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Examining the Effects of Oil Price Long Memory and Exchange Rate Long Memory on Stock Market Behavior in Nigeria

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ABSTRACT

The study examined the effect oil price long memory and exchange rate long memory on Nigeria's stock. We have used ARMA estimating techniques to assess whether one or both variables exert impact on the stock market in Nigeria. Our result shows that long memory stock price is driven by a long memory of the exchange rate and long stock of the oil price. We therefore recommend that policymakers pursue policies aimed at stabilizing, on the one hand, the exchange rate regime and ensuring the economy has a position in net oil exportations. We also recommend the development of portfolio strategies by market practitioners so that long-term memory in exchange rates as well as in oil pricing are considered when making investment decisions.

Keywords: Exchange Rate, Oil Prices, Share Prices, Long Memory, ARMA
JEL Classifications: G15, Q43, C58, O40

1. INTRODUCTION

The theoretical basis through which the multifactor framework is used to determine stock market prices and the long memory mechanisms is set out in the arbitrage pricing theory (APT), 1976 several literatures have been investigating stock market behavior using a number of variables since the theoretical analysis was introduced in 1976. It is theory that, by means of the expected dividends, discount routes or both, any anticipated or unexpected arrival of new information on macroeconomic bases will influence stock price behaviour. The objective of this study is to explore the long stock market memory as induced by long exchange rate memory and long oil price stock, with the help of data from 1985 to 2018 from the Nigerian economy. Virtually all different economic actors need to consider this relationship. The investors will find that knowledge of inestimable value can be used to build portfolio strategies for this relationship, on the other hand, since it will help analyze the transmission channel between the variable, thus facilitating better policy formulations.

According to Basher et al. (2012), literature on the relationship between these three variables, namely stock prices, petroleum prices and exchange rates can be divided into two main areas in general. The first strand is about the link between the price of oil and the bourses while the second strand deals with the relationship between the price of oil and the exchange rate. They observed that the relationship between the two literature strands has still to be studied, particularly from the perspective of emerging economies.

Furthermore, Chinzara (2011) classified studies into two categories, the first set of literature studies at first instance using model VAR, multivariate cointegration, Autoregressive distributed lag, and the second set of literature studies on the link between stock market and macroeconomic variables (exchange rate and oil price). The study of the relationship between stock market prices and macroeconomic variables at the second stage is believed to produce better results for significant policy formulation (Hsing, 2011; Chinzara, 2011; Isola et al., 2015; Lawal et al., 2016: 2017a: 2017b; Otekunrin et al., 2018; Dahunsi et al., 2019; Hsing, 2011). The literary approach to the relationship was most frequently taken using data from the Nigerian economy (Somoye and Ilo, 2008; Ologunde et al., 2006; Oracle and Okoro, 2014; Okere et al., 2019; Lawal et al., 2018a: 2018b).

Our article aims to advance literature by exploring the relation between the three variables from the second strand of the moment. The question is whether Nigeria exchange rates have long-lasting stock memory? Will long stock price memory in Nigeria exert long memory on stock market? Where there competitive in the stock market in Nigeria? These are the questions to be addressed in this paper.

The remaining articles are arranged as follows: The literature review is summarized in Section 2; Section 3 discusses the data and methods used; Section 4 interprets the results; Section 5 summarizes the analysis and provides a policy recommendation.

2. LITERATURE REVIEW

2.1. Theoretical Structure

The APT by Ross (1976) is a theoretical framework connecting macroeconomic variables and the price/return in stock markets. The theory provides the basis for a multivariable structure in the relationship between asset and real estate. According to the theory, a certain number of macroeconomic factors affect stock price, altering stock price behaviour. The theoretical connection between stock prices and foreign exchanges can be classified into three main approaches: Flow-oriented approah, an approach that explains that currency fluctuations cause stock price changes by changing company cost structures across international exchanges; stock – oriented approaches which found that the causality flows constitute exchange price stock through fluctuation in both foreign capital inflows and outflows due to price fluctuations; and the Indifferent approach that states neutrality of relationship between asset prices and other fundamentals Rigobon and Sack, 2004; Lawal et al., 2019; Dornbusch and Fisher, 1980; Dreger and Reimers, 2016.

The theoretical connection between oil prices and the movement in stock prices is rooted in a theory of substitution. In this regard, it was expected that the rise in oil prices would raise the production cost which would affect income negatively. The rise in production costs caused by higher petroleum prices may be handed over to consumers in the form of higher prices for final goods and services, but higher prices in oil can shift demand in the face of the degree of demand elasticity (this can also lead to lower profits). Basher et al. (2002), noted that higher oil prices are often viewed as inflationary by policy makers, thus increasing interest rates in order to cope with inflationary pressure, affecting the discount rate for the bond pricing (Sadorsky, 2006: 2014; Salisu and Mobolaji, (2013).

