Archives of Business Research – Vol.5, No.11
Publication Date: Nov. 25, 2017
DOI: 10.14738/abr.511.3791.
Peters, I. O., Ndugbu, M., & Emeka, O. (2017). Empirical Regularities of Nigeria's Foreign Private Portfolio Investment Return and Volatility. *Archives of Business Research,* 5*(11),* 108-122.

Empirical Regularities of Nigeria's Foreign Private Portfolio Investment Return and Volatility

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ABSTRACT

This paper examined the Empirical Regularities of Nigeria's Foreign Private Portfolio Investment Return and Volatility. The study covered the periods between 1981 and 2014. An EGARCH model was specified. The analysis involves carrying out the tests for Financial Assets and Risk assumptions. The study revealed that Foreign Private Portfolio Investment Returns show Volatility clustering. Secondly, Foreign Private Portfolio Investment Return and Risk were found to have Thick tail. Variance Ratio Test [VRT] was used to test the weak form efficiency of the efficient market hypothesis and hence the non-predictability of financial markets. The Results showed that changes in one direction are more often followed by similar changes in either direction (volatility clustering). Given that Nigeria's Foreign Private portfolio investment empirical imperatives is regular like that of the rest of the world, the paper thus recommends that investment decision models used by advanced analyst in developed countries can be applied to developing countries like Nigeria with little modification with respect to Foreign Private Portfolio Investment as their assets and risks display similar characteristics with assets and risks in developed countries.

Keywords: Empirical Regularities, Foreign Private Portfolio Investment Return and Volatility,

INTRODUCTION

In a paper titled "Principal Component analysis of Nigeria's Foreign Private Portfolio Investment (FPPI) volatility", Ndugbu, Ihejirika and Ochiabuto (2017) asserted that the decisive test to classify a purchase as investment is whether there is a "potential to turn return". The statement "potential to turn return" enfolds potential to turn losses. Succinctly, they inferred that investments are volatile.

Their study examined Foreign Investment Explicit Volatility and Volatility Theories and thus revealed that Foreign Private Portfolio Investment volatility proxy by ten key risks factors can be de – parameterized to Six (6) Principal components using the Kaiser's criterion and Cattell's scree test. These six components were selected as they were heavily affected by factors which are not common to all the other risks. The names of the extracted principal components were Taxability risk, Liquidity risk, Economic Risk, Political Risk, Commodity risk and Market risk.

The researchers admitted that the Principal Components have much implication and that these key Components can be used for further analysis. Hence, the objective of this paper is to use the Principal Components of Nigeria's Foreign Private Portfolio Investment volatility to examine the Empirical Regularities of Nigeria's Foreign Private Portfolio Investment Return and Volatility.

REVIEW OF RELATED LITERATURE

Review of Concepts

Foreign Investment

Foreign investment involves capital flows from one country to another, granting extensive ownership stakes in domestic companies and assets (Investopedia, 2016). Foreign investment is largely seen as a catalyst for economic growth. Foreign investments can be classified in one of two ways: direct and indirect. There are two additional types of foreign investments: commercial loans and official flows. Commercial loans are typically in the form of bank loans that are issued by a domestic bank to businesses in foreign countries or the governments of those countries. Official flow refers to different forms of developmental assistance to a developed or developing nation given by donor countries.

Foreign direct investment is investment made by a company or entity based in one country, into a company or entity based in another country. Entities making direct investments typically have a significant degree of influence and control over the company into which the investment is made. The accepted threshold for a foreign direct investment relationship, as defined by the Organization for Economic Co-operation and Development (OECD), is 10% (OECD, 2008). The foreign investor must own at least 10% or more of the voting stock or ordinary shares of the investee company. Foreign portfolio investment (FPI) consists of securities and other financial assets passively held by foreign investors. FPI does not provide the investor with direct ownership of financial assets, and thus no direct management of a company. This type of investment is relatively liquid, depending on the volatility of the market invested in.

Rate of Returns on International Investments

Rate of return is profit on an investment over a period of time, expressed as a proportion of the original investment. A loss instead of a profit is described as a negative return. The time period is typically a year, in which case the rate of return is referred to as annual return. Return on investment (ROI) is return per naira invested. Ready Ratios (2016) explicate ROI as a performance measure used to evaluate the efficiency of investment. It is a measure of investment performance, as opposed to size (c.f. return on equity, return on assets, return on capital employed). The return or rate of return can be calculated over a single period, or where there is more than one time period, the return and rate of return over the overall period can be calculated, based upon the return within each sub-period.

