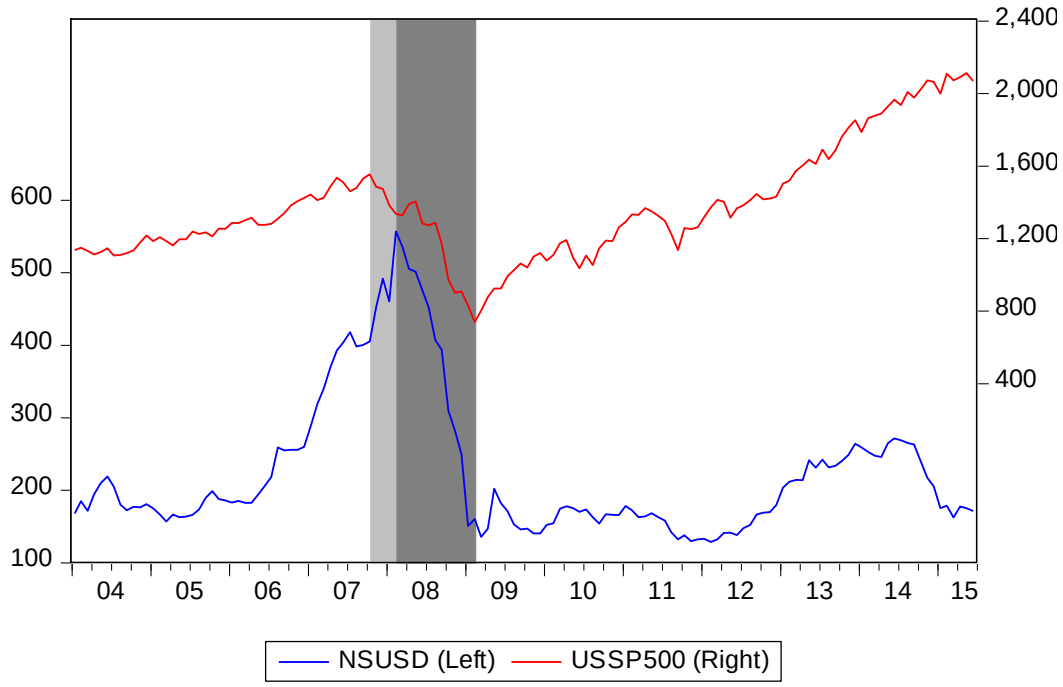
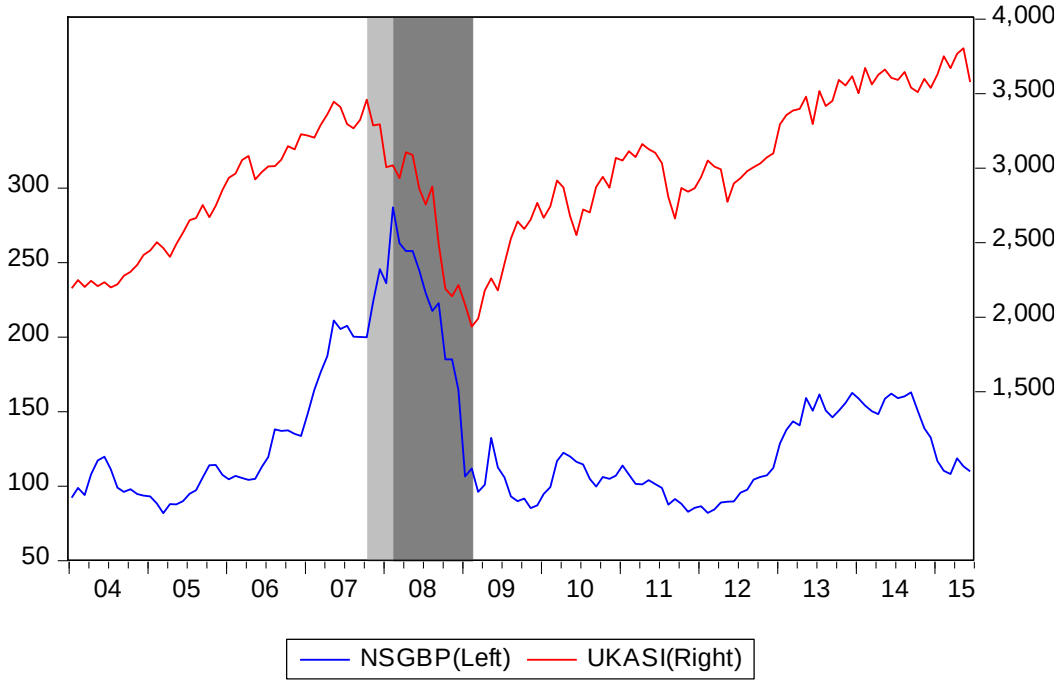