2.2. Empirical Literature

2.2.1. Oil price and stock market long memory

The literature on the relationship between oil and exchange prices, and equity price, as stated by Basher et al. (2012), can be largely divided into two streaming literatures: Literature on the relationship between oil and inventory prices, on the one hand; and literature about the relation between oil prices and exchange rates, on the other. The authors have argued that the links of oil-price and stock-price-exchange-rating between these two classes have been very retrograde. Several recent literatures have studied the relation between the stock market and certain macroeconomic factors; and between long stock market history and long memory of oil prices, in particular in the developing economies. Some of this literature is mentioned here briefly. A number of works have been published in literature on South Africa's economy which examined the relationship between stock prices, exchange rate and oil price. The links between stock prices for example and several macroeconomic variables for South Africa, Zimbabwe and Botswana were examined by Jefferis and Okeahalam (2000). Their results show that there is a positive connection between stock and real currency. Chinzara (2011) observed the significant effect of long exchange memory on stock price in the South African economy, while the effect on stock market of the price of oil was less important. Hsing (2011) pointed out that South African stock market indexes and nominal, effective exchange rates have a negative but insignificant link. Gupta and Modise (2013) found a positive relationship exit for the economies of South Africa between stock prices and global oil prices.

Zarour (2006) used VAR to look at the ratio of the oil pricing with five Gulf countries stock markets for 2001-2005 and found that oil price increases in long-term memory led to an increase in long-term stock market memory Zhong and Enke, 2017; Zhang et al., 2017. Ågren (2006) used the asymmetric variant of the BEKK-GARCH model (1, 1) to analyze weekly data from 1989 to 2005, with a view to examining the long transmission memories from oil prices into stocks in some of the five major countries of Japan, Norway, Sweden, the United Kingdom and the U.S. He also noted that evidence of strong spillover of long-term memory exists in the economies except Sweden, coming from oil to all stock markets. Malik and Hammoudeh (2007); Hammoudeh et al. (2009) have analyzed the US equity, gulf equity and crude oil markets for the period 1994-2001 using a multivariate GARCH model to investigate their long memory and shock transmission mechanisms and observed long memory transmits over the samples from the oil market to equity markets in the gulf. The analysis also showed remarkable results for the Saudi Arabia economy, as long as the stock market to oil markets were spilling over, and the authors attributed the development to Saudi Arabia's significant role in the world petroleum market (Banumathy and Azhagaiah, 2015; Balcilar et al., 2014; Balcilar et al., 2017).

For the China economy, Rong-Gang et al. (2008), using VAR techniques, analyzed the interactive relationship between long memory oil prices and China's stock market, found that long memory oil price had no significant impact on stock returns. However, the authors also observed that the long memory of oil prices has a negative effect on Chinese stock prices of oil companies. Malik and Hammoudeh (2007) analyzed for the period 1992-2008 long memory transmission of oil prices and stock prices using BEKK GARCH and found that there was substantial long memory transmission from oil prices to the various industries studied for the period 1992-2018. Oberndorfer (2009), using the techniques of the ARCH and GARCH estimates, considered the relationship between energy market trends, energy prices and stock prices in the Eurozone from 2002 to 2007 and pointed out the negative relationship between long memory of oil prices and the eurozone return on stocks Aloui and Jammazi (2009) used the regime's switching estimation technique for Markov to analyze the conditional correlations and long-lasting memory spillover between the crude oil and the stock market indices for the economies of France, Japan and the UK for the period of 1998 to 2009. And observed that the increase in oil prices influenced considerably for the three economies ‘ long stock market memory (Aloui et al., 2016; Aloui and Hkiri, 2014; Aloui et al., 2016; Jammazi and Roboredo., 2016).

Hammoudeh et al. (2009) used VAR-GARCH models for the economies of the GCCs of Kuwait, Saudi Arabia, Qatar and the UAE to investigate the long memory and transfer competitive exchange of stock and oil between the markets of these economies. Their findings show that past memory is more critical than previous shocks, and that the sectors in individual countries except Qatar share a mild, long memory break. Their outcomes are supported, who have noted that Qatar, the United African Arabs and the UK indicate a long-term stock return response to oil than others (Kuwait, Oman, the UAE, Bahrain, Qatar, the United Kingdom and America) (Bouri et al., 2016; Bouri et al., 2017).