Empirical Regularities of Financial Asset Return and Volatility

News in financial market can be seen from dimensions of non-trading periods, forecast able events and asymmetric effects. Non-trading period news refers to Information that accumulates when financial markets are closed as reflected in prices after the markets reopen. Fama (1965) and French and Roll (1986) found that information accumulates more slowly when the markets are closed than when they are open. Variances are higher following weekends and holidays than on other days, but not nearly by as much as would be expected if the news arrival rate were constant.

Forecast able events news refers to announcement effects. Forecast able releases of important information are associated with high ex ante volatility. For example, Cornell (1978) and Patell and Wolfson (1979, 1981) showed that individual firms' stock returns volatility is high around earnings announcements. Similarly, Harvey and Huang (1991, 1992) found that fixed income and foreign exchange volatility is higher during periods of heavy trading by central banks or when macroeconomic news is being released. For example, volatility is typically much higher at the open and close of stock trading than during the middle of the day. Trading and non-trading periods contribute differently to volatility.

The effect of good news and bad news may have asymmetric effects on volatility. In general when negative news hits a financial market, asset prices tend to enter a turbulent phase and volatility increases, but with positive news volatility tends to be small and the market enters a period of tranquility.

Leverage effect or asymmetric term first noted by Black (1976), refers to the tendency for changes in stock prices to be negatively correlated with changes in stock volatility. Fixed costs such as financial and operating leverage provide a partial explanation for this phenomenon. A firm with debt and equity outstanding typically becomes more highly leveraged when the value of the firm falls. This raises equity returns volatility if the returns on the firm as a whole are constant. Black (1976), however, argued that the response of stock volatility to the direction of returns is too large to be explained by leverage alone.

Amplitude of return as Mandelbrot (1963) wrote . . . large changes tend to be followed by large changes, of either sign, and small changes tend to be followed by small changes…. Volatility clustering phenomenon is immediately apparent when asset return are plotted through time. The best known statistical model for the volatility-clustering phenomenon is the ARCH model (Robert M. Kunst and Johannes Kepler, 1997). According to Bo Sjö (2011) Volatility clusters mean that the variance appears to be high during certain periods and low in other periods.

"Persistence" of a shock to volatility: One perfectly reasonable definition of "persistence" would be to say that shocks fail to persist when shocks are stationary and ergodic. Nevertheless, apparent persistence of shocks may be driven by thick-tailed distributions rather than by inherent non-stationarity.

Review of Theories

Foreign Investment Theories

The Evolutionary Perspective

Views international investment as an ongoing, evolutionary process shaped by a Multinational Enterprise's (MNE's) international experience, organizational capabilities, strategic objectives, and environmental dynamics.

The Integration–Responsiveness Perspective

FDI is a complex process requiring coordinating subsidiary activities across national boundaries. Business people often talk about "thinking globally but acting locally." This theory establishes a framework. The framework, known as the global integration (I) and local responsiveness (R) paradigm (or the I–R paradigm), suggests that participants in global industries develop competitive postures across two dimensions.

Keynes investment theory

Keynes' main contention was that investment is a function of the prospective marginal efficiency of capital relative to some interest rate which reflects the shadow cost of the invested funds. According to Keynes (1936), because of incomplete and uncertain information about private investment volatility in the future, potential investors would depend on their "animal spirits" in making their investment decisions rather than a rational calculation of an inherently intermediate distant future (Chete, 1998).

Tobin's "Q" theory of investment of 1969

This alternate formulation of the investment function postulates that the ratio of the market value of the existing stock of capital to its replacement cost (otherwise termed Q ratio) is the force driving investment. This is a disequilibrium approach to investment. In this respect, investment is a function of both profitability and output demand considerations.

The neoclassical theory

The term "Neo-classical Theory" refers to work done in the eighteenth and nineteenth centuries by classical economists such as Adam Smith, David Ricardo, and Irving Fisher. The neoclassical theory argues that places that offer the highest rates of return will attract the most capital. The theoretical explanation offered at that time was the neoclassical capital arbitrage theory of portfolio flows. Based on assumptions of perfect competition, absence of transaction costs, and perfect information, the neoclassical theory explained international capital flows as responding to interest rate differentials (Williamson, 1985)

The industrial organization approach

In the 1960s, neoclassical theory was questioned because it did not distinguish foreign direct investments from portfolio investments. Hymer (1960) was among the first to see that FDI could not be coupled with portfolio investments. According to Hymer (1960), in order to analyze foreign investment, one must first analyze the multinational enterprise which thrives on market imperfections. Foreign firms face greater risks in making investments than do domestic firms because different and unfamiliar laws, different languages and cultures, and possible discrimination add to the costs of firms investing abroad. Therefore, MNCs must have some advantage over competitors or other reasons to invest directly in a foreign country.