Figure 2b: Relationship between UK stock and Nigerian stock expressed in GBP(£)



The summary of the net average return gains or losses over the whole period for US investor (with and without portfolio in Nigeria) and UK investor (with and without portfolio in Nigeria) is presented in Tables 2a and 2b below respectively. The average values are calculated as simple average of the continuous compounded monthly returns over the initial and advanced period of the financial crisis. From table 2a, it is observed that a US investor with investment portfolio in Nigeria loses more (15.030%) than a US investor with portfolio diversification in Nigeria, who loses 12.038% during the same period. Similarly, it is observed from table 2b that a UK investor without portfolio diversification in Nigeria also loses 11.808% while a UK investor with portfolio diversification in Nigeria gains 4.024% due to the positive returns derived from exchange rate volatility[3]. Hence, it may be summarized that a US and UK investor could reduce their net investment loss by having investment portfolio in Nigeria. In other words, Nigerian stock may appear as one of the suitable financial markets for effective hedging of the US and UK investment risk. However, evidence based analysis may be required to empirically validate this assertion.

Table 2a: Average analysis of the net gains/loss for US investor during the global financial crisis

	(1)	(2)	(3)	(4)=(2)+(3)	(5)=(1)+(4)	(6)=(1)*2
Crisis Period	Average Return (Gain/Loss) in US Stock (%)	Average Return (Gain/Loss) in Nigeria Stock	Average FX return ($/N)	Average Return (Gain/Loss) in Nigeria Stock converted to USD (%)	Average Gain/Loss to US investor with portfolio in Nigeria (%)	Average Gain/Loss to US investor without portfolio in Nigeria (%)
Oct 2007 – Jan 2008	-2.553	1.898	1.621	3.519	0.966	-5.356
Feb 2008 – Feb 2009	-4.837	-6.467	-1.699	-8.167	-13.004	-9.674
Net Gain/Loss for US investors with and without portfolio investment in Nigeria					**-12.038**	**-15.030**

Source: Computed by the author

Table 2b: Average analysis of the net gains/loss for UK investor during the global financial crisis

	(1)	(2)	(3)	(4)=(2)+(3)	(5)=(1)+(4)	(6)=(1)*2
Crisis Period	Average Return (Gain/Loss)	Average Return (Gain/Loss)	Average FX return (£/N)	Average Return (Gain/Loss) in Nigeria	Average Gain/Loss to UK investor	Average Gain/Loss to UK investor without

[3] This could be used to explain the finding of Caporale et al. 2015 that exchange rate uncertainty have positive effect on equity flow of some countries. Verily, more investment inflow will accumulate if foreign investors perceive marginal gains in exchange rate volatility of the domestic market.

	in UK Stock (%)	in Nigeria Stock		Stock converted to GBP (%)	with portfolio in Nigeria (%)	portfolio in Nigeria (%)
Oct 2007 – Jan 2008	-2.510	1.898	2.259	4.157	1.647	-5.020
Feb 2008 – Feb 2009	-3.394	-6.467	0.697	5.770	2.377	-6.788
Net Gain/Loss for UK investors with and without portfolio investment in Nigeria					**4.024**	**-11.808**

Source: Computed by the author

Meanwhile, in order to select a suitable estimation technique, careful examination of the statistical properties of the usable data for analysis is necessary. For studies using low frequency data such as annual equity returns (for example, Ziobriowski and Ziobriowski, 1995), the focus would be on the long run relationship between different set of investment portfolio, hence, test for stationarity would be required. However, for high frequency data such as monthly or daily returns, the focus is on short-run dynamics and as such, tests for stationarity may not be required. More importantly, since the process generating the continuous compounded monthly/daily returns is a transformed and differenced process; stationary may be assumed *ab initio*.

Usually, for low frequency financial returns, the stylized facts from both theoretical and empirical studies observed that the series usually exhibit fat tailness, non-normality, autocorrelation and conditional heteroscedasticity. According to Engle (1982), conditional volatility in a series could be observed graphically when volatility clustering noticed, such that, a period of high volatility is followed by a period of high volatility and a period of low volatility is followed by a period of low volatility. Engle further developed Autoregressive Conditional Heteroscedasticity (ARCH) test as a formal test for testing the significance of ARCH effect in the series.