Similarly, ARJI (-ht)—GARCH models were used by Chuanguo and Chena (2011) to estimate data on China's 1998-2010 economy to examine the effect on the Chinese stock market of global oil price long memory, finding a positive relationship between world oil prices and China's inventory.

Filis et al. (2011) used DCC-Garch model to investigate the time – a variation in correlation between the stock and oil prices of the oil import and export economies from 1997 to 2009, and observed the negative link between the price of the oil and the entire stock market investigated except for the financial crisis in 2008 (Sadorsky, 2012; Basher et al., 2012; Huang et al., 2016).

2.2.2. Exchange rate - stock market long memory

The link between the exchange rate variation and the stock price can be traced to works by Chen et al. (1986); Solnik, (1987); Dhornbush and Fischer, (1980). In addition, Soenen and Henniger (1988) analyzed the correlation between the double one using the data from developed economies; Bahmani-Oskooee and Ng (2002) later explored the relation between the two variables by using cointegration estimating techniques, documenting that there exists, in the short term, a bi-directional causality between them but that no long term relation exists between them. Najang and Seifert (1992), using GARCH models in the study of daily data from USA, Canada, United Kingdom, Germany and Japan, analyze the relationship between these two variables. They recorded the major effect on the long-range exchange rate of stock fluctuations. Similarly, in the analysis of daily data for 8 economies from 1985 to 1991, Ajayi and Mougoue (1996) used error correction model and causality tests, observing the long-term impact of upward change in domestic stock prices on the domestic currency. It was also documented that the short- and long-term effects of depreciation on the stock market (exchange rate fluctuation) on the economies under study (Ajayi et al., 1998). Abdalla and Murinde (1997) observed that causality for the Asian economy was from the exchange rate fluctuation to stock price movements for the Indian, Korean and Pakistani economies; however, causality for the Philippines is from the stock market to the exchange. This is contrary to Smyth and Nandha (2003), which stated that there is no relationship between the variables in Pakistan, India, Bangladesh and Sri Lanka over the long term, though the causal unidirectional character of the exchange rate with Indian and Sri Lankan stock prices exists. Morley and Pentecost (2000) described the effect on the G-7 countries of foreign exchange controls on adjusting the exchange rate relationship to stock prices in 1980. in the G-7 countries. Ibrahim and Aziz (2003) have documented that between 1977 and 1998 there was a negative relationship between exchange and stock market for Malaysia. The findings of Ozair (2006) were supported by Nieh and Lee (2001) who find no substantial causality among two variables but contradict Vygodina (2006) which set causality in relation to high-cap exchange rates. Ozair (2006) found that neither a causality nor a cointegration exist for the US economy Pan et al. (2007) found that exchange causality and stock price are two-directed for Hong Kong before the Asian cries in 1997, while the exchange rate and stock price causality for the economies of Japan, Malaysia, Thailand is unidirectional for Korea, and Singapore. A unidirectional causal association has been found by Takeshi (2008) between stock prices and exchange rates in the Indian economy. Agrawal et al. (2010) noted that there is no connection between the two Indian economy variables using daily data from October 2007 to May 2009 and that there is a unidirectional relation between stock return and exchange rate.

The above presents a summary of the empirical literature on stock market volatility, oil price volatility, and exchange rate fluctuations, which shows that no substantial work has been done to analyze the relation using the Nigerian economic data, while Nigeria is a major player on the global petroleum market and is the world's largest economy in Africa, This study therefore aims at advancing literature by examining the relationship between the trio in order to enhance decision making by investors on the one hand, and good policy formulation on the other, in relation to the selection of portfolios.

3. DATA AND METHODOLOGY

3.1. Data

Data for the research were collected from the Statistical Bulletin of the Central Bank of Nigeria (several issues). For 1985 to 2018, data are given in monthly form. The year 1985 was chosen because it was known publicly for the year of All Share Index (ASI) while 2018 was chosen as the current month statistics. All variables have been translated to real value for analytical purposes.

3.2. Methodology

The main objective of the research was to study the effect of the long memory of exchange rates and oil price on stock prices using ARMA estimating techniques.

We have done this by following Nelson (1991) to derive the EGARCH equation

$$log\, h_t = \alpha + \theta\, log\, h_{t-1} + \lambda \frac{\epsilon_{t-1}}{h_{t-1}^{1/2}} + \vartheta\left[\frac{|\epsilon_{t-1}|}{h_{t-1}^{1/2}} - \sqrt{\frac{2}{\pi}}\right] \quad (1)$$

Where h_t represent the conditional variance for year t $h_t^{1/2}$ is the conditional long memory prediction for year t; $\frac{\epsilon_t}{h_t^{1/2}}$ represents the standardized shock for year t. it shows the number of standard deviation that ϵ_t has deviated from its mean and ϵ_t represent the error term of a prediction model of a time series.