RESEARCH METHODOLOGY

Research Design

The research follows a non-experimental design. The research is an ex post facto research. This means that relationships are investigated after the fact has been known. The variables needed were specified viz. Foreign Private Portfolio Investment Return and the Principal Component Risks.

Sources of Data and Typology

The Data typology is a time series Data. The sample size for the analysis was determined judgmentally. The researcher looks at a set of data covering a period of 34 years from 1981 – 2014. The data were sourced from a previous paper titled "Principal Component analysis of Nigeria's Foreign Private Portfolio Investment (FPPI) volatility" (Ndugbu et al, 2017)

Tools of Analysis

The Finometric model in question is the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) – in mean sector I given by equation (1) and (2):

$$FPI_R = b_0 + K\log(h_t) + b_1AA + e_t \ldots\ldots 1$$

$$\text{Log}(h_t) = w + a_1|e^2_{t-1}/\delta_{t-1}| + b_2\log(h_{t-1}) + re^2_{t-1}/\delta_{t-1} + a_2CR_t + a_3PR_t + a_4MR_t + a_5LR_t + a_6RR_t + a_7IR_t + a_8HR_t + a_9LR_t + a_{10}FIR_t + a_{11}KR_t + a_{12}TR_t + v_t \ldots\ldots 2$$

The second equation is fine tuned to encompass the Principal Components as follows:

$Log(h_t) = w + a_1|e^2_{t-1}/\delta_{t-1}| + b_2log(h_{t-1}) + re^2_{t-1}/\delta_{t-1} + a_2TR_t + a_3LR_t + a_4ER_t + a_5PR_t + a_6CR_t + a_7MR_t + v_t$ 3

Where

r – Asymmetric or Leverage effect.

$FPPI_R$ – ForeignPrivate Portfolio Investment Returns.

K – Risk - return tradeoff.

AA – Asset Allocation.

e_t– Returns shock.

TR - Other Risk.

LR – Liquidity Exchange Rate Risk.

ER - Political Horizon Risk.

PR - Economic Longevity Risk.

CR - Market Risk.

MR – Market Ability Risk.

v – Risk shock.

δ_{t-1} – Lagged Standard error of Returns shock.

h_t- Implied volatility.

W – Average Return or Riskless Return.

GARCH-in-mean (GARCH-M) model provide three distinct specifications – one for the conditional mean equation, one for conditional variance, and one for conditional error distribution. The conditional variance is a function of three terms:

- a conditional term
- News about volatility from the previous period, measured by e^2_{t-1} (the ARCH term)
- Amplitude of return (the GARCH term)

Time series assumptions:

1. Variability in X values.
2. The construct is correctly specified.
3. Y and X are stationary random variables.
4. The errors are serially uncorrelated but not independent.
5. The number of observations n must be greater than the number of parameters to be estimated.

Empirical regularities of asset returns and risk

1. Leptokurtic: they tend to be thick tails.
2. Volatility clustering: large changes tend to be followed by large changes of either sign.
3. Leverage effect: tendency for changes in stock prices to be negatively correlated with changes in volatility.
4. Non - trading period's effect: when a market is closed information seems to accumulate at a different rate to when it is open.
5. Forecast able events: volatility is high at regular times such as news announcements or other expected events.
6. Inverse relationship between volatility and serial correlation.
7. Co – movement in volatility: volatility is positively correlated across assets in a market and even across markets.

Distributional assumptions

1. Normal (Gaussian) assumption.
2. Student t distribution {has degrees of freedom which allow greater kurtosis}.
3. Generalized error distribution (GED)

The objective of the paper is to test the empirical assumptions based on which Nigeria's Foreign Private Portfolio Investment Risk – Return is modeled. Hence, the tool of analysis involves carrying out the tests for these assumptions.

DATA PRESENTATION AND ANALYSIS

Data Presentation

The table array of variables needed for this analysis is presented in Appendix E.

Stationarity

A time series is not stationary if it has the following features:

- If it has time varying mean.
- Or if it has time varying volatility.
- Or both.

A time series is strictly stationary if all the moments of its probability distribution and not just the first two (mean and variance) are invariant overtime. Here focus is on weak stationarity.

The Kwiatkowski – Phillips – Schmidt – Shin (KPSS) test is used to test for time varying mean, while Brock, Dechert, Scheinkman and LeBaron (BDS) test is used to check for time varying variance. The KPSS test for mean stationarity is laid out in the table below. The KPSS test shows that the variables are stationary I (0) in mean, while the BDS and variance ratio test (VRT) test conducted later indicates that the variables are not stationary in variance. This implies that we can study the series behavior beyond the time period under consideration. Each set of time series will not be for a particular episode. As a consequence, it is possible to generalize it to other time periods.