Figure 3: Graphical presentation of stocks and exchange rate prices and their respective returns series

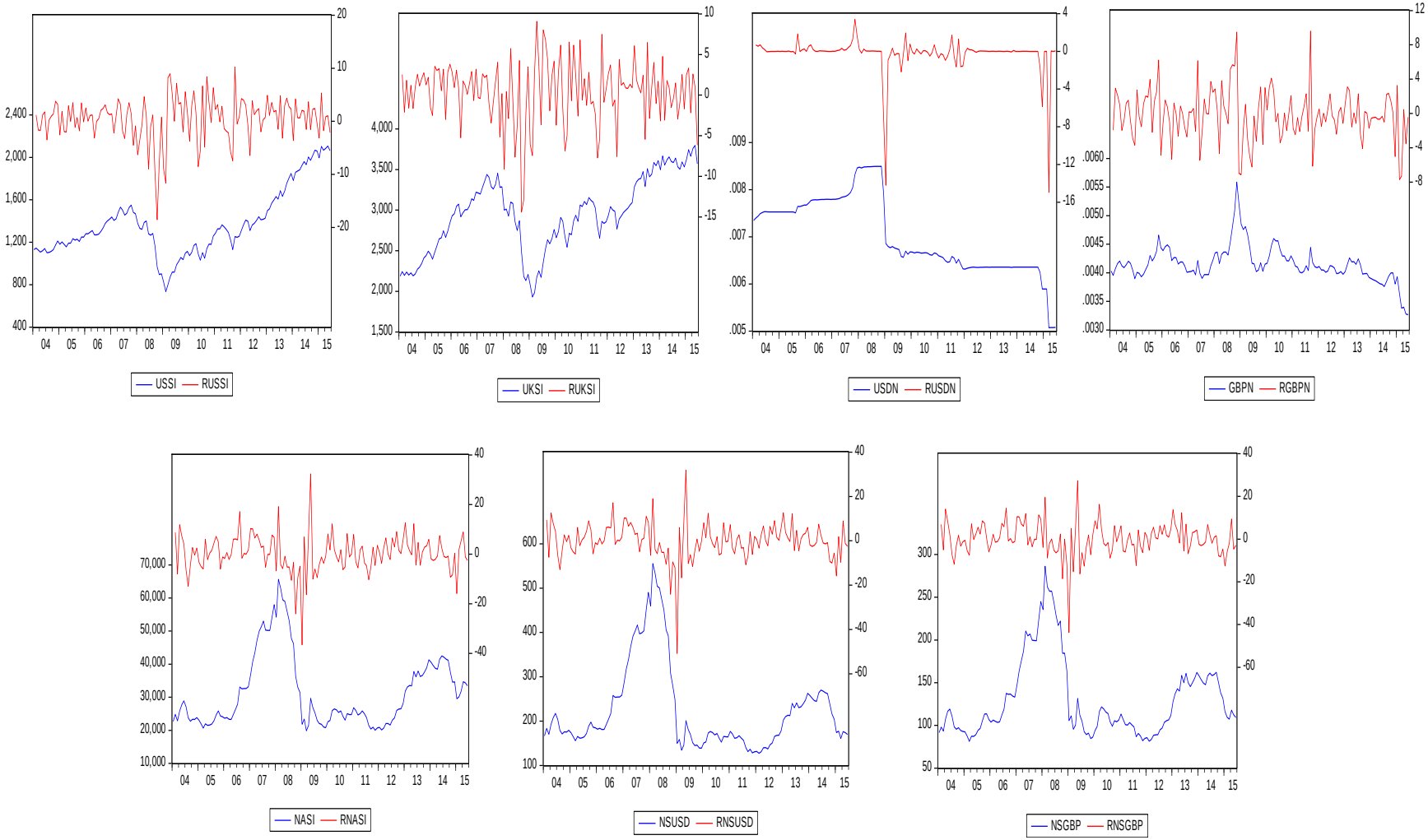


Figure 3 shows the graphical presentation of the trend of all series (including the level, computed level, and return series) over the period under consideration. Both level series (Nigeria stock, US stock, UK stock, USD/Naira FX rate and GBP/Naira FX rate) and computed level series (Nigeria Stock in USD($) and Nigeria stock in GBP(£)) are in blue ink on the left axis, while the transformed series (returns) corresponds to every level and computed level series are in red ink on the right axis. As noticed from the graph, all the return series display evidence of volatility clustering, suggesting that a formal conditional volatility test such as ARCH test can be used to confirm this and also examine its statistical significance. Also from the graph, an all pervasive high volatility clustering is noticed between 2007 and 2008, and for the stock and FX returns. This period corresponds to the period of global financial crisis and suggesting that the test for structural break should be carried out and should be duly accounted for in the empirical analysis if found significant.

Table 3 below shows the descriptive and statistical properties of the Nigerian stock prices and returns and its denomination in USD and GBP to represent net returns to US and UK investors Nigeria respectively. This is calculated using equation (2) to incorporate element of exchange rate volatility usually faced by investors in foreign countries (see Ziobriowski and Ziobriowski, 1995). From the table, it is noticed that the average returns to an indigenous investors during the period under consideration is 0.283 percent while the net average return to US and UK investors in Nigeria is 0.013 and 0.129 percent respectively. Perhaps this outcome may be due to high exchange rate volatility during this period. Particularly, lower average return accruable to US investor relative a UK investor, may partially be explained by the results of ARCH test which revealed that USD denominated Nigerian stock return is more volatile than its GBP denominated counterpart. Evidence of higher volatility in USD denominated Nigerian stock above its GBP denominated counterpart could also be observed from the range (wider gap between the maximum and minimum values) and the standard deviation statistic.

