CARD International Journal of Management Studies, Business & Entrepreneurship Research
ISSN: (Print): 2545-5907 (Online): 2545-5885
Volume 2, Number 2, June 2017
http://www.casirmediapublishing.com

Econometrics test of Arbitrage Pricing and its Volatility in the Nigerian Equities Market

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ABSTRACT

The study is an empirical test of validity of arbitrage pricing theory (APT) in Nigerian Stock Exchange Market (NSEM) and its volatility for the sample period of 2010 to 2014 using quarterly data on forty-two stocks listed in NSE. Using the EGARCH model, GLS and the fixed effect panel data estimator with cross section specific coefficients, the study validates the APT for NSEM. The policy implication is such that the study upholds the *APT* theory for NSEM. Results show money supply had significant positive outcome on stock return; Treasury bill with inflation rates had significant negative outcome on return of NSEM. Above all, a significant EGARCH effect was found with indication of harmful market volatility on stock return. This indeed validates that Nigerian stock exchange is vulnerable to instability in the market. The study so recommends the need for stock investors to be cognizant of trend of both domestic macroeconomic fundamentals.

Keywords: APT, Volatility, Nigerian Stock Exchange Market (NSEM) JEL Classification: A38, D26, F45

INTRODUCTION

Stock markets occupy a pivotal part of a country's financial system (Van-Treek, 2009). The foremost models in financial economics that explains association between risk and asset returns are the c*apital asset pricing model (CAPM)* and the *arbitrage pricing theory (APT).*

This study is on the *APT*. The *APT* predicts an association linking returns of a portfolio and risky asset returns by means of combination of explanatory macroeconomic variables.

As the test for *APT* relies on variable analysis, the concern for number and variable type in explanation of stock performance is yet to be established for the NSEM. Hence, this study attempts to test validity of *APT* for NSE using forty-two individual firms enlisted in the NSE. We so hypothesized that findings of Chen, Roll and Ross (1986) for US are invalid to Nigerian Stock Exchange.

Chen et al. (1986) argued that amongst the economic variables affecting stock market are aggregate production, inflation, short-term interest rates, the maturity risk premium and default risk premium. The next section is the literature on *APT*. This if flowed by framework and model. Results are in section four and after that, conclusion.

The Economics of Arbitrage Pricing and Trends in Nigerian Equities Market (NEM)

Arbitrage refers to the trade in two assets with one of assets being mispriced. It is the practice of taking positive expected returns from overvalued or undervalued securities in the inefficient market with no incremental risk and zero additional investments. The arbitrageur sells the asset which is relatively exceptionally costly and using proceeds to purchase the one which is comparatively low-priced.

In line with the *APT*, an asset is mispriced if its current price deviates from the price forecasted by the model. In effect, current asset price equals sum of every future cash flows discounted at the *APT* rate. Arbitrageur generates portfolio by spotting number of accurately priced assets, one asset per macroeconomic variable plus one and then weighting the assets such that portfolio beta per macroeconomic variable is equal to mispriced asset.

Recently, the NEM has witnessed scenario when practically investors sell or hurry to sell stocks to exit the market at all cost. The reality as at today is that investors' trading incentive is declining fast and hence demand to exit the market and seek safe haven in investments such real estate (Abdullahi, 2011). The worst current market trend is the urgency by foreign portfolio managers to exit the NEM in sense of shock absorber to their collapsed situation in Nigeria's economic recessions.

Regarding domestic investors, the mass transfer of funds from stocks to safer investments and increased news on investors' not having interest and day after day losses in stock replaced the records of the early 2008, when every individual dispense money into penny stocks that had no basic strengths (Maku and Attanda, 2009). Regulator's intervention in the direction of stabilizing the market has in recent times induced controversial wiles amongst operators in the market. While some operators envisaged it as a vehicle for thwarting timely market recovery, authority of Stock Exchange holds that it an indispensable measure to protect stock market investors.

EMPIRICAL REVIEW

Empirical studies of APT theory abound for different countries. Wongbangpo and Sharma (2002) found inflation induces long run negative link with stock prices in Indonesia and Philippine while money growth in Malaysia, Singapore and Thailand led to positive outcome on their stock market indices.