Table 1: Unit root test with the KPSS statistic

Variable	Level of integration	Observed level of significance at 10%
Returnoninvestment	I (0)	0.333908
Commodity risk	I (0)	0.124545
Market risk	I (0)	0.108098
Liquidity risk	I (0)	0.255366
Political risk	I (0)	0.307143
Taxability risk	I (0)	0.263823
Economic risk	I (0)	0.762668
Mygarch	I (0)	0.46745

Source: Eview output

Empirical Regularities of Financial Asset Return and Volatility

Amplitude of Return

Volatility clustering means that there are periods when large changes are followed by further large changes and periods when small changes are followed by further small changes. Volatility clustering implies that the residuals are serially uncorrelated, but not independent. Being serially uncorrelated, but not independent implies that the residuals are strict white noise. The aim is to look at the heteroscedastic random walk. Serially uncorrelated simply means the series are random walk (white noise). White noise process hovers around zero. A white noise series is probably stationary. One popular approach to answering the question of serially uncorrelated is the Lo and MacKinlay overlapping variance ratio test. The variance ratio test examines the predictability of time series data by comparing variances of differences of the data (returns) calculated over different intervals. Alternately, Lo and MacKinlay outline a heteroskedastic random walk hypothesis where they weaken the independent and identically distributed (*i.i.d.)* assumption and allow for fairly general forms of conditional heteroskedasticity and dependence. This hypothesis is sometimes termed the martingale null, since it offers a set of necessary (but not sufficient), conditions for $\in_t$ to be a martingale difference sequence (*m.d.s.*). The EGARCH – IN mean residuals is a random walk or follows the martingale difference as the Chow Denning Maximum |z| statistic observed significance of 0.5667 (see appendix A) accepts the null hypothesis. Thus conclude that the residual are serially uncorrelated and dependent.

The other side of volatility clustering is that apart from being serially uncorrelated, the residuals are not independent. A test to check for independence is the BDS (Brock, Dechert, Scheinkman and LeBaron) test. The BDS test is a portmanteau test for time based dependence in a series. The test can be applied to a series of estimated residuals to check whether the residuals are independent and identically distributed (*iid*). The dimensions of the BDS reject the hypothesis of i.i.d and conclude that observations of the residuals are not independent.

Volatility clustering can also be tested by conducting test for strict white noise. The Ljung-Box *Q*-statistics (see appendix B) for high-order serial correlation is often used as a test of whether the series is white noise. The *Q*-statistic at lag k is a test statistic for the null hypothesis that there is no autocorrelation up to order k (that is are white noise). The Q – statistics are insignificant correlations at all lags, thus the result indicates volatility clustering. This is because all the standardized residuals are white noise. Another test for volatility clustering is the test for ARCH effect performed in section 4.3.4.

Thick Tails

Thick Tails means that asset returns and risks tend to be leptokurtic. To model the thick tail in the residuals, we will assume that the errors follow a Student's *t*-distribution. The T-DIST. DOF of the EGARCH – IN MEAN output shows that the distribution of the standardized errors departs significantly from normality with a probability value of 0.0000. Given that the white noise (standardized errors) has different distribution (Jarque–Bera observed level of 0.000000 rejects the normality assumption) than normal, then white noise inherits a non – vanishing skewness (3.233367). The kurtosis shows that the white noise has thick tail (17).