Table 3: Descriptive Statistics and Statistical Properties

Statistics	Nigeria stock (N)		Nigeria stock ($)		Nigeria stock (£)		US stock		UK stock	
	P_t	r_t	P_t	r_t	P_t	r_t	P_t	r_t	P_t	r_t
Mean	31424.560	0.283	224.193	0.013	130.349	0.129	1367.983	0.439	2944.618	0.358
Median	26442.060	0.023	181.351	0.129	112.115	-0.032	1307.075	1.100	2978.650	0.975
Maximum	65652.380	32.352	555.388	31.934	286.367	27.279	2107.390	10.231	3797.120	9.094
Minimum	19851.890	-36.588	127.470	-50.793	81.299	-43.719	735.090	-18.564	1929.750	-14.412
Std. Dev.	10820.180	7.716	97.517	8.494	45.704	7.983	310.209	4.117	460.289	3.902
Skewness	1.197	-0.407	1.653	-1.266	1.368	-0.881	0.769	-1.083	-0.188	-0.829
Kurtosis	3.621	8.165	4.959	12.490	4.219	9.355	3.110	6.089	2.180	4.520
Jarque-Bera	35.197***	156.080***	84.909***	550.658***	51.570***	248.250***	13.683***	81.268***	4.687*	28.873***
ARCH (3)	3.013**	4.296***	5.523***	2.807**	2.720**	1.881	4.987***	6.387***	4.041***	6.322***
ARCH (5)	1.908*	5.720***	3.320***	3.452***	1.690	2.689**	5.648***	7.035***	2.606**	3.960***
LB-Q(2)	10.164***	2.129	18.442***	4.283**	7.669***	1.788	1.272	0.930	0.018	0.564
LB-Q(5)	23.047***	13.903***	37.994***	19.593***	19.680***	15.349***	1.293	8.994*	4.609	8.890*
LB-Q^2(2)	2.641	4.883**	3.880**	3.250*	1.554	2.881*	10.565***	14.162***	9.062***	14.046***
LB-Q^2(5)	10.511**	31.824***	18.172***	22.041***	10.442**	18.556***	28.227***	45.120***	15.141***	24.630***
Obs.	137	136	137	136	137	136	137	136	137	136

Source: Computed by the author

Note: ***, ** and * indicate rejection of null hypothesis at 1%, 5% and 10% level of significance respectively. ARCH is Engle's (1982) Conditional heteroscedasticity test with the null hypothesis of "No ARCH effect" while LB-Q and LB-Q^2 is the Ljung-Box Q-statistic test for the level and higher order autocorrelation respectively with the null hypothesis of "No Autocorrelation".

In addition, evidence of fat tailedness appears to manifest in the three financial markets as they all possess kurtosis statistics above the threshold for a normally distributed series (i.e. 3); this indicates the preponderance of positive outliers in these financial markets. Specifically for the financial returns of the three markets, the fat tailedness, coupled with negative skewness properties explains their inherent non-normality.

Also, as part of the preliminary analysis, we carry out the test for structural break using Perron (2006) unit root test with structural break. We observe structural shift in both level and trend return series following the generalized test regression below (see also, Salisu and Oloko, 2015):

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t^* + \delta D(T_1)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \; ; \; e_t \square \; i.i.d. \; (0, \sigma_e^2) \qquad (5)$$

where $DU_t = 1$; $DT_t^* = t - T_1$ if $t > T_1$ and 0 otherwise; $D(T_1)_t = 1$ if $t = T_1 + 1$ and 0 otherwise. Perron test has the statistical power to determine the period of structural change in any series endogenously. The test considered is the minimal value of the t-statistic for testing that $\alpha = 1$ versus the alternative hypothesis that $|\alpha| < 1$ over all possible break dates in some pre-specified range for the break fraction $[\grave{o}, 1-\grave{o}]$. The implementation of the test regression follows the Innovational Outlier (IO) framework as it allows the change to the new trend function to be gradual rather than being instantaneous as assumed by the Additive Outlier (AO) framework. The results are presented in table 4 below:

Table 4: Results of Unit Root test with Structural break

Investment Returns	T-stat	Break Date	Structural Dummies
US stock	-11.220	2009:01	D1
Nigeria stock ($)	-12.077	2008:12	D2
UK stock	-12.058	2008:09	D3
Nigeria stock (£)	-12.128	2008:12	D4

Source: Computed by the author

Note: D1, …, D4 represent the dummies for the structural break in each series; it takes the value of zeros before and up till the break date and the value of 1s thereafter. Also, the critical value for the test statistic is -5.28 and -4.62 for 1% and 5% levels of significant respectively.