Both the $\frac{\epsilon_{t-1}}{h_{t-1}^{1/2}}$ and $\left[\frac{|\epsilon_{t-1}|}{h_{t-1}^{1/2}} - \sqrt{\frac{2}{\pi}}\right]$ represents the news impact curve of the model. The $\frac{\epsilon_{t-1}}{h_{t-1}^{1/2}}$ is the standardized innovation at t–1 and is usually centered at $\epsilon_{t-1} = 0$. Given that ϵ_t is conditionally normal, $\frac{|\epsilon_{t-1}|}{h_{t-1}^{1/2}}$ will follow the half normal distribution with the mean $\sqrt{\frac{2}{\pi}}$ such that $\Delta\eta\left[\frac{|\epsilon_{t-1}|}{h_{t-1}^{1/2}} - \sqrt{\frac{2}{\pi}}\right]$ is the standardized absolute innovation at t–1.

In order to deepen our knowledge of the news impact of the model, we followed Engle and Ng (1993); Engle (2004); Engle and Siriwardane, (2014) to derive equation (2) as follows

$$(1-\eta)\left[\frac{|\epsilon_{t-1}|}{h_{t-1}^{1/2}} - \sqrt{\frac{2}{\pi}}\right] = \mu; \mu_t \approx \vartheta \frac{|\epsilon_{t-1}|}{h_{t-1}^{1/2}}(0,\infty) \quad (2)$$

Under this condition, the $e^{\gamma \frac{\epsilon_{t-1}}{h_{t-1}^{1/2}}}$ implies a normal variate skewed to the left, and the γ determines the degree of skewness.

By rearranging equation (2), we will be able to determine the combined impact of both the α and γ in our results, thus we derived

$$h_t = \Delta h_{t-1}^{\beta} \times e^{\left(w-\sqrt{\frac{2}{\pi}}\alpha\right) + (\gamma-\alpha)\frac{\varepsilon_{t-1}}{h_{t-1}^{1/2}}} \text{ when } \epsilon_{t-1}>0 \quad (3)$$

and

$$h_t = \Delta h_{t-1}^{\beta} \times e^{\left(w-\sqrt{\frac{2}{\pi}}\alpha\right) + (\gamma-\alpha)\frac{\varepsilon_{t-1}}{h_{t-1}^{1/2}}} \text{ when } \epsilon_{t-1} \quad (4)$$

Following Zhang and Li (2018), we account for the long memory in the series by employing ARMA models stated as follows:

$$(1–L)\partial y = \mu;\ \mu_t \sim iid\,(0, \sigma^2) \quad (5)$$

Here, L is the lag operator, the standard white noise is represented by μ_t and the constant variance is σ. The minimization objective is obtained as follows:

$$Q_m^*(G,d) = m^{-1}\sum\nolimits_{j-1}^{m}[In\left(G\lambda_j^{-2d}\right) + \frac{\lambda_j^{2d}}{G}I(\lambda_j)] \quad (6)$$

Specifically, for $0 \le d \le 0.5$, y_t is stationary but has a long memory, if $0.5 \le d \le 1$, the procedure is covariance nonstationary, but unlike the $I(1)$ procedure, it implies existence of mean-reversion, suggesting that a shock to the underlying assets will have a temporary effect with the chances of self-adjustment to equilibrium.

When d is smaller than 0.5, this suggests that the long run equilibrium exists and could be re-established quickly in case of any unforeseen external shocks. When the order of d lies between 0.5 and 1, this suggests existence of long run, though longer time is required for assets to revert to equilibrium in case of any shock. When d is equal to 1 or higher, no long run equilibrium exists, and the impact of the shock could have a permanent effect.

For d to be consistent, m is expected to grow faster than d. For consistent results, m should be estimated for 0.5, 0.55, and 0.6 in order to check for robustness. A parameter δ between 0.45 and 0.70 is often considered as consistence.

4. PRESENTATION OF RESULTS

This section presents the results of the various estimation techniques used in conducting empirical analysis of data in this study.

