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Verifying the Effects of Risk Variables on Return Volatility of Sector Price Indices in the Nigerian Stock Exchange

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Abstract

The aim of this paper is to determine whether risk variables in particular interest rate and exchange rate play any important role in predicting sector price indices in the stock market. The stock market indices used include All-share index, banking index, insurance index, food and beverage index and oil and gas index .Index return and volatility is estimated using GARCH (1, 1).The findings revealed that exchange rate has a high negative influence on All-share index (ASI) and food and beverage index (FBI), while interest rate has a high significant negative impact on Oil and Gas Index (OGI). The variance of these indices also varies overtime. In other words, these indices exhibit volatility clustering. Worthy of note is that exchange rate (EXR) affects the volatility of the Food /Beverage index. It therefore implied that investors should watch this trend in return volatility changes before choosing their portfolio of investment for better risk management.

Key words: Sector indices, return-volatility, risk variables, GARCH (1, 1)

Introduction

Common stock value is affected by two important economic and finance risk factors namely interest rate and exchange rate. Interest rate which reflects the price of money also affects other variables in the financial market. Valuation of stock prices is indirectly affected by interest rates while directly its volatility causes a shift between financial markets instruments. Volatility in interest rates affects the valuation of stocks through the basic values of the firm like interest margin, sales etc. In theory it is a known fact that an increase in interest rates negatively affects the value of assets by increasing the required rate of return. It can also make investors to change the structure of their investment from capital market to fixed income securities market. Contrary, a decline in interest rate leads to an increase in the present value of future dividends (Hashemzadeh & Taylor 1988).Confirming, Modigliani & Chon (1979) posit that interest rate is one of the most important determinants of prices.

For foreign exchange rate, the variable is one of the major sources of macroeconomic uncertainty that affects the firm. Theory explains that a change in exchange rates would affect a firm's foreign operation and overall profits which in turn affects its stock prices. Foreign exchange volatility affects the value of the firm. This is because the future cash flows of the firm changes with the fluctuations in the foreign exchange rates. According to Luehrman (1991), when a currency of a country depreciates, the competitiveness of the firms engaged in international competition is affected. How? There will be an increase in the demand for its export foods.

The Nigeria financial system has experienced major changes as a result of financial liberalization and deregulation. Also with the adoption of a floating exchange rate, the economy has become vulnerable to many economic and financial risks. There is the need therefore to investigate whether these two basic financial risks factors – interest rate and foreign exchange rate have significant predictive power on stock return indices and their volatilities. Investment in stock index has of recent gained remarkable attention. Investors have acknowledged many of the advantages with holding index fund rather than having only individual stocks in their portfolio of investments. One of this advantage is risk diversify and a fall in trading costs. Knowledge

of how these sectors are affected by the changes in these macroeconomic variables is important to decision makers and investors. It will be insightful to know how these two different factors may affect stock returns and volatility.

As a central objective, this study seeks to investigate the predictive power of interest rate and exchange rate on the returns and volatility of the All-share index and sector indices in Nigerian Stock Exchange. The use of all the sector indices plus All-share index will indicate which of the indices that is affected more by the risk variables. It is needful studying the indices separately because the nature and composition of each index are different and as such the sensitivity of the sector return series to interest rate and foreign exchange rate volatility will also not be the same. Moreover, economic, social and political risks in the country may influence the sector indices differently. This paper contributes to literature in that it analyses the effects of interest and exchange rates on the stock market return and volatility in a joint framework at the sector index level to obtain more reliable and efficient findings. Previous works in Nigeria have dealt mainly on the stock market per se and All- share index (ASI) alone. The sector indices are a comparative new addition to the stock market having first been introduced in 2008. As such researches on it have been scanty or even nonexistent. Secondly it contributes to literature by considering a long sample period, which is, from the inception of stock indices to the present thereby capturing the whole period of its existence. Furthermore, a cursory examination of foreign exchange rate history in Nigeria shows considerable level of volatility. Therefore it would be interesting to explore the effect of exchange rate volatility on the stock market volatility. With all these shortcomings, the researcher attempts to apply this study to Nigeria. The plan of this paper is as follows: section 2 reviews related literature and is followed by section 3 that outlines the data and methodology. Section 4 reports the empirical findings. Finally section 5 concludes.