As observed from the result of Perron test in Table 4 above, all the identified period of structural change falls within the observed period of Global Financial Crisis, thus confirming the output of Perron test. Also, with the T-statistics for the identified break points being greater than the critical values for 1 percent and 5 percent levels of significant, it would be erroneous not to account for structural break when carrying out analysis with these series. Therefore, we formulate structural dummies for each structural break, which assumes the value of (0s) before and up till the break point and (1s) afterwards.

4.0 The Econometric Model

In order to analyze the effect of financial risk originating from developed economies on the portfolio management of Nigeria – US stock and Nigeria – UK stock portfolio, we employ GARCH variant model. Bollerslev et al. (1988) was the first to apply GARCH model in the study of portfolio diversification, and they applied Multivariate VECH-GARCH (MGARCH) model to study investment diversification in three US assets. Since the work of Bollerslev et al. (1988) several other versions of MGARCH models have been developed and applied in later studies[4].

In this study, we propose a bivariate VAR - GARCH model with BEKK representation by Engle and Kroner (1995), and modify the return equation of this model to capture the significance of structural break in the returns of the concerned stock assets. But for robustness check, the results of the VAR- BEKK-GARCH model with structural break and without structural break are presented. The best fit model is selected using Akaike Information Criterion (AIC), Hannan-Quinn (HQ) and Swartz Bayesian Criterion (SBC). The three information criteria select the model with minimum likelihood ratio (LR) as the best fit model; while they all penalize for model size and power properties, SBC specifically penalizes for model complexity.

Meanwhile, while GARCH variant models have been used to examine portfolio effectiveness between two financial markets (see for example, Arouri et al. 2011; Salisu and Mobolaji, 2013; Salisu and Oloko, 2015b), it has not been used for testing the effectiveness of portfolio diversification between two countries. On the other hand, although Caporale et al. 2015 employ Engle and Kroner (1995) model, they do not account for the significance of structural break in investment return. This study therefore introduces the use of GARCH based portfolio management strategies into international portfolio diversification literature following VAR-BEKK-GARCH model of Engle and Kroner (1995), and also modify the return equation of the model, following Salisu and Oloko (2015b) to account for structural break in international assets returns.

5.0 Empirical Results

The empirical result is presented in the Table 5 below. It consists of the results of VAR-BEKK-GARCH for model (1) and model (2), indicating model structured without and with structural break, respectively. In explaining the parameters of the model, foreign asset returns (RUSSI and RUKSI) entered the model first, thus takes (1), while the domestic asset returns denominated in foreign currencies (RNSUSD and RNSGBP) entered the model second, thus takes (2). The VAR-BEKK-GARCH model as discussed earlier is partitioned into conditional mean and conditional variance equations. The conditional mean equation explains the dynamics of the financial environment facing a US and UK investor in Nigeria by estimating the influence lagged returns of domestic (Nigeria) and foreign (US and UK) assets on the present value of the Nigeria and foreign assets returns. The influence of lagged value of an asset on its current value (indicated by; ψ_{11}, ψ_{22}) represents the influence of domestic (foreign) economy in determining the domestic (foreign) asset returns, while the influence of lagged value of an asset on the current value of

[4] Recently, Caporale et al. (2015) applied VAR BEKK-GARCH-in-mean and Miralles-Marcelo et al. (2015) also applied VAR DCC-GARCH

another asset (indicated by; ψ_{12}, ψ_{21}) indicates the return spillovers from domestic (foreign) economy to foreign (domestic) economy. The conditional variance equation on the other hand, explains the nature of volatility persistence and the volatility spillovers between the domestic and foreign assets market. The nature of volatility persistence; short term and long term, is explained by own shock (indicated by; a_{11}, a_{22}) and lagged conditional volatility (indicated by; b_{11}, b_{22}) respectively; while volatility spillovers are explained by cross-market shocks (indicated by; a_{12}, a_{21}) and cross market lagged conditional volatility (indicated by; b_{12}, b_{21}).

