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Augmented Dickey Fuller and Johansen Co-integration Tests of Oil Price Volatility and Stock Price in Emerging Capital Market: A Case of Nigeria

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ABSTRACT:
Generally, high oil prices slow economic growth, cause inflationary pressures and creates global imbalances. In addition, oil price volatility increase uncertainty and restrain the much-needed investment in the capital market. Thus, this paper applies the Augmented Dickey Fuller and Johansen Co-integration Tests in which the effect of oil price volatility, crude oil price and stock price is analyzed in a unifying model. The model is applied to Nigeria using time series data spanning 1980 to 2013. The empirical result suggests that oil price volatility affect stock price positively and negatively. This was confirmed in the normalized co-integrating coefficients that there are positive and negative relationships between the variables. The inference is that when oil price positively affect stock price it mean that stock price is deemed to flourish (i.e. it creates a favorable investment climate) and the negativity indicates that oil price volatility does not mean well for stock price (i.e. it creates an unfavorable investment climate) in the capital market. The higher and more volatile the oil price, the worse the stock price is and vice versa. Based on this, it was recommended that policy aimed at capital market growth should focus on price stability. Also, viable and consistent economic diversification policies aimed at focusing on alternative sources of government revenue is recommended.

Keywords: *Oil price volatility, Stock price, Augmented dickey fuller, Johansen Co-integration, Nigeria*

INTRODUCTION

In Nigeria, oil plays a significant role in the country's economy as the largest contributor in terms of government revenue and also as the overall donor in her exports composition, thus oil revenue forms the pivot for government budgets. Volatility in oil prices may result to a positive (i.e. a boom) or negative (i.e. a collapse) effect on economic activities. This effect is apparent in almost all sectors of the economy including the financial sector where the capital market is a part of partly because of the over-reliance on oil as the main driver of the economy (Edesiri, 2013). The volatility in oil prices has been attributed to a number of factors. OECD (2011) reports that oil price volatility is influenced by a number of factors that is beyond the traditional movements of demand and supply, notably geopolitics. Akpan (2012) opines that the unstable nature of oil prices in Nigeria can be attributed largely due to the country's membership of Organization of Petroleum Exporting Countries (OPEC), political upheavals in the oil-rich region and militancy in the Niger Delta region.

However, Madueme (2011) asserts that oil price volatility manifests on the demand side and

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operates through consumption and investment decisions. Consumption is indirectly affected because of its positive association with disposable income (for instance a rise in oil prices may lead to an increase in the general price level which then reduces consumer's purchasing power). Accordingly, Berument et al. (2009) observe that volatility in oil prices can be either permanent or persistent. When oil prices increase is perceived as permanent, investment decreases. Moreover, if the oil price increase is perceived as persistent, oil is used less in production, capital and labor productivity, hence investment is directly affected. This simply portrays that oil price volatility may have some implications for stock price in the capital market especially where fluctuations in oil prices creates a favorable or unfavorable investment climate.

With regard to oil price volatility, one interesting issue is the effect it may hold for stock prices in an emerging capital market like Nigeria. Hence, persistent volatility in oil prices could imply severe economic implications for stock prices in the capital market. Thus, it is possible to empirically examine if oil price volatility affects stock price in emerging capital market like Nigeria. The next section reviews some prior literatures that have emerged from empirical studies; the third section focus on the methodological approach; section four present a concrete discussion of results and section five concludes the paper as well as recommendations.