Literature Review

There is no shortage of research on the impact of financial and macroeconomic variables on stock prices in different economies. For instance, Maysami and Koh (2000) and Choi et al (1992) investigated the impact of interest rate and exchange rate on the stock returns and showed that both are determinants in the stock prices. Similarly, Ehrhasdt (1991) recorded a strong effect of the interest rates on stock returns. Studying different countries, Campbell (1987), Shanken (1990), Apergis and Eleftherion (2002) confirmed the same result.Yang (2000) studied the correlation between exchange rates and stock prices and found a significant positive correlation between the two. Tabak (2006) analyzed the dynamic relationship between stock prices and exchange rate in the Brazilian economy and revealed that there is no long-term relationship between these variables. Cifles and Ozun (2007) examined the impact of changes in interest rates on stock returns using wavelet analysis with Granger Causality. Using daily closing values of the Istanbul Stock Exchange 100 index and compounded interest rates, they reported that interest rates on stock returns increases with higher time scales. The argument then follows that bond market has significant long-term effect on stock market. Bren et al (1989) examining economic significance of predictable variations in stock returns showed that one-month interest rate is useful in forecasting the sign an well as the variance of the excess return on stocks.

Literature agrees with the idea that volatility of returns in stock prices exhibit time varying conditional variance characteristic which is implied in a Generalized Autoregressive Conditional Heteroscedastity (GARCH) model. Based on these, Erdem et al (2005) analyzed the effects of macroeconomic variables on the Istanbul stock exchange indexes using the Exponential Generalized Autoregressive (GARCH) model to test unvaried volatility spillover for macroeconomic variables. They discovered the existence of unidirectional strong volatility spillover from inflation, interest rate to all stock price indices .In the same vein, Aloui (2006) explored the nature of the mean, volatility and causality transmission mechanism between stock and foreign markets for the United States and some European markets. Adopting the extended Multivatiate EGARH model, the results support the asymmetric and long-range persistence volatility spillover effect and showed strong evidence of causality in the mean and

variance between foreign exchange rate and stock price.

The sector index returns are also used in many studies to measure the impact of interest and exchange rates on them. For example, Malik and Hassan (2004) testing with five major sectors for the events that alter the volatility pattern of financial assets and how unanticipated shocks determine the persistence of volatility over time, detected that accounting for volatility shifts in the standard GARCH model considerably reduces the estimated volatility persistence. They also detected time periods of sudden changes in volatility by using the iterated cumulated sums of squares (ICSS).

Jayasinghe and Tsui (2007) researched the exchange rate exposure of sector returns and volatilities in Japanese industries. With the use of a bivariate GJP – GARCH model on a sample of fourteen sectors, they proved a significant presence of exposed returns and its asymmetric conditional volatility of exchange rate exposure. In addition returns in many sectors are correlated with those of exchange rate changes. Hyde (2007) examines the response of industry stock returns to exchange rate and interest rate risks in four major European economies namely France, German, Italy and the United Kingdom. Results revealed that in addition to exposure to the market, significant levels of exposure to both exchange rate risk in the four countries, and interest rate risk in France and Germany are proved.

Data and Methodology

The monthly closing sector price indices, exchange rates and interest rates are used for the period beginning from 1st January, 2008 to December, 2011. Data were obtained for the sector indices from NSE "FACTBOOK" while data for the exchange and interest rates were sourced from the Central Bank of "Nigeria Statistical Bulletin" .These variables are used to show the impact of exchange and interest rate changes on the underlying index volatility.

All-share index (ASI), food/Beverage (FBI), Banking (BKI), Insurance (INSI), and (OGI) sector indices are implored in the analysis. The Nigerian Stock Exchange (NSE) indices are especially, important to examine. A broad-based index is composed of companies from all sectors of the economy, so it provides an easy way to gauge the performance of the entire market, as well as, by proxy, the economy as a whole. Therefore indices act as indicators of business conditions since stock markets are believed to be sensitive to business conditions. The foreign exchanges are stated in United States dollars per local currency and interest rate is measured as the Treasury bill rate (TBR).

Volatility of monthly sector index returns and the impact of interest and exchange rate changes on index return and volatility is estimated using GARCH (1, 1) model as developed by Engle (1982). GARCH model requires the joint estimation of a mean and conditional variance equation.

To appreciate the impact of the exchange and interest rates changes on the sector indices, two models are employed. Model 1 estimates the volatility of sector index returns series without any exogenous variables whereas in Model 2, exchange rate and interest rates changes are introduced as exogenous variables in the mean and conditional variance equation for the sector index return. The equations are given as :

Model 1

$$Y_{it} = \phi_o + \phi_1 Y_{t-1} + \varepsilon \qquad (1)$$

i=1,2,3,4,5;t =1,2,….30

$$\sigma^2_{it} = ¢_o + ¢_1 \varepsilon^2_{t-1} + \beta_1 \sigma^2_{t-1} \qquad (2)$$

i=1, 2, 3, 4, 5; t=1, 2…30

Where Y_{it} represent returns on the indices All-Share (ASI), Food/Beverage (FBI), Banking (BKI), Insurance (INSI), and Oil/Gas (OGI) respectively.