Table 5: Estimation Result

Parameters	**US INVESTOR (RUSSI=1, RNSUSD=2)**		**UK INVESTOR (RUKSI=1, RNSGBP=2)**	
	BEKK – GARCH (1)	**BEKK – GARCH (2)**	**BEKK – GARCH (1)**	**BEKK – GARCH (2)**
Mean Equation				
ϕ_{10}	1.028***	0.245	0.606**	0.808**
ψ_{11}	-0.138	-0.031	-0.098	-0.062
ψ_{12}	-0.025	-0.014	-0.062	-0.069*
φ_{11}	-	10.188**	-	-12.492***
φ_{12}	-	-9.340**	-	12.414***
ϕ_{20}	0.619	0.954	0.125	0.861
ψ_{21}	0.031	0.236	0.098	0.177
ψ_{22}	0.195**	0.136*	0.215***	0.185**
φ_{21}	-	49.298***	-	-5.579
φ_{22}	-	-50.297***	-	4.930
Variance Equation				
c_{11}	1.507***	-1.288**	1.424***	-0.625
c_{21}	2.461***	-4.490**	0.233	-3.250***
c_{22}	-1.36e-05	2.270	2.079e-05	5.89e-05
a_{11}	0.627***	0.583***	0.501***	-0.004
a_{12}	0.661***	0.716***	-0.238	1.048***
a_{21}	0.005	-0.046	-0.092*	-0.026
a_{22}	-0.210***	0.195	0.038	0.151**
b_{11}	0.694***	0.788	0.742***	0.342**
b_{12}	0.401**	-0.556**	1.215***	-1.061***
b_{21}	-0.220***	-0.032	-0.252***	0.457***

b_{22}	0.767***	0.370	0.623***	0.461***
Model Selection Criteria				
AIC	12.191	12.153	12.248	12.184
SBC	12.556	12.603	12.613	12.634
HQ	12.339	12.336	12.396	12.367
FPE	12.193	12.156	12.250	12.187
Log-L	-812.020	-805.426	-815.897	-807.545

Source: Computed by the Author

Note: Parameters in mean and variance equations are as defined in the model. RUSSI represents US Stock Index Return; RNSUSD represents Nigeria Stock Returns in USD; RUKSI represents UK Stock Index Returns; and RNSGBP represents Nigeria Stock Returns in GBP. Also, ****, ** and * represent level of significance at 1%, 5% and 10% respectively.

From the results presented in the above table, it could be noticed that failure to account for structural break would have led to inefficient estimates as the coefficients of structural dummies in the model are significant. The non-significant of the structural dummies in the equation for return spillover from UK to Nigeria indicates that asset returns of UK investors in Nigeria do not change swiftly in response to financial crisis.

The conditional mean equation analyses the returns spillover between each pair of the markets. The results of the return equations summarizes that insignificant return spillover exist between the selected developed and developing economies, given the weakly or grossly insignificant coefficients of ψ_{12} and ψ_{21}, indicating the low level of association between the pairs of markets. Meanwhile, although the return spillovers are insignificant, there are lessons to be learnt from the signs of the returns spillover relationship. Firstly, it is observed that the return spillover from Nigeria stock to US and UK stock is negative. This indicates that higher return in Nigeria stock precedes lower return in the US and UK stock. In other words, Nigeria stock return is high as at the time when US and UK stock returns are falling. This fact really buttressed our argument in the preliminary analysis as reflected on the graphs; explaining that US and UK investors in Nigeria may benefit from the transmission lag of the financial crisis from developed economies to reach the developing economies. Secondly, positive return spillovers are observed from US and UK stocks to the Nigerian stock. This implies that lower (higher) return in US and UK stocks induced lower (higher) stock return in the Nigerian stock. This suggests that there is potential effect for the financial risk or financial bubble to transmit from US and UK stock markets to Nigerian stock market.

Furthermore, the own spillover, which explains the effect of domestic economy on assets return is negative for developed economies and positive for Nigeria. This implies that in the developed economies, higher (lower) returns in the immediate past period is followed by lower (higher) return in the current period, indicating the effectiveness of financial market policies to stimulate the market when need arises. Whereas, the positive own return spillover for Nigeria suggests that higher (lower) returns in the immediate past period is followed by higher (lower) return in the current period, indicating the financial market policies of Nigeria are less effective in stimulating the financial market. This result may explain why the stock market of developed

economies have overcome the menace of the financial crisis to maintain stock prices and returns above the pre-global financial crisis values and why the stock market of Nigeria has not (see figures 1 and 2).

Meanwhile, it could be noted that the results analysed for the return equation of consistent across equations and across models, but there is no such consistency for the variance equation. This may be due to use of monthly stock returns which exhibits lower variance compared to daily returns. The author would therefore recommend that subsequent studies in this area employs daily data. However, the model selection tests using three model selection criteria and model Log-Likelihood. From the three model selection criteria, two (i.e. AIC and HQ) have their values for model(2) lower than that of model(1), while only SBC differs in its judgement, having its value for model(1) lower than that of model (2). The difference may be due to the stiffness of SBC in penalizing model complexities; that may have caused it to perceive additional variables (structural dummies) as unnecessary burden on the model. However, this may not be correct since these additional variables are significant. The judgement of the model Log-Likelihood supports that of AIC and HQ. Similarly, we could observe from the results of the post-estimation residual diagnostic tests in Table 6 below that model (2) captures autocorrelation (measured with Ljung-Box statistics) and ARCH effects (measured with McLeod-Li test) better than model (1). Hence, we may conclude that the VAR-BEKK-GARCH with structural break outperforms VAR-BEKK-GARCH without structural break.