Table 1: Descriptive statistics of all the variables

Parameters	ASI	OIL	EXC
Mean	1.7659	0.8754	2.5191
Median	1.6300	0.6403	0.5402
Maximum	38.1840	60.4032	392.9435
Minimum	–30.643	–27.4076	–19.4390
Std. Dev.	7.1430	9.6208	25.3720
Skewness	0.1278	0.7034	10.7839
Kurtosis	11.5415	8.059796	17.5643
Jarque-Bera	872.8391	382.9121	32882.7
Probability	0.000000	0.000000	0.000000
Sum	610.0714	284.7051	841.6337
Sum Sq. Dev.	13878.49	29677.39	177780.3
Observations	3586	3586	3586

Source: Authors' computation 2020

4.1. Descriptive Statistics

Table 1 presents the descriptive statistics of all the variables used in this work. We employed the Jarque-Bera (JB) test to examine the normality of the time series used to know if the series follow the normal probability distribution. From the table, it can be deduced that the JB test result are large for all the variables thus we concluded that variables are not normally distributed. In other word, we reject the null hypothesis of normality for the variables.

4.2. Correlation Matrix

The result of the correlation analysis is shown in Table 2, from the result, it can be deduced that both negative and positive relationship exist among the variables. For instance, a positive relationship exists between the ASI and oil price (OIL), while the relationship exhibits a negative sign between ASI and exchange rate (EXC). From the result, it can also be seen that when exchange increase by 1%, stock price decreases by 3.9%. The implication is that increase in exchange rate causes investors to shy away from the market and offload stocks; this will force stock prices to fall by 3.9%. The result of the oil price – ASI nexus shows that when oil price fall by 1%, ASI will increase by 1.9%.

Form the results in the Table 3, it can be deduced that the unit root for all the variables are stationary at level since the critical values is greater than ADF statistics, thus we reject the null hypothesis.

Table 2: Correlation matrix results

	ASI	OIL	EXC
ASI	1.000000	0.01954	–0.03459
OIL	0.01954	1.000000	0.01954
EXC	–0.03459	–0.03459	1.000000

Source: Authors' computation (2020)

Table 3: ADF, KPSS, and Peron unit root tests

Variables	ADF Statistics	KPSS	Perron
ASI			
First	–5.68***	3.77***	7.657***
Level	–12.47***	0.98	
Difference			
OIL			
First	–3.48***	3.402***	8.564***
Level	–12.46***	0.876	
Difference	–2.01		
EXCHANGE			
First	–3.876***	3.874***	7.345***
Level	–4.876***	0.456	
Difference			

Source: Authors' computation (2020) *** implies 1% significance level

Table 4: Results of the long memory measurement of the variables

Variables	d	m @ 0.5	m @ 0.55	m @ 0.6
ASI	0.416***	0.473	0.356	–0.435
EXC	0.401***	0.490	0.473	0.488
OIL	0.319***	0.405	0.460	–0.46

Source: Authors' computation (2020)

4.3. Interpretation of Results

4.3.1. ASI long memory

The coefficient of d as presented in Table 4 is positive and significant at 1% level of significant, this implies that large shocks of both positive and negative signs will lead to increase in long memory. The negative sign of the coefficient of shows the existence of leverage effect, and that bad news has a larger impact on stock return long memory.

4.3.2. Exchange rate long memory

The magnitude of the long memory as presented in Table 4 is high at 0.401 and significant. This indicates that long memory in exchange have significant impact on long memory in stock market price. With the coefficient of *d* being positive and significant at 1% level of significant, evidence abound to show that large shocks in exchange rate will increase long memory in the ASI.

4.4. Oil Price Long Memory

Like with the exchange rate coefficient, the magnitude of the long memory (*d*) Table 4 is high at 0.319 and highly significant at 1% significant level, an indication that long memory in oil price have significant impact on long memory of stock market prices. The coefficient of *m* is positive and significant at 1% level of significant. This implies large shock in oil price volume will increase long memory in the stock market. The negative sign of –0.46 indicate that there are presence leverage effects in the series and that bad news on oil price long memory exerts larger impact on stock market long memory.

5. CONCLUSION

This paper discusses the long memory of the stock asset, exchange rate and the oil prices using monthly statistics from the Nigerian economy, from the Central Bank of Nigeria Statistical Bulletin for 1985-2018 (different issues). To examine the relationship, we used ARMA estimation techniques. Our findings show that there is plenty of evidence that stock prices long memory is motivated by both the long memory of the exchange rate and oil price long memory. From the outcome of exchange rate long memory estimates, the long memory (*d*) and *m* magnitude coefficients are important at a significantly one percent level, which suggests that large exchange rate shocks are boosting the long share price memory.

Based on this study, policy makers should pursue policies that stabilize the exchange rate strongly. Also, because Nigeria is a petroleum exporting and importing economy, policies should be followed that guarantee the economies a good net export status. The study suggested that investors or market experts find exchange rates and volatility in oil prices as a key source of unavoidable risk in designing portfolio selection strategies.

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