Literature Review

Over the years, dozens of researchers have investigated the relationship between oil price volatility and economic growth using some macroeconomic variables in different countries. Diverse techniques of investigation have yielded dissimilar results, sometimes sharply dissimilar, sometimes modestly. For instance, much of the existing literatures investigated oil price volatility and economic growth (Rebecca and Marcelo, 2004; Nouriel and Brad 2004; Lutz, 2006; Lutz and Cheolbeom 2007; Stella and Onyekwere, 2012; Akpan, 2012; Adeniyi, 2012; Edesiri and Ejuvbekpokpo, 2014). Questions regarding the relationship between oil price volatility and stock price are fundamental empirical issues that have attracted attention of researchers in recent times. Specifically, studies are rare, as far as we know in Nigeria that has taken explicit examination on oil price volatility and stock price in emerging capital market. Some studies provide empirical evidences that oil price volatility negatively affect stock market (Cheung and Ng, 1998; Lutz and Cheolbeom, 2007; Bjørnland, 2008; Adebiyi et al., 2012) and some other studies provide empirical evidences suggesting that oil price volatility positively affect stock market (Papapetrou, 2001; Park and Ratti, 2007; Cong et al., 2008; Henriques and Sadorsky, 2008; Afshar et al., 2008).

Cheung and Ng (1998) employed the Johansen co-integration technique and established the existence of long run co-movement between five national stock market indexes and real oil price, real consumption, real money and real output. The study found that oil prices were negatively correlated with stock prices. Lutz and Cheolbeom (2007) by means of a VAR model on the U.S stock market revealed that the response of aggregate U.S. real stock returns differ greatly depending on whether the increase in the price of crude oil is driven by demand or supply in the crude oil market. The study also showed that oil volatility have no significant effects on stock returns but the responses of industry-specific U.S. stock returns to demand and supply volatility in the crude oil market were consistent with accounts of the transmission of oil price volatility that emphasize the reduction in domestic final demand.

Bjørnland (2008) in Norway examined oil price volatility and stock returns in a Structural VAR Model. The study revealed that a 10 percent rise in oil prices, increase stock returns by 2.5 percent with robust results for linear and non-linear measures of oil prices. The study concluded that the Norwegian economy responds to higher oil prices by increasing aggregate wealth and demand, while emphasizing the role of monetary policy shocks, in particular, as driving forces behind stock price variability in the short run. Adebiyi et al. (2012) investigated the effects of oil price volatility and exchange rate on the real stock returns in Nigeria over 1985-2008 using a multivariate VAR analysis. The results showed an immediate and significant negative real stock returns to oil price volatility in Nigeria. The study further indicated that the impact of interest rate on the stock

market is greater than oil price volatility and thus monetary policy responds systematically to oil price volatility by raising the interest rates, leading to a decline in real stock returns.

Papapetrou (2001) examined the linkages among oil prices, real stock prices, interest rates, real economic activity and employment for Greece using a multivariate vector auto-regression technique. The empirical results suggested that while oil prices were important in explaining changes in stock price, stock market returns did not lead to changes in real activity and employment. They however, observed that changes in the oil price affected real economic activity and employment. Park and Ratti (2007) using multivariate vector autoregressive approach for a sample period of 1986:1-2005:12 in Norway found that oil price fluctuations account for 6 percent volatility in real stock returns. However, for most European economies understudied, it has been shown that increased volatility of oil prices significantly depresses real stock returns. In the case of United States, the study divulges that oil price instability, rather than interest rates, explain more of the fluctuations in real stock market returns.

Cong et al. (2008) while analyzing oil price volatility and stock prices of some Chinese oil companies using a multivariate vector-auto-regression observed that oil price shocks do have positive effects only on manufacturing index and some oil companies. The oil price volatility increased the stock returns of manufacturing, mining and petrochemical companies as a result of speculative activities arising from volatility in the oil prices, with less impact on the real stock returns of the Chinese stock market indices. Henriques and Sadorsky (2008) used a VAR model to estimate the relationship between alternative energy stock prices of some companies, technological stock prices, oil prices and interest rates. The study revealed that technology stock price and oil prices Granger causes alternative energy companies' stock prices.