Chakravarty (2005) found link from industrial production to stock prices in India. Tan, Loh and Zainudin (2006) found inflation; crude oil price and Treasury Bills' rate have long-time relation with Malaysian stock market.

To Maysami et al. (2004), interest rate has both significant positive and negative impact on Singapores stock markets. Engle and Rangel (2008) investigate the GARCH equation for low rate volatility. The outcome was high frequency aggregate capital market volatility had both short-run and long-rung component and suggest long-run dimension is related to the fluctuation of economic activities. Results of Tursoy *et al.* (2008) indicate no significant pricing link connecting stock return with interest rate.

Robert (2008) validates absence of a considerable link involving present and past market returns with macroeconomic variables, suggesting that the markets of Brazil, Russia, India and China exhibit weak form of market efficiency.

Humpe and Macmillan (2009) obtained negative inflation effect on stock prices. Mohammad, Hussain and Ali (2009) observe significant positive impact of exchange rate plus foreign exchange reserves on stock price in Kerachi exchange in Pakistan using quarterly data.

Asaolu and Ogunmuyiwa (2010) found feeble association between share price and economic variables was observed under the error correction model. Choo, Lee and Ung (2011) using GARCH models found macroeconomic variables have no impact on the volatility of Japanese stock market. Sangmi and Hassan (2013) found a significant association between variables like inflation, exchange rate, interest rate and money supply in India.

The findings of the literature suggests existence of linkage between macroeconomic variables and stock prices in developed economies but such relationship is yet to be robust in developing economies.

THEORETICAL FRAMEWORK, MODEL SPECIFICATION AND RESEARCH METHODOLOGY

Theoretically, an econometric test of the *APT* demands the modelling of anticipated return of a financial asset as linear function of macroeconomic variables in return generating process Chen and Ingersoll (1983), taking into cognizance degree of responsiveness to changes in variables which are represented by a factor-specific coefficient subsequent to a return generating process, which is mathematical computation of how the equity returns move with economic factors.

$$R_i - E(R_i) = \delta_{i,1}(\Im_1) + \ldots + \delta_{i,K}\Im_K + \upsilon_i \qquad (3.1)$$

Where $\Im_i$ is sensitivity of variables to stock returns. For every variables, $E(\Im_i) = 0$. Practically, we rather define an *f* as deviation of returns from what was expected. Often we assume $E(\Im_i, \Im_j) = 0, \forall \; i \neq j$. Thus, we re-specified our model is:

$$R_i = E(R_i) + \delta_{i,1}\Im_1 + \ldots + \delta_{i,K}\Im_K + \upsilon_i \qquad (3.2)$$

Where $\delta_{i,j}$ denotes the loading of the i^{th} stock on the j^{th} macroeconomic variable and it explains by how much quantity stock return rises when the variable is one unit higher than expected. The υ_i denotes the idiosyncratic risk. So, υ_i is negative when a firm loses large contract. Going by the usual econometric assumption, $Cov(\upsilon_i, \upsilon_j) = 0$ for all securities *i* and *j*. In this study, we estimated variance-components equation and fixed effect model. The variance-component model was estimated with the panel GLS estimator:

$$R_{it} = \delta + G_{it}\Im_i^{'} + \upsilon_{it}$$
$$\upsilon_{it} = u_i + s_{it}$$
$$u_i \sim IID(0, \sigma_u^2)$$
$$s_{it} \sim IID(0, \sigma_s^2)$$

Where $\Im_i$ is the sensitivity of every variable to stock return. For $i = 1, \ldots, N;\; t = 1, \ldots, T;\; u \text{ and } s$ are serially independent. The *GLS* regression equation is consequently specified as:

$$R_{it} = \delta_{NT} + G'\Im + \upsilon_{it}$$
$$Var(\upsilon) = \sigma_u^2 (I_N \otimes J_T) + \sigma_s^2 I_N$$