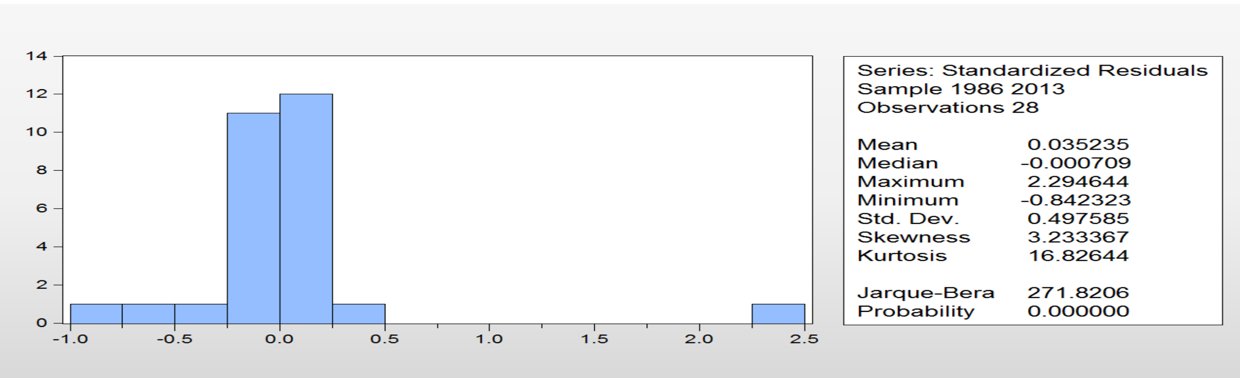

Figure A: Standardized residuals characteristics

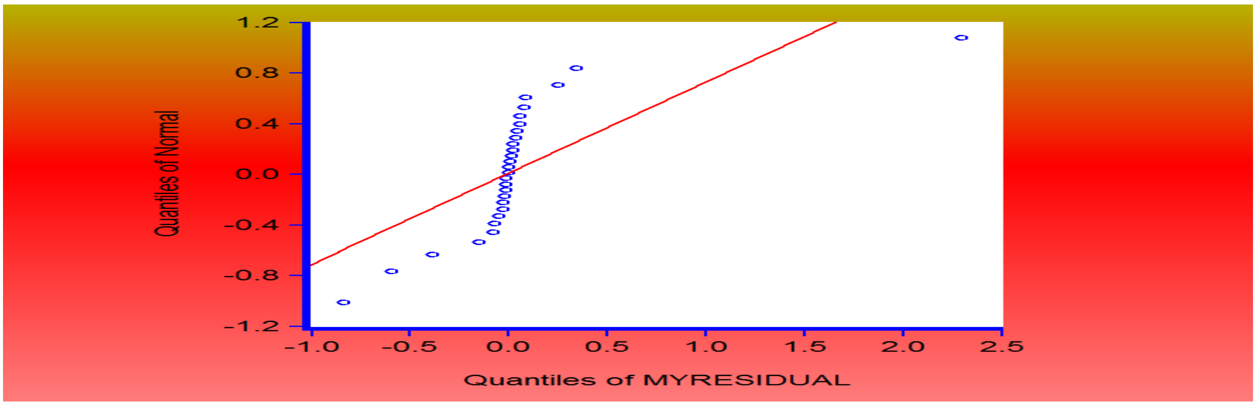

Figure B: Standardized residual Q - Q statistic

Similarly, the Jarque-Bera (JB) statistic observed level 0.139097 indicates that the returns are normally distributed, while the kurtosis value of 4 shows that asset returns are leptokurtic. The plot of Q-Q theoretical in figure B above indicates that it is primarily large negative shocks that are driving the departure from normality

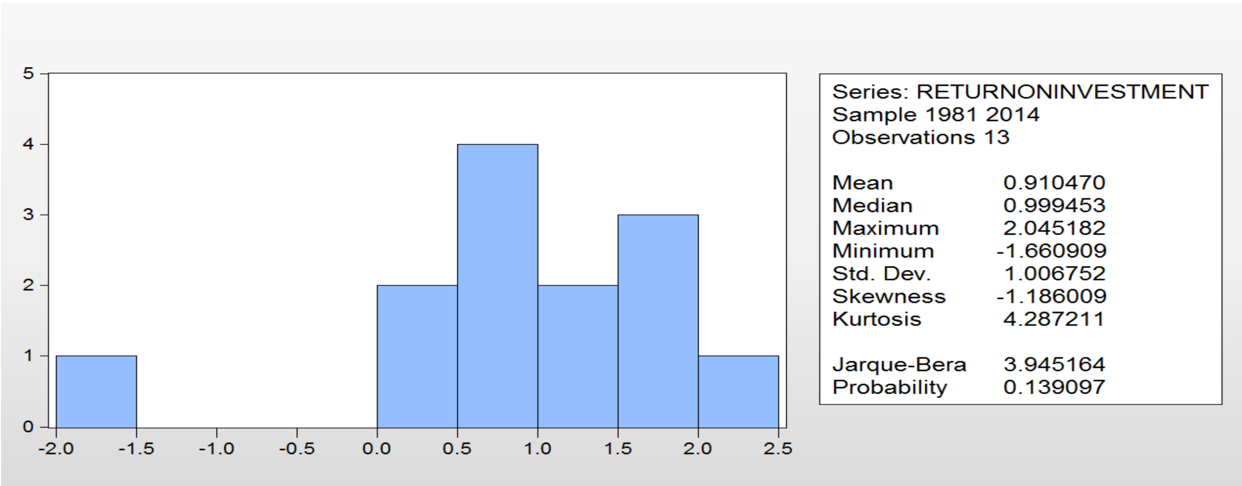

Figure C: Return on investment characteristics

Mean Reversion and Forecast able Events

Mean reversion apply the idea of buy low sell high. Mean reversion is measured with the variance ratio test (VRT). The variance ratio test measures trendiness or degree of mean reversion in a price or return of a series. VRT also tests the weak form efficiency of the efficient market hypothesis and hence the non-predictability of financial markets (see Ihejirika and Anyanwu 2013).