In a study conducted by Afshar et al. (2008) for United States for the period 1990:1 to 2007:2 with the Granger causality approach, three specifications of oil prices on stock returns were explored. They found that oil price declines had a significant impact on stock returns, but not oil price increases. The study further suggested that oil price shocks and the USD currency were important sources of stock return variability. Moreover, concerns over research design and conflicting findings have caused earlier researchers to fail in addressing the position regarding the relationship between oil price volatility and stock price movement in the capital market. Therefore, the position above leaves much gap in literature as to the need for continuous research into the area.

RESEARCH METHOD

This paper applies the Augmented Dickey Fuller (ADF) and Johansen Co-integration Tests (JCT) in which the effect of oil price volatility, crude oil price on stock price is analyzed in a unifying model. The model is applied to Nigeria using time series data spanning 1980 to 2013. The unit root test was used to determine whether the variables under study are stationary or not as well as co-integration test to showcase the existence of a long run relationship of the variables. The econometric model to consider in this regard takes crude oil price and oil price volatility as the independent variables and stock price as dependent variable. The model is specified as:

$$SP = F(OPV, COP) \qquad (Eq.1)$$

Where:

SP = Stock Price
OPV = Oil Price Volatility
COP = Crude Oil Price

Equation 1 can be translated to its explicit form into equation 2 as below:

$$SP_{it} = m_0 + A_1 OPV_{t-1} + A_2 COP_{t-2} + €_t \qquad (Eq.2)$$

Equation (2) specifies the process, where $A_i(_i=1,2,\ldots p)$ are K x K matrices of coefficients, m is a K x 1 vector of constants and $€_t$ is a vector of white noise process. The data for this study were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin and the Nigerian Stock Exchange Fact-book.

RESULT AND DISCUSSION

This section presents the empirical results from the E-views 5.0 Version of Statistical

Software Package. The analysis were done in sections, first was the descriptive statistics, followed by covariance statistics and correlation matrix. The tests for co-integration were in two phases: unit root test (Augmented Dickey Fuller Test) and co-integration test (Johansen Co-integration Test), this concludes this section.

The descriptive statistics showed relatively low variability. The minimum stock price is ₦8 while ₦34 is the maximum. The average (mean) stock price is ₦14. Crude Oil Price (COP), as reported in table 1 gives 41, 32, 90 and 22 as mean, median, maximum and minimum statistics respectively while Oil Price Volatility (OPV) shows negativity for mean, median, maximum and minimum values respectively. Diagnostic test was also conducted. The diagnostic test is used to test whether the errors are normally distributed, whether the variance is constant or not and whether the errors are serially correlated. The result of the Jarque-Bera normality test shows that the errors are normally distributed.

The covariance matrix measures the linear relationship between the random variables. It indicates how much two variables intertwine or change together. Positive covariance indicates that higher than average values of one variable tend to be paired with higher than average values of the other variable vice versa (Ram and Prabhakar, 2010). In table 2, it was evident that the values in the covariance matrix are positive and negative thus, these variables are directly and inversely related.

The correlation matrix in table 3 shows the relationship between the variables under study. The study found that the correlations are mixed (i.e. positive and negative). The highest at the same time correlations are shown between the independent variables of crude oil price and oil price volatility. Crude oil price is negatively related with stock price while oil price volatility is positively related with stock price.

Table 1: Descriptive statistics of variables (1980 – 2013)

	SP	COP	OPV
Mean	13.602031	40.7156%	-7347842
Median	21.88610	31.5021%	-5982926
Maximum	33.51284	90.0113%	-4495250
Minimum	8.218374	22.3400%	-43749015
Std. Dev.	54.45080	21.0182%	6695522
Skewness	0.295532	1.0801	-4.282818
Kurtosis	1.217738	2.674579	19.94285
Jarque-Bera	3.378904	4.573858	345.4123
Probability	0.184621	0.101578	0.000000
Sum	1380.462	468.7300	-1.48E+08
Sum Squares Dev.	65227.56	9718.848	9.86E+14
Observations	34	34	34