Denoting the error variance matrix by $E(\upsilon\upsilon') = \Omega$ the GLS estimation grips the inversion of the $(NT \times NT)$ matrix Ω from a 'spectral' decomposition into orthogonal parts such that:

$$\Omega = T\sigma_u^2 (I_N \otimes \bar{J}_T) + \sigma_s^2 I_{NT}$$
$$= (T\sigma_u^2 + \sigma_s^2)(I_N \otimes \bar{J}_T) + \sigma_s^2 (I_{NT} - I_N \otimes \bar{J}_T)$$
$$= (T\sigma_u^2 + \sigma_s^2) P + \sigma_s^2 Q$$

In effect, cross-section weighted regression is apposite to take care of residuals that are cross-section heteroskedastic and contemporaneously linked. This is derived as follows:

$$\Omega = E(\upsilon\upsilon') = E\begin{bmatrix} \sigma_1^2 IT_1 & 0 & \dots & 0 \\ 0 & \sigma_1^2 IT_1 & \dots & 0 \\ 0 & 0 & \dots & \sigma_1^2 IT_1 \end{bmatrix} \qquad (3.7)$$

By definition, $\bar{J}_T$ is a $(T \times T)$ matrix of elements T^{-1}. Given the properties of the spectral decomposition, we inverted Ω component-wise such that:

$$\Omega^{-1} = (T\sigma_u^2 + \sigma_s^2)^{-1}(I_N \otimes \bar{J}_T) + \sigma_s^{-2}(I_{NT} - I_N \otimes \bar{J}_T)$$

$$GLS\ \ estimator := \left(G'\left[(T\sigma_u^2 + \sigma_s^2)^{-1} P + \sigma_s^{-2} Q\right] G\right)^{-1} G'\left[(T\sigma_u^2 + \sigma_s^2)^{-1} P + \sigma_s^{-2} Q\right] R$$

Given that GLS estimator is invariant to any re-scaling of the transformation matrix, the unidentified weight parameter was estimated as:

$$\hat{P}1 = \frac{\sigma_s}{\sqrt{(T\sigma_u^2 + \sigma_s^2)}} P + Q$$
$$= (1 - \theta) P + Q$$
$$\theta = 1 - \frac{\sigma_s}{\sqrt{(T\sigma_u^2 + \sigma_s^2)}}$$

Therefore, we utilized Nerlove method to estimate σ_u^2 directly from the estimates in a first-step least square dummy variable regression and therein form θ accordingly.

Modelling Stock Volatility

The study modelled stock volatility by variance equation of exponential GARCH model. Thus, mean and variance equations of EGARCH model are specified as:

$$Ln(R_i) = \zeta + \sum_{i=1}^{q} \aleph_j \left| \frac{\upsilon_{t-i}}{\sqrt{R_{t-i}}} \right| + \sum_{i=1}^{q} \Im_i \frac{\upsilon_{t-i}}{\sqrt{R_{t-i}}} + \sum_{j=1}^{p} \phi_j Ln(R_{t-i})$$

Where $\zeta, \aleph, \Im$ *and* β are the parameters of equation. The working of variance equation is that $\Im_i > 0 \ \forall \ i = 1, 2, 3, \ldots, k$ represents significant effect of positive speculation in market. Using return generating process, we calculated the portfolio variance for macroeconomic variables as:

$$Var(R_i) = Var(\delta_{i,1}\Im 1 + \delta_{i,2}\Im 2 + \delta_{i,3}\Im 3 + \delta_{i,4}\Im 4 + \delta_{i,5}\Im 5 + \upsilon i$$

$$Var(R_i) = \delta_{i,1}^2 Var(\Im_1) + \delta_{i,2}^2 Var(\Im_2) + 2\delta_{i,1}.\delta_{i,2}.Cov(\Im 1, \Im 2) + \sigma_{\upsilon,i}^2$$

$$Var(R_i) = \delta_{i,1}^2 Var(\Im_1) + \delta_{i,2}^2 Var(\Im_2) + \delta_{\upsilon,i}^2 \quad (3.3)$$

Equation (3.3) holds for uncorrelated macroeconomic variables. The regular formula for n variables is derived thus:

$$\sigma_i^2(R_i) = \sum_{j=1}^{N} \sum_{K=1}^{N} \delta_{i,j} \delta_{i,K} .\sigma_{j,K} .\sigma_{\upsilon,i}^2 \quad (3.4)$$