Variance ratio equal to one indicates that returns are pure random walk. Hence, no predictions are possible and hence trial to create a profitable trading system on such a return will fail. A variance ratio value greater than one indicates that returns show tendency to form trends. This means that changes in one direction are more often followed by similar changes in either direction (volatility clustering). Variance ratio less than one indicate that returns show some degree of mean reversion. This means that changes in one direction are followed by changes in the opposite direction.

The returns show volatility clustering using the variance ratio statistic and graph.

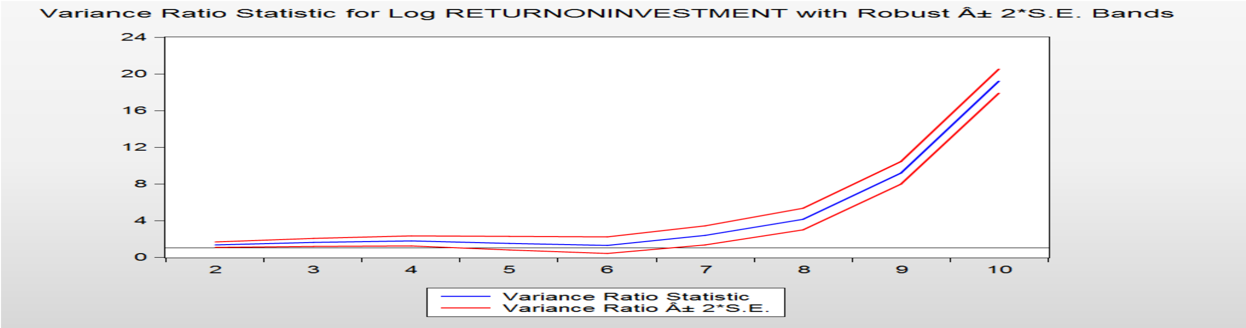

Figure D: Variance ratio graph

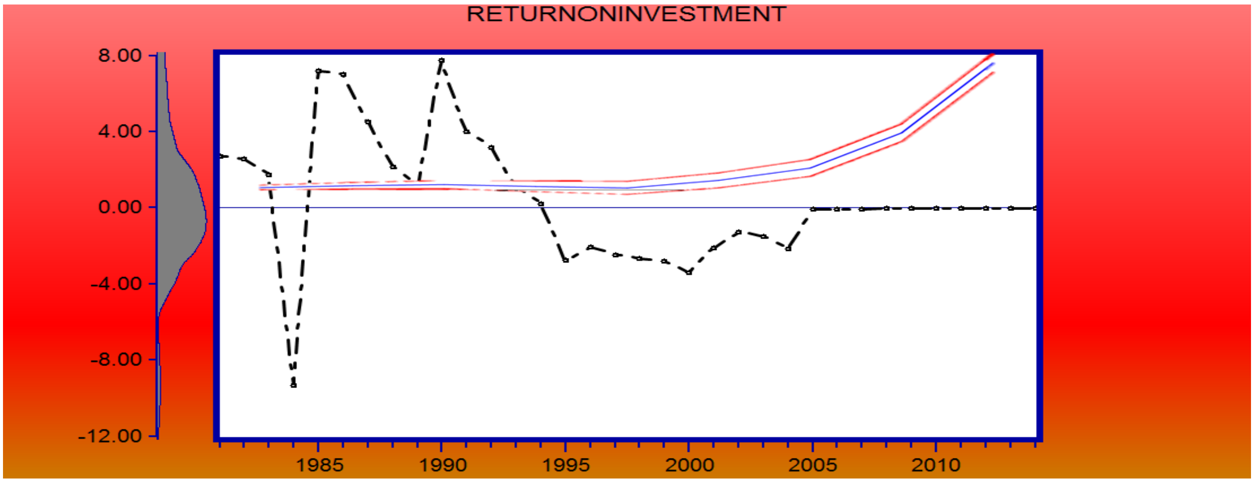

Figure E: graph of return on investment and variance ratio

Arch Effect (Time Varying Volatility)

The LaGrange multiplier test F statistic observed level of 0.7641 indicates no evidence of remaining ARCH (see appendix C)

DISCUSSION OF FINDINGS

The study revealed that Returns show Volatility clustering. This implies Investment Returns residuals are strict white noise. Foreign Private Portfolio Investment Return and Risk were found to have Thick tail. This implies that Foreign Private Portfolio Investment Return and Risk tend to be leptokurtic.

Mean reversion apply the idea of buy low sell high. The Variance Ratio Test (VRT) was used to test this as well as the weak form efficiency of the efficient market hypothesis and hence the non-predictability of financial markets. The results show volatility clustering using the variance ratio statistic and graph. This means that changes in one direction are more often followed by changes in the same direction.