Model 2

$$Y_{it} = \phi_o + \phi_1 Y_{t-1} + \phi_2 exc + \phi_3 int + \varepsilon_{it} \qquad (3)$$

i=1, 2, 3, 4, 5; t =1, 2….30

$$\sigma^2_{it} = ¢_o + ¢_1 \varepsilon^2_{t-1} + \beta_1 \sigma^2_{t-1} + \delta exc + \eta int \qquad (4)$$

i=1, 2, 3, 4, 5; t=1, 2…30

Where $\phi_o, \phi_1, ¢_O$ $¢_1$ and β_1 are constant terms, Y_{it} represent the return on the indices , the change in the logarithm of the sector price indices in period t, ε is the disturbance term and EXR, INTR are the variables reflecting exchange rate and interest changes or volatility respectively.

Monthly returns are computed as logarithm price relatives given by:

$$Y_{it} = \ln(P_{it} / P_{it-1}) \quad \ldots\ldots\ldots (5)$$

where P_{it} is the monthly price of sector i at time t.

The GARCH (1, 1) model requires that the variables used for the study be stationary. The data were therefore subjected to the Dickey-Fuller 'Unit Root' test for stationarity. This is to avoid misleading results. All analyses were carried out using Eviews while tests of hypotheses are at 5% level of significance.

Results and Discussion

The study investigates the ability of exchange and interest rates changes to impact on the returns and volatility of the Nigerian stock market assuming that these variables can proxy for the rate of information arrivals. The study started its empirical analysis by first testing for stationarity of the time series data to be used for the analysis. This is important because most time series data exhibit non-stationary behavior in their level form that eventually lead to spurious result in the study. For this reason, economic theory requires that variables be stationary before application of standard econometric techniques. The Dickey-Fuller (ADF) test was therefore applied for the stationary test. The result is shown in Table 1. As observed from the ADF result, ASI, EXR, INTR, BKI and FBI were found to be non-stationary at levels but became stationary after their first differences. Hence the null hypothesis of no stationarity was rejected for these variables. However, OGI and INSI were stationary at levels. Therefore, in equations (1), (3) and (4) the first differences of the non-stationary variables were used in the analyses.

In using GARCH (1,1) to investigate the impact of volatility of monthly index returns two models were specified, Model 1 without any exogenous variables while the exogenous variables were added in Model 2. Both models have both the mean and variance equations as shown in Tables 2 and 3.

Table 2 gives the results of the estimation for the mean equation (with and without the exogenous variables) for all the sectors. Here the autoregressive lag parameter (ϕ_1) in insurance and oil/gas sectors are significant at1% , 5% and 10% respectively. Implication of this is that INSI and OGI are affected by their immediate past values. Contrarily, the outcome is different for All-share, Banking, and Food/Beverage. These are not significant. But when the exogenous variables-exchange and interest rates were introduced into the model, the autoregressive lag became significant in ASI sector. Furthermore, the conditional return showed a negative insignificant relationship with interest rates in all the sectors except oil/gas, where the relationship is positive and significant at 5%.

Analysing the variance results in Table 3, $¢_o$, $¢_1$ and β_1 parameters gave different results. $¢_o$ - the constant term in the conditional variance equation is positive in all sectors but significant only in All-share(ASI) and insurance index (INSI) at 1% and 5%. Implicitly, there is significance in the time-invariant component in the return generating process of these sectors unlike in the other sectors. Also in the variance equation the $¢_1$ and β_1 which stands for the Arch and GARCH coefficients respectively are significant at even at 1% level in ASI, BKI, INSI, OGI but only GARCH in FBI. Also it is only the estimate of the GARCH coefficient that is positive in all the sectors. This agrees with the assumptions of the model since variance can never be negative. The negativity of the ARCH coefficient is one of the drawbacks of the ARCH model (Brooks, 2008:392). But the sum of the ARCH and GARCH coefficients is less than one which also agrees with the assumption of the GARCH model. In all cases the magnitude of the GARCH parameter is greater than that of the ARCH. The implication of this is that volatility is more sensitive to its own lagged values than news about volatility from the previous period. This is for the analysis of the variance results without the exogenous variables that is, Model 1.

Then for variance results in Model 2 with the predictors, the constants $¢_o$ are all positive but with only INSI showing significance at even 1% level. The ARCH and GARCH parameters are both significant in ASI but only the GARCH is significant in INSI, OGI and FBI .