Where $\sigma_{j,k}$ denotes covariance between j^{th} and k^{th} variables. The systematic variance is $\sum_{j=1}^{n} \sum_{k=1}^{n} \delta_{i,k} .\delta_{j,k} + \sigma_{\upsilon,i}^2$. The idiosyncratic variance is $\sigma_{\upsilon,i}^2$. The covariance of stocks, *i* and *j* (for two factors) is obtained as:

$$Cov(R_i, R_j) = Cov(\delta_{i,1}\phi 1 + \delta_{i,2}\phi 2 + \upsilon_i, \delta_{j,1}\phi 1 + \delta_{j,2}\phi 2 + \upsilon i \quad (3.5)$$

$$Cov(R_i, R_j) = \delta_{i,1}\delta_{j,1}Var(\phi_1) + \delta_{i,2}\delta_{j,2}Var(\phi_2) + (\delta_{i,1}\delta_{j,2} + \delta_{j,1}\delta_{i,2})Cov(\phi_1, \phi_2)$$

$$Cov(R_i, R_j) = \delta_{i,1}\delta_{j,1}Var(\phi_1) + \delta_{i,2}\delta_{j,2}Var(\phi_2) \qquad (3.6)$$

Equation (3.6) holds for uncorrelated macroeconomic variables. The *APT* provides the impetus for a supply-side modeling of portfolio proceeds and linear combination of exogenous macroeconomic variables, since its beta coefficients denote responsiveness of causal asset to macroeconomic variables. So, variable shocks could cause structural changes in assets' expected returns or in firms' profit level.

Utilizing panel fixed effect estimator to test validity of arbitrage pricing theory, we estimated link involving macroeconomic variables with stock market returns in individual firms enlisted in the *NSE*. There are forty two cross-sectional stocks and five-year time series such that panel is consisted 210 *NT* pooled observations. Given that each cross-sectional unit has equal number of time series observation, we then have a balanced panel.

Explicitly, our panel model for the cross-sectional level of *NSM* is hereby specified as:

$$R_{it} = \delta_{it} + G_{it}^{'}\phi_i + \upsilon_{it} \qquad (3.7)$$

Where R_{it} is stock market returns, $W_{it}^{'}$ is the k vector of macroeconomic variables $G_{it}^{'} = [Ln(f), Ln(b), Ln(d), Ln(m)]$, f is inflation rate, i is the treasury bill rate, d is the index of industrial production, m is the growth of broad money in circulation, υ is stochastic error term in the model specification and ϕ_i is the parameter vector, that is, $\phi_i = [\phi_1, \phi_2, \phi_3, \phi_4, \phi_5]$ for i = 1, 2…., k cross sectional unit of stock.

Each cross-section unit of stock is observed for dated period t= 1, 2…, 210, $\delta_{i,t}$ is common effect of intercept which is assumed to be identical for all the pool of stocks in the Nigerian Stock Market. To detect cross-section heteroskedasticity and contemporaneous correlation, the residual variance-covariance matrix for the equation is specified thus:

$$\Omega = E(\upsilon\upsilon') = E\begin{bmatrix} \upsilon_1\upsilon_1' & \upsilon_2\upsilon_1' & \ldots \upsilon_N\upsilon_1' \\ \upsilon_2\upsilon_1' & \upsilon_2\upsilon_1' & \ldots \upsilon_N\upsilon_2' \\ \upsilon_N\upsilon_1' & \upsilon_N\upsilon_2' \ldots & \upsilon_N\upsilon_N' \end{bmatrix} \quad (3.8)$$

The basic specification treats the pool specification as a system of equation and estimates the model using fixed estimator. This specification is apt when the residual are contemporaneously uncorrelated and the time-period and cross section homoskedastic such that:

$$\Omega = \sigma^2 I_N \otimes I_T \quad (3.9)$$

The coefficients and their covariance are estimated using the techniques applied to the stacked model. Fixed effect estimator allows the intercept δ_i to differ across cross-section units by estimating different constants for every cross section. The fixed effect is computed by subtracting "*within*" mean from each variable and estimating the equation using transformed data as specified:

$$R_i - \overline{R}_i = (Q - \overline{Q})\phi + (\upsilon_i - \overline{\upsilon}_i) \quad (3.10)$$
$$where\ \overline{R}_i = \sum_t R_i / T,\ \ \overline{Q} = \sum_t Q_{it} / T, \overline{\upsilon} = \sum_t \upsilon_{it} / T,$$