CONCLUSION

This paper used the Principal Components of Nigeria's Foreign Private Portfolio Investment volatility to examine the Empirical Regularities of Nigeria's Foreign Private Portfolio Investment Return and Volatility. The study concludes that Nigeria's Foreign Private portfolio investment empirical imperatives is regular like that of the rest of the world. Based on the above findings the study recommends that investment decision models used by advanced analyst in developed countries can be applied to developing countries like Nigeria With little modification with respect to Foreign Private Portfolio Investment as their Assets and Risks display similar characteristics with Assets and Risks in Developed countries.

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APPENDIX

Appendix A: Variance ratio test

Null Hypothesis: MEANRESIDUAL is a martingale
Date: 10/19/16 Time: 04:17
Sample: 1981 2014
Included observations: 27 (after adjustments)
Heteroskedasticity robust standard error estimates
Use biased variance estimates
User-specified lags: 2 4 8 16

Joint Tests	Value	df	Probability
Max |z| (at period 4)*	1.314511	27	0.5667

Individual Tests

Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.481958	0.398679	-1.299395	0.1938
4	0.212082	0.599400	-1.314511	0.1887
8	0.068730	0.740442	-1.257721	0.2085
16	0.026046	0.879408	-1.107511	0.2681

*Probability approximation using studentized maximum modulus with
parameter value 4 and infinite degrees of freedom

Test Details (Mean = -0.0119518900946)

Period	Variance	Var. Ratio	Obs.
1	0.50740	--	27
2	0.24454	0.48196	26
4	0.10761	0.21208	24
8	0.03487	0.06873	20
16	0.01322	0.02605	12

Null Hypothesis: Log RETURNONINVESTMENT is a martingale
Date: 10/19/16 Time: 05:24
Sample: 1981 2014
Included observations: 11 (after adjustments)
Heteroskedasticity robust standard error estimates
Lags specified as grid: min=2, max=10, step=1

Joint Tests	Value	df	Probability
Max |z| (at period 10)*	27.63640	11	0.0000

Individual Tests

Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	1.359774	0.158324	2.272389	0.0231
3	1.629494	0.225187	2.795422	0.0052
4	1.776950	0.282565	2.749628	0.0060
5	1.518257	0.367090	1.411797	0.1580

6	1.305822	0.453209	0.674792	0.4998
7	2.367640	0.522629	2.616848	0.0089
8	4.161073	0.577707	5.471761	0.0000
9	9.193746	0.622345	13.16591	0.0000
10	19.22092	0.659309	27.63640	0.0000

*Probability approximation using studentized maximum modulus with
parameter value 9 and infinite degrees of freedom

Test Details (Mean = -0.371199369234)

Period	Variance	Var. Ratio	Obs.
1	0.81718	--	11
2	1.11118	1.35977	10
3	1.33159	1.62949	9
4	1.45208	1.77695	9
5	1.24069	1.51826	8
6	1.06709	1.30582	7
7	1.93478	2.36764	6
8	3.40034	4.16107	5
9	7.51292	9.19375	4
10	15.7069	19.2209	3

Appendix B: Ljung – Box Q statistic

Date: 10/19/16 Time: 03:46
Sample: 1981 2014
Included observations: 28
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. | . |	. | . |	1	-0.029	-0.029	0.0266	0.870
. | . |	. | . |	2	0.007	0.007	0.0284	0.986
. | . |	. | . |	3	0.002	0.002	0.0285	0.999
. |* . |	. |* . |	4	0.127	0.127	0.5929	0.964
.**| . |	.**| . |	5	-0.247	-0.244	2.8167	0.728
. | . |	. | . |	6	0.004	-0.005	2.8172	0.831
. | . |	. | . |	7	-0.020	-0.019	2.8331	0.900
. | . |	. | . |	8	0.027	0.015	2.8628	0.943
. | . |	. |* . |	9	0.025	0.093	2.8903	0.968
.**| . |	.**| . |	10	-0.243	-0.330	5.6348	0.845
. | . |	. | . |	11	-0.022	-0.012	5.6590	0.895
. | . |	. | . |	12	0.015	0.005	5.6706	0.932

Appendix C: Langrange multiplier test

Heteroskedasticity Test: ARCH

F-statistic	0.092063	Prob. F(1,25)	0.7641
Obs*R-squared	0.099063	Prob. Chi-Square(1)	0.7530

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 10/18/16 Time: 06:53
Sample (adjusted): 1987 2013
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.261676	0.204812	1.277642	0.2131
WGT_RESID^2(-1)	-0.060599	0.199722	-0.303418	0.7641