With the introduction of the predictors in the variance equations, exchange rates was highly significant to the All-share index in the conditional mean equation but does not affect variance in the variance equation. Interest rate neither affected the variance in the variance equation nor ASI in the mean equation.

It was also revealed that in all cases in Table 3, the sum of the volatility persistency parameters ($¢_1$ and $\beta 1$) is less than one which agrees with the assumption of the GARCH model. Also, the volatility persistent parameter in all the cases varies from each other. They are not identical. One can conclude that most of the persistency in volatility can be as a result of exchange rate and interest rate changes. The results therefore show that the exchange rates and interest rate cause volatility in sector returns.

Summary and Conclusion

This paper is an attempt to verify how the changes in exchange and interest rates can affect the return and volatility in stock indices in the Nigerian stock market. The GARCH modeling technique was employed for the study. The key results emerging from the study is that the lag of ASI is not significant in the ASI equation while the ARCH and GARCH effects are highly significant. The lag of BKI is not significant in the BKI equation while the ARCH and GARCH effects are highly significant. Only the GARCH effect is significant in the FBI model. The lag of INSI is highly significant in the INSI equation while the ARCH and GARCH effects are highly significant too. The lag of OGI is highly significant in the OGI equation while the ARCH and GARCH effects are highly significant too. EXR and the lag of ASI influence ASI in the mean equation. In fact, EXR has a high negative significant impact on ASI. The ARCH and GARCH effects are also significant in the variance equation. Neither EXR nor INTR affect BKI in the mean and variance equations. The same applies to the ARCH and GARCH effects. Only the GARCH effect is significant in the FBI model. EXR has a significant negative impact on FBI in both the mean and variance equations of the FBI model. Also, the GARCH effect is significant. The lag of OGI and INTR are significant in the mean equation of the OGI model. INTR has a significant negative impact on OGI. Only the GARCH effect is significant in the variance model.

In general, it appears that Exchange Rate (EXR) has a high negative influence on All-Share Index (ASI) and Food/Beverage Index (FBI), while Interest Rate (INTR) has a high significant negative impact on Oil and Gas Index (OGI). The variance of these indices also varies over time. In order words, these indices exhibit volatility clustering. One can conclude that most of the persistency in volatility can be as a result of exchange rate and interest rate changes. The results therefore show that the exchange rates and interest rate cause volatility in sector returns. Worthy of note is that Exchange Rate (EXR) affects the volatility of the Food/Beverage Index. It therefore follows that investors should watch this trend in return volatility changes before choosing their portfolio of investments for better risk management.

Table-1: ADF Stationary tests for the variables

Variables	Level	1st Difference
ASI	-2.664331	-6.047398 **
BKI	-2.558872	-6.354799***
FBI	-2.003018	-5.654034***
OGI	-5.068019*	-
INSI	-3.812186***	-
INTR	0.344865	-3.835139***
EXR	-1.719382	-7.423593*
*Indicates stationarity at 5%, ** at all levels,***at 10%		

Table-2: Mean Equation Results

	ASI	BKI	FBI	INS1	OGI
Model 1					
ϕ_o	-2.46E-05	-6.09	6.66	17.65	2.7E-05
ϕ_1	0.182	0.055	0.087	0.871*	0.888*
Model 2					
ϕ_o	3.73E-06	11.8E-05	12.4E-06	6.87E-06	6.47E-05
ϕ_1	0.076	0.026	0.129	0.835	0.540
ϕ_2	-2.54E-06	-7.96	-8.28	-4.402	-3.162
ϕ_3	1.69E-06	3.27	1.33	0.730	-4.415

Table-3: Variance Equation Results

	D(ASI(-1)	D(BKI(-1)	D(FBI(-1)	INS1(-1)	OGI(-1)
Model 1					
$¢_o$	2.67E-06*	42.78	6.59E-06.	4.886***	4.3E-05
$¢_1$	-0.215**	-0.185*	-0.215	-0.1438*	-0.140*
β_1	1.119**	1.107*	0.997*	1.083*	0.974*
$¢_1+\beta_1$	0.904	0.988	0.782	0.940	0.834
Model 2					
$¢_o$	3.96E-05	1.17E-05	2.97E-05	11.0E-06**	9.20E-06
$¢_1$	-0.216*	0.026	-0.219	-0.039	-0.167
β_1	1.126*	0.574	0.975	0.699*	0.887
EXR	-2.51E-05*	-4.591	-1.35E-05	-7.35E-05	-3.768
INTR	-1.46E-06	-8.9E-05	-4.11E-06	3.41E-06	-31.857*
$¢_1+\beta_1$	0.910	0.600	0.756	0.660	0.720

Significant at 5% &1% ; *at 5%.,*at 10%

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