Covariance matrix estimates are given by OLS covariance formula applied to mean difference model:

$$Var(\phi_{FE}) = \sigma_w^2(\overline{q}'\overline{q})^{-1} \quad (3.11)$$

Where $\overline{Q}$ represents the mean difference and

$$Var(\phi_{FE}) = \sigma_w^2 = \frac{\upsilon FE'\upsilon FE}{NT - N - K} = \frac{\sum_{it}(R_{it} - R_{it}'\phi FE)^2}{NT - N - K} \quad (3.12)$$

Where $\upsilon FE'\upsilon FE$ is the SSR from fixed effects model. In effect, the weighted statistics are derived from equation (3.12). The rationale for panel fixed effect estimator is that it cognizance heterogeneity effect of the individual firms.

Panel Unit Root and Co-integration Test

The study utilized Im, Pesaran and Shin (IPS) unit root test to test for the presence of unit root in panels that combines time series with cross section dimension, such that lesser time observations are required for the test to have power. IPS begins by specifying an ADF equation for every cross-section with individual effects and no time trend:

$$\Delta R_{it} = a_i + \Im_i R_{i,t-1} + \sum_{j=1}^{\Im_i} \phi_i \Delta G_{it} + \mu_{it} \qquad (3.13)$$

Where $i = 1, . . ., N$ cross-section units, that are observed over periods and $t = 1, . . ., T$. The G_{it} represent the exogenous variables in model with fixed effects or individual trends, ρ_i are the autoregressive coefficients, and errors μ_{it} are mutually independent idiosyncratic disturbances. The test procedure is that if $|\Im_i| < 1$, R_{it} is weakly (trend) stationary. If $|\Im_i| = 1$ then R_{it} contains a unit root.

We utilized E Views to compute IPS test which is based on Augmented Dickey-fuller (ADF) statistics averaged across groups. The average of the t-statistics for ρ_1 from the individual ADF regressions is computed as:

$$\bar{t}_{NT} = \frac{1}{N} \sum_{i=1}^{N} t_{it}(\Im_i \beta_i) \qquad (3.14)$$

The standardized *t-bar* statistic converges to the standard normal distribution as N and $T \to \infty$.

We utilized the Pedroni test of panel co-integration. The Pedroni's panel co-integration test is based on the estimated residuals from a co-integration regression of the form in equation (3.15) after regularizing panel statistics with correction terms.

$$R_{i,t} = f_i + \delta_i t + \beta_{1i} G_{1i,t} + \beta_{2i} G_{2i,t} + \ldots + \beta_{Ki} G_{Ki,t} + \mu_{i,t} \quad (3.15)$$
$$\forall \; t = 1,\ldots,T; \; i = 1,\ldots,N; \; k = 1,\ldots,K$$

Where T is the number of observations over time, N number of cross-sectional units in the panel, and M number of macroeconomic variables. Thus, f_i is the individual fixed effects parameter which varies across individual cross-sectional units. This also holds for slope coefficients and individual specific time effects, $\delta_i t$.

Variables, Data Description, Measurement and Sources

In this study, we measured stock volatility as the variance of stock market returns over time. Standard deviation measures extent of return fluctuation in relation to its mean over a period. Our variables are inflation rate measured as consumer price index (f), Treasury bill rate (b), index of industrial production (d) and money supply (m). The variables were transformed into natural logarithm to diminish heteroskedasticity.
Data were obtained sourced from different sources. Data on macroeconomic variables were acquired from CBN, while stock returns were acquired from equities report. The data covers January 2000 to September, 2016.

EMPIRICAL RESULTS

The rundown statistics of the variables are provided in Table 4.1. Deviation of variables is relatively high as it portrays enormous variation of the series. Analysis of the results is perhaps reliable to stand the test of time given the co-integrating vector.