Table 6: Post Estimation Residual Diagnostics Test

Statistics	US INVESTOR				UK INVESTOR			
	BEKK-GARCH(1)		BEKK-GARCH(2)		BEKK-GARCH(1)		BEKK-GARCH(2)	
	RUSSI	RNSUSD	RUSSI	RNSUSD	RUKSI	RNSGBP	RUKSI	RNSGBP
Ljung-Box (10)	8.036	16.831*	5.312	10.091	4.492	13.639	5.254	9.442
Ljung-Box (20)	26.734	31.046*	27.378	23.569	31.476**	23.864	34.067**	22.139
McLeod-Li (10)	21.416**	6.508	10.733	6.057	10.492	6.466	14.050	4.835
McLeod-Li (20)	28.994*	13.628	24.818	21.374	20.240	18.027	25.814	20.241

Source: Computed by the author

Note: RUSSI represents US Stock Index Return; RNSUSD represents Nigeria Stock Returns in USD; RUKSI represents UK Stock Index Returns; and RNSGBP represents Nigeria Stock Returns in GBP. Also, ***, **and * represent 1%, 5% and 10% significance level respectively.

6.0 Portfolio Management strategy in the presence of financial shock from developed economies

The preliminary analysis as well as the empirical results has find evidence of transmission lag between the period of outbreak of financial shock in the developed financial market and the period the shock afflicted the financial market of the developing economies, with US and UK stock markets relative to Nigeria stock market as a case study. Thus, on the average, it is arguable that a US and UK investor with portfolio diversification in developing economy such as Nigeria will tend to face lower portfolio risk compared to a US and UK investor who invests wholly in US and UK stock market respectively. However, while the respective US and UK investor would be seeking to maximize returns from holding more of US and UK assets he/she would hold certain portion of Nigeria stock in order to reduce the probable portfolio risk from financial shock from developed economies. In this study, we identified two useful portfolio management strategies; that is, the optimal portfolio weight (OPW) and optimal hedging ratio (OHR).

As stated earlier, these two optimal portfolio management strategies which are based on the minimization of the conditional variance and covariance of asset returns (see Kroner and Sultan, 1993) is being introduced newly into the study on international portfolio diversification, and it is considered relevant in terms of its simplicity and practicability rather the optimization approach which is based on mostly unrealizable constraints. Meanwhile, these portfolio management strategies have been widely employed in the study of the effect of oil price shock on two-asset (oil included) investment portfolio (see Arouri et al., 2011 for oil and stock; Salisu and Mobolaji, 2013 for oil and exchange rate; Kumar, D., 2014 for gold and stock; Salisu and Oloko, 2015b for oil and stock), but adopting it in studying the effect of financial shock in developed economy on the internationally diversified asset portfolio containing stocks of developed and developing economies is unique to this study.

In order for a portfolio manager holding combination of stock assets of developed and developing economies to hedge financial risk from developed financial market, he would engage in future contracts. Hedging proffers opportunity for portfolio investment manager to minimize unwanted risk without reducing the expected returns (see Salisu and Oloko, 2015b). In the present world of under-developed or non-existence of future markets (see Hau and Rey, 2004), optimal portfolio diversification may be necessary. Thus, the two portfolio management strategies will provide useful hedging effectiveness measures in the absence of future markets. The first being the optimal portfolio weight (OPW) measures the optimal amount of each asset that should be included in the investment portfolio, while the second, being the optimal hedging ratio (OHR) is used to determine the rate at which long position of one dollar in one market could be hedged by taking short position in the other market, such that risk is minimized without reduction in the expected returns. Following Arouri et al. 2011 and Salisu and Oloko, 2015b, the optimal of Nigeria stock in the Nigeria-US stock and Nigeria-UK stock portfolio can be described as below:

$$w_{NGUK,t} = \frac{h_t^{UK} - h_t^{NGUK}}{h_t^{NG} - 2h_t^{NGUK} + h_t^{UK}} \tag{8a}$$

$$w_{NGUS,t} = \frac{h_t^{US} - h_t^{NGUS}}{h_t^{NG} - 2h_t^{NGUS} + h_t^{US}} \quad (8b)$$

Where

$$w_{21,t} = \begin{cases} 0, & if\ w_{21,t} < 0 \\ w_{21,t} & if\ 0 \le w_{21,t} \le 1 \\ 1, & if\ w_{21} > 1 \end{cases}$$

The ordering follows the sequence in the model; Foreign stock assets ranked (1) and Nigeria stock in foreign currency ranked (2). The dependent variable w_{21} represents the weight of Nigeria stock assets in one-dollar of Nigeria - US stock and Nigeria – UK stock portfolio, while the optimal weight of US and UK stock in the portfolio is $1-w_{21,t}$. In addition, h_t^{21} (as in h_t^{NGUS} and h_t^{NGUK}) is the conditional covariance between the two pair of stock assets, while h_t^1 (as in h_t^{US} and h_t^{UK}) is the conditional variance.