R-squared	0.003669	Mean dependent var	0.246607
Adjusted R-squared	-0.036184	S.D. dependent var	1.014282
S.E. of regression	1.032470	Akaike info criterion	2.972971
Sum squared resid	26.64983	Schwarz criterion	3.068959
Log likelihood	-38.13511	Hannan-Quinn criter.	3.001514
F-statistic	0.092063	Durbin-Watson stat	2.006718
Prob(F-statistic)	0.764082		

Appendix D: Correlogram squared residuals

Date: 10/19/16 Time: 15:20
Sample: 1981 2014
Included observations: 28

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. | . |	. | . |	1	-0.060	-0.060	0.1135	0.736
. | . |	.*| . |	2	-0.062	-0.066	0.2393	0.887
. | . |	.*| . |	3	-0.065	-0.074	0.3823	0.944
. | . |	.*| . |	4	-0.054	-0.068	0.4844	0.975
. |*. |	. |*. |	5	0.127	0.111	1.0766	0.956
. | . |	. | . |	6	-0.025	-0.023	1.1006	0.982
. | . |	. | . |	7	-0.026	-0.022	1.1277	0.992
. | . |	. | . |	8	-0.028	-0.022	1.1609	0.997
. | . |	. | . |	9	-0.025	-0.021	1.1882	0.999
. | . |	. | . |	10	0.048	0.022	1.2947	0.999
. | . |	. | . |	11	-0.027	-0.026	1.3296	1.000
. | . |	. | . |	12	-0.029	-0.029	1.3725	1.000

*Probabilities may not be valid for this equation specification.

APPENDIX E

Table1: Cell array of the principal component risks

YEAR	TAXABILITY RISK	LIQUIDITY RISK	ECONOMIC RISK	POLITICAL RISK	COMMODITY RISK	MARKET RISK
1981	NA	NA	NA	NA	NA	NA
1982	-1.287362	-0.54043	-1.72633	-3.09946	-1.59839	-0.36905
1983	-0.234714	0.059317	-1.56481	-2.01706	-0.58422	-0.44029
1984	0.160926	0.058752	-1.07884	-0.96249	-0.57641	-0.04561
1985	-0.708898	-0.5568	-0.38287	-0.44021	-0.38835	0.079286
1986	-1.100047	-0.18001	-0.01409	-0.36647	0.132203	0.025998
1987	0.341295	0.397972	-0.61174	-0.24051	0.281479	-0.97795
1988	1.405822	-0.74948	-0.60471	-1.17059	0.729271	-0.36155
1989	0.100069	-0.132	-0.73887	-0.23989	-0.06469	-0.21831
1990	1.003987	-1.31958	0.237017	-0.50013	0.601952	-0.40547
1991	0.377801	-2.35379	0.583389	0.806474	-0.39172	0.200879
1992	0.764743	0.09145	-0.71135	-0.75423	0.56374	-0.63932
1993	-0.18949	0.732523	-1.38445	1.2666	0.65538	0.86087
1994	-0.174356	0.895389	-2.81538	1.380854	0.965991	1.179281
1995	2.793582	4.108904	-0.89368	0.583524	0.345773	2.590952
1996	6.433625	-2.60076	1.818112	-0.81019	0.787195	0.897761
1997	0.221517	-1.63657	0.052576	1.075546	0.054107	-0.09598
1998	-1.049415	-1.94369	-0.69729	2.875814	0.01294	-0.11306
1999	-0.937469	-1.41855	-0.69889	2.469624	0.04057	-0.3753
2000	0.213552	-0.29041	-0.54171	0.062356	-0.00417	-0.16026
2001	1.181952	1.583117	2.554715	1.382464	-3.4824	-0.53993
2002	0.315594	1.336058	0.631184	0.376442	-1.81282	-1.36655
2003	-0.716947	-0.29152	-0.20025	0.071518	-0.15477	-0.04027
2004	-0.528171	-0.78359	-0.01582	0.196094	-0.21974	0.19726
2005	1.238905	1.527031	0.146404	0.005847	-0.40879	0.159978
2006	-0.079888	-0.12871	-0.73328	-0.10915	0.059789	-0.11393
2007	-0.977566	0.000315	0.206931	-0.07683	-0.33092	0.53849
2008	-1.499516	0.135709	0.960551	-0.2368	0.723454	0.216345
2009	-2.399554	0.614129	2.75926	-0.73387	2.570088	0.524738
2010	1.111552	2.255397	0.377498	0.261564	1.547876	-3.00517
2011	-1.06097	1.151042	1.578838	0.210968	1.695399	-1.793
2012	-0.901421	-0.12918	-0.08116	-0.00957	-0.7274	0.106293
2013	-2.319558	-0.01727	1.833828	-1.07234	0.17253	2.510201

Source: Authors computations (factor scores from principal component analysis, Ndugbu et al (2017)