Table 4.1: Descriptive Statistics

Variables	Measure	Statistic
Ln(R)	Mean	1.492
	Std. dev	0.256
	Min	-1.635
	Max	1.823
Ln(f)	Mean	9.658

	Std. dev	0.234
	Min	1.398
	Max	2.643
Ln(b)	Mean	1.973
	Std. dev	2.245
	Min	2.589
	Max	4.879
Ln(d)	Mean	12.435
	Std. dev	0.692
	Min	0.594
	Max	6.352
Ln(m)	Mean	5.768
	Std. dev	0.524
	Min	1.298
	Max	2.963

The correlation results are in Table 4.2. A strong positive link involving stock market returns, money supply, growth rate of output and real interest rate is evident. While a fairly weak negative association involving stock market returns, exchange rate and industrial production is observed, the negative relationship between stock market returns and inflation and oil price level is rather strong.

Table 4.2: Correlation Results

Variables	Ln(R)	Ln(f)	Ln(b)	Ln(d)	Ln(m)
Ln(R)	1.000				
Ln(f)	-0.234	1.000			
Ln(b)	0.657	0.826	1.000		
Ln(d)	-0.492	0.856	0.286	1.000	
Ln(m)	0.862	0.542	0.659	-0.286	1.000

Table 4.3 shows unit root results at first difference for IPS test in constant and constant plus time trend. With IPS test, every series is integrated of order one.

Table 4.3: Im, Pesaran and Shin Panel Unit Root Test Results

Variables	Constant	Constant and Trend
Δ Ln(R)	-4.267* (0.000)	-2.291** (0.004)
Δ Ln(f)	-2.958* (0.005)	-3.928* (0.002)
Δ Ln(b)	-2.534** (0.002)	-3.273* (0.002)
Δ Ln(d)	-2.459** (0.008)	-2.549** (0.006)
Δ Ln(m)	-2.964** (0.005)	-2.075** (0.003)
Note: *, ** indicates co-integration at 1% and 5% levels		

The results of panel co-integration test are as presented in Table 4.2. The results reject the null hypothesis of no co-integration at the 5% for the Panel ρ-Statistic, Panel t-Statistic, Group ρ–Statistic and Group t-Statistic. These results are analogous to outcomes of the model in constant level only.

Table D: Pedroni Panel Co-integration Test

Test	Constant	Constant and Trend
Panel v-Statistic	-1.068	-1.845
Panel ρ-Statistic	-2.925**	-2.634**
Panel t-Statistic: (non-parametric)	-1.546	-0.325
Panel t-Statistic (adf): (parametric)	-2.982**	-2.591**

Group ρ–Statistic	-3.782^{*}	-2.468^{**}
Group t-Statistic: (non-parametric)	-1.693	-1.296
Group t-Statistic (adf): (parametric)	-4.728^{*}	-3.287^{*}

(a) The Pedroni critical value of k < -1.64 acceptance of alternative except the v-statistic that has a critical value of k > 1.64 suggests rejection of the null.
(b) *, ** indicates co-integration at 1% and 5%, level

The GLS and fixed effects results are shown in the Table 4.4 below. A comparison of both estimates shows similar findings that inflation, Treasury bill rate and money supply are significant in explaining stock market returns in Nigeria while industrial production is statistically insignificant. The estimated result validated positive association involving money supply stock return with a significant coefficient of 0.537 and 0.53 for the GLS and fixed effect respectively.

Significant negative coefficients of inflation rate on stock return was obtained as seen in the coefficient of -1.052 and -0.273 respectively for the GLS and fixed effects. In fact, with inflationary tendencies, prices are rising and as such stock return would decline. This further highlights import dependence of Nigerian economy. So, fallen Naira will skyrocket the price level and this discourages saving for investment.

The estimates also reported significant negative impact of Treasury bill price on stock return with coefficients of -0.453 for GLS estimator and -0.039 for fixed effects estimator respectively. The negative coefficients could be interpreted to mean that increase in rate of Treasury bill discourages investment in the stocks of Treasury bills. Hence, the adverse effects on stock return.