Having achieved evidence of better performance of VAR-BEKK-GARCH with structural break (Model 2) above the VAR-BEKK-GARCH without structural break, we interpret the optimal portfolio and hedging ratio in Table 7 from the point of view of the VAR-BEKK-GARCH model with structural break. Similarly, comparing the results of the optimal portfolio weight and hedge ratio obtained from the two models as presented in Table 7 below, it is noticed that VAR-BEKK-GARCH without structural break grossly understates the values of the optimal ratios, thus portraying the hedging strategies as being more effective than usual[5]. Hence, the use of VAR-BEKK-GARCH model with structural break is further justified.

From the result in Table 7, it is discovered that the optimal weight of Nigerian stock in the Nigeria – US stock portfolio is 0.10 while the optimal weight of Nigerian stock in Nigeria-UK stock portfolio is 0.25. In other words, the result suggests that a US investor may have to hold 10 percent of Nigerian stock, while a UK investor may have to 25 percent of Nigerian stock when diversifying with Nigerian stock to minimize financial risk from developed financial markets. Invariably, the remaining percentage; 90 percent and 75 percent will be held in US stock and UK stock respectively.

Table 7: Optimal portfolio weight and hedge ratio

	BEKK GARCH (1)		BEKK GARCH (2)	
Optimal Ratios	US investor	UK investor	US investor	UK investor
Optimal weight	0.1073	0.1805	0.1014	0.2468

[5] Note: the lower the values of optimal weight and hedging ratios, the better the hedging (see also, Arouri et al. 2011)

Optimal hedging	0.0779	0.0511	0.0941	0.1655

Source: Computed by the author

Meanwhile, for hedging ratio, the formula for its computation is presented in equations (9a) and (9b), see also, Kroner and Sultan (1993). It explains that the risk Nigeria-US stock and Nigeria-UK stock portfolio is minimal if a long position of one dollar or one pounds (as the case may be) can be hedged by a short position of $\beta_{12,t}$ in the Nigerian stock market.

$$\beta_{USNG,t} = \frac{h_t^{USNG}}{h_t^{NG}} \tag{9a}$$

$$\beta_{UKNG,t} = \frac{h_t^{UKNG}}{h_t^{NG}} \tag{9b}$$

The result as revealed in the Table 7 above indicates that a US investor would hedge financial risk from developed financial market by taking short position of 9.4 cents in the Nigerian stock market for every long position of one dollar in the US stock. Whereas, a UK investor would hedge financial risk from developed financial market by taking short position of 16.6 shillings for every long position of one pound in the UK stock market. The fact that the hedging ratios for both US and UK investors in Nigeria are low indicates the suitability of the diversification with Nigerian stock.

7.0 Conclusions and Policy recommendation

This study examines the hedging effectiveness of portfolio investment diversification between developed and developing economies; with focus on the Nigerian stock asset vis-à-vis the stock assets of the United States (US) and United Kingdom (UK). It carries out preliminary analysis to observe structural changes in the returns of the assets in the international investment portfolio, which was explained by the global financial crisis. Thus, it modifies VAR-BEKK-GARCH model by Engle and Kroner (1995), and compares the results of VAR-BEKK-GARCH with structural break with that of VAR-BEKK-GARCH without structural break. Thereafter, it uses conventional model selection criteria to select the best fit model. Its main contribution is in the analysis of optimal portfolio diversification using optimal portfolio weight (OPW) and optimal hedging ratio (OHR) rather than the optimization approach. From our preliminary result is was observed that the risk adjusted stock returns on Nigerian stock by the US and UK investors is critically low on account of high exchange rate volatility of the Nigerian exchange rate. Empirical findings reveal that structural break is significant, as VAR-BEKK-GARCH with structural break outperforms the VAR-BEKK-GARCH without structural break; and that OPW and OHR are low, indicating the suitability of US and UK assets diversification with Nigeria assets.

Further results suggests that US and UK investors in Nigeria could benefit from the transmission lag for the financial crisis originated from developed economies to reach the developing economies, and that there is potential effect for the financial risk or financial bubble to transmit

from US and UK stock markets to Nigerian stock market. The results also reveal the effectiveness of financial policies in the financial market developed economies that have made the market prices and returns to rise above its pre-global financial crisis values and the ineffectiveness of the financial market policies of Nigeria that has made the stock prices and returns to remain flat after the global financial crisis.

Based on the outcome of this research, it is recommended that the monetary authority in Nigeria should pursue decisive policies towards reducing exchange rate volatility, in order to enhance the potential gains from diversification and attract portfolio inflows from US and UK.

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