Source: Computed from data via E-view

Table 2: Covariance statistics

Variables	SP	COP	OPV
SP	2835.98	-477.93	32702175.42
COP	-477.93	422.56	29070891.27
OPV	32702175.42	29070891.27	42880880803596

Source: Computed from data via E-view

Table 3: Correlation matrix

Variables	SP	COP	OPV
SP	1.00		
COP	-0.55	1.00	
OPV	0.09	0.33	1.00

Source: Computed from data via E-view

Table 4: Augmented dickey fuller unit root test

Variables	ADF t-statistics	Critical Value	Order of Integration
SP	-3.9710	-3.7880	I(1)***
COP	-5.5194	-3.8085	I(1)***
OPV	-5.05	-3.7695	I(0)***

Source: Author's Compilation
* implies significance at 10 percent
* implies significance at 5 percent
* implies significance at 1 percent

Table 5: Johansen co-integration test

Null Hypothesis	Trace Tests	χMax-Eigenvalue	Critical Value (95%) TT	Critical Value (95%) MAX
r = 0*	137.03	108.19	47.86	27.58
r ≤ 1	28.85	20.28	29.80	21.13
r ≤ 2	8.57	8.54	15.49	14.26
Parameter Estimates (Normalized)			**Co-integrating Vector**	
	Variables			
	SP		1.0000	
	COP		-0.8957	
	OPV		0.000005	

Source: Computed from data via E-view
r = represents the numbers of co-integrating vectors in the system indicated by asterisk (*). The Critical Values is 5% significant level. Asterisk (*) denotes rejection of the hypotheses at the 5% level.

A test to show whether the variables are stationary or not was performed; if a series is stationary, then all the usual regression results suffer from spurious regression (Granger and Newbold, 1977; Gujarati, 2003). In this regard, the Augmented Dickey Fuller, ADF (1979, 1981) test was performed both on the levels and the first differences of the variables. Ramanathan (1992) emphasized that the first or second differenced terms of most variables will usually be stationary. In table 4, it was evident that the ADF indicates that stock price and crude oil price are integrated of order one, I (1) while oil price volatility is stationary at levels I (0).

The purpose of the co-integration test is to show the existence of a long run relationship of the variables. Van den Berg and Jayanetti (1993) argued that the co-integration test procedures of Johansen and Juselius can distinguish between the existences of one or more co-integrating vectors and also generate test statistics with exact distributions. Thus, the Johansen co-integration results in table 5 shows support for the existence of long run relationship among stock price, crude oil price and oil price volatility. The Trace and Eigenvalue tests show at least one co-integrating vector each at 5% level. The result suggests the existence of a long

run relationship in the model. The normalized co-integrating coefficients as shown in the last row of table 5 above confirm that there are positive and negative relationships between oil price volatility, crude oil price and stock price.

CONCLUSION

This study investigates the relationship between oil price volatility, crude oil price and stock price in emerging capital market using time series data spanning 1980-2013 by applying the Augmented Dickey Fuller (ADF) and Johansen Co-integration (JCI) Tests. The empirical result suggests that oil price volatility and crude oil price affect stock price positively and negatively. This was confirmed in the normalized co-integrating coefficients. The normalized co-integrating coefficients as shown in the study suggest that there are positive and negative relationships between the variables. The inference is that oil price positively affect stock price meaning that stock prices are deemed to flourish (i.e. creating a favorable investment climate) and the negativity indicates that oil price does not mean well for stock price (i.e. creating an unfavorable investment climate) in the capital market. The higher and more volatile the oil price, the worse the stock price is and vice versa. Thus, policy aimed at capital market growth should focus on price stability in which changes in oil price play a significant role. Also, viable and consistent economic diversification policies aimed at focusing on alternative sources of government revenue is recommended for emerging capital market. Finally, there should be reduction in monetization of crude oil price and aggressive saving of proceeds from oil boom in order to withstand vicissitudes of oil price volatility on stock price in the capital market in future.

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