Table 4.4: GLS & Fixed Effects Results

Variables	GLS Estimates	Fixed Effects Estimates
c	-1.347** (2.050)	-1.225** (3.624)
Ln(f)	-1.052** (2.391)	-0.273* (2.152)
Ln(d)	-0.231 (1.364)	-0.051 (1.123)
Ln(b)	-0.453** (7.568)	-0.039** (9.326)
Ln(m)	0.537 (16.142)	0.253 (1.902)
Adjusted R^2 F-stat.(Prob)	0.32 2.35(0.002)	0.34 2.453(0.003)

The results of exponential GARCH model are reported in Table 4.5 below. The EGARCH effect is statistically significant even at 1%. The negative coefficient of (-1.569) is shows stock volatility have harmful effects on returns. In fact, the results amplify asymmetric volatility effect on stock market in Nigeria.

Table 4.5: EGARCH (3,3) Model Results of Stock Returns

Variables/Coefficients		z-statistics	prob
RESID(-1)^2	-2.373	-5.324*	0.000
EGARCH(-1)	-1.569	-33.947*	0.000

ζ	-2.373	-1.924**	0.000
$\aleph_1$	1.986	7.528*	0.000
$\aleph_2$	0.345	2.469**	0.005
$\aleph_3$	-0.638	-9.359*	0.000
$\Im_1$	1.354	0.472	0.349
$\Im_2$	1.348	23.584*	0.000
$\Im_3$	0.592	15.743*	0.000
ϕ_1	-2.736	-1.845***	0.000
ϕ_2	-1.045	-7.439*	0.000
ϕ_3	-0.845	-26.472*	0.000
Adjusted R^2= 0.25, F-stat. 2.563(0.000), Durbin-Watson = 2.40, See = 0.005, sum of square residual = 1.38-9, Wald statistic = 0.000 *,**,*** indicates 1%, 5%, 10% statistical significance level respectively			

Utilizes the Lo and MacKinlay (1988, 1989) overlapping variance proportion test to examines predictability of data by comparing variances of differences of the data (returns) calculated over different intervals, the study evaluated empirical evidence for otherwise against the restriction of random walk given variance ratio test results of in Table 4.6 below. The s.e.e assume no heteroskedasticity and included observation after adjustment stood at 1326. The user-specified lags for the variance test include 3, 8, 12 and 36.

Table 4.6: Variance Ratio Test

Variance ratio	z-statistics	Probability
1.836	2.917	0.002
1.542	5.368	0.000
1.736	2.569	0.005
1.926	3.6042	0.001

Joint Tests	Value	Probability
Max|z|@ (period 8)*	5.368	0.000
Wald (chi-Square)	35.270	0.000
Probability is based on studentized highest modulus with parameter figure 6 and infinite df		

Thus, the statistical significance and validity of variance ratio results for homoskedastic random walk were ascertained using the asymptotic normal distribution of Wild bootstrap (Kim, 2006) to evaluate. Given that we have specified above one test period namely, 3, 8, 12 and 36, there are two categories of test results. These include *joint* and *individual test* results.

The joint test is test of joint hypothesis for all the periods, while individual test is variance ratio as conducted on individual period. Results show the Chow-Denning maximum|z| statistic of 4.295 for period 8 individual tests. The p-value of 0.000 is obtained using the studentized highest modulus with infinite *df* in order that null of random walk is rejected. The Wald statistic for the joint hypotheses also invalidates hypothesis of random walk.

CONCLUSION

The study tests validity of arbitrage pricing theory for NEM and the volatility therein. This was conducted by estimating the EGARCH model together with the GLS and fixed effects models with cross section specific coefficients of the stocks enlisted in NSEM. The policy implications are indeed uncomplicated as the study upholds the *APT* theory for Nigerian Stock Market. Accordingly, money supply had significant positive outcome on stock return, Treasury bill rate plus inflation rate had significant negative outcome on return of NSEM. In particular, the EGARCH effect was found statistically significant with the implication that stock volatility is harmful stock return. This indeed validates NSE as vulnerable to the instability in the market. The study so recommends the requirement for stock investors to be cognizant of trend of both domestic macroeconomic fundamentals.

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