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Markovian Approach to Stock Price Modelling in the Nigerian Oil and Gas Sector

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The study investigates the stock price movement of quoted Nigerian oil and gas firms using the Markovian model. Specifically, the study estimates the change in likelihoods and steady-state distribution of the share prices of the firms to determine the average time spent by the share price to move to another state and the turnover rate of the selected stocks. Markov chain-based stochastic modelling approach was employed by using the daily closing share prices of all the seven oil and gas firms quoted on the Nigerian Stock Exchange from April 2017 to January 2020. The study finds that the transition probabilities and the steady-state distribution of all the firms are stationary at first-order, implying that chain depends on the previous state. The steady-state probabilities of all the firms examined exhibit relatively high price stability in the long run. The study recommends that investors with diverse attitudes to risk-taking can explore the estimated long-run prospect of the investigated stocks in making guided investment decisions.

Keywords: Markov chain, oil and gas firms, share prices, stochastic process, transition probabilities.
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1. Introduction

Different stakeholders participate in the stock markets with diverse motives. Some of the participants are out to gain access to additional funds to facilitate their business operations while others take part in the market to invest their surplus financial resources for capital gain and/or dividends purposes (Ataman *et al.,* 2017). Irrespective of the motive of the participants, the market serves as a veritable platform for participants seeking funds and the ones foraging for investment opportunities for their financial resources to transact profitably (Tafamel *et al.*, 2015).

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Access to timely and beneficial information is critical in participating in the capital market because investment decisions are made based on available information. Studies have shown that in an efficient market, news received by the market has immediate effects on the stock prices (Heston & Sinha, 2017; Syed & Bajwa, 2018). Good news has a way of creating positive expectations in investors thereby leading to rise in stock prices while news perceived to be bad provides a cautionary sign for investors to divest their holdings thereby leading to fall in stock prices (Angelovska, 2017; Comlekci & Ozer, 2018; Groening & Kanuri, 2018).

To profitably participate in the markets as a successful investor, one must be able to predict the direction of news in the market. A review of financial market-based studies has shown that predicting stock market movement to make an informed investment decision is a difficult task. For instance, scholars such as Fama (1965), Flietz and Bhargava (1973), and Obodos (2005), among others, argue that share prices are dynamic and therefore cannot be predicted. However, others such as Leung *et al.* (2000) and Kara *et al.* (2011), that do not believe in the random walk hypotheses argued that stock price can be predicted in a systematic manner that gives room for investors to make gains based on available information and hedge against market risk (Amiens & Oisamoje, 2020; Ataman *et al.,* 2017).

For scholars that believe in the predictability of stock price, they have developed different models to reliably forecast the market movement. Some of these models include Markowitz model for estimating mean and variance; Capital Asset Pricing Model for comparing the stock prices to market index point to derive model for measuring return and variability; the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and the Exponential Generalized Autoregressive Conditional Heteroskedastic (EGARCH) framework for deriving ex-ante share prices. Aside from the aforementioned models, the Markov chain model has been recognized as one of the commonly used models for forecasting stock price movement through the use of a transition probability matrix.

Several studies have been done in Nigeria using the Markov chain to predict stock price movement (Idolor, 2011; Choji *et al.*, 2013; Onwukwe & Samson, 2014; Ogbeide, 2017; Amiens, 2018). However, most of the studies are predominantly carried out in the banking and manufacturing sectors. It is on this basis that this study employed Markov chain-based stochastic modelling approach using the daily closing share prices of all the seven oil and gas firms quoted on the Nigerian Stock Exchange from April 2017 to January 2020, a period considered to be post-recession era, to model the share price behaviour in the sector. The choice of modelling stock prices of the Nigerian oil and gas sector is based on the fact that, the financial resources used in funding government recurrent and capital expenditure are substantially sourced from the revenues generated from the sector.

The objectives of this study, therefore, are to: estimate the transition likelihoods and steady-state distribution of the stock prices of quoted oil and gas firms; determine the average time spent by the prices to move to another state; and estimate the turnover rate of the selected stocks.

This paper is sectionalised into five (5) sections. Section 1 contains the introduction while Section 2 focuses on the review of theoretical and empirical literature. Section 3 discusses the data and methodology employed in the study, while Section 4 comprises the results and discussion of findings. The last section (Section 5) contains the conclusion and recommendations for policy and further studies.

2. Literature Review

2.1 Theoretical Literature

The efficient market hypothesis (EMH) also known as random walk hypothesis opines that making profit from the prediction of the movements of share price is very difficult and unlikely. McQueen and Thorley (1991) test the random walk hypothesis using Markov chain model and found the transition probabilities of the model to be equal irrespective of the past years. One of the pioneering studies on random walk hypothesis was conducted by Bachelier (1900) using commodity prices in France to provide well-founded proof that demonstrates the fair game nature of speculation in commodities. That is, the expected future commodity price that is obtainable from past and current price would be equal to the current price. Slutsky (1937) further validated the fair game nature of changes in stock price with the presence of cyclical patterns. In the context of EMH, efficiency can be categorized into strong, semi-strong and weak forms depending on the information level reflected in the prices. In the weak form, information on past prices are reflected on the prices of the financial assets while semi-strong form replicates all the information that are made available publicly. The strong form combines the attributes of the other forms in addition to the reflection of inside information (Fama, 1991). EMH suggests that changes in stock prices have the same distribution and are independent of each other. The theory therefore states that all available information on the value of the firm are fully reflected on the current stock prices thereby making it impossible to earn excess profits by using such information. The theory relies on the use of statistical time series model to explain the movements of stock prices (Ruhani *et al.*, 2018). Contrary to the EMH that the prediction of the future behaviour of share is not dependent on past information, with Markov chain model it is possible to make prediction in a systematic manner that gives room for investors to make gains based on available information and hedge against market risk (Amiens & Oisamoje, 2020; Ataman *et al.,* 2017).

2.2 Empirical Literature

The concept of share simply refers to a portion of a larger amount which is divided among many people, or to which some people contribute. According to Weston and Fred (1989), "share price is the value of the firm divided by the number of shares outstanding." The behaviour of share price represents its movement which could be in the form of increase, decrease or stable. This movement takes place regularly which Abu-Mustafa and Atiya (1996) described as chaotic, non-linear, dynamic and complicated. Studies by Stock and Watson (2007), Albuquerque *et al.* (2008), and Kara *et al.* (2011) further reiterated the dynamic nature of the markets because of the frequent changes in the internal and external environmental factors. To enhance the accuracy of the forecast, investors must understand and properly analyse these factors and the possible implications they have on investment decisions (Adekunle *et al.*, 2015; Adekunle & Ejechi, 2018).

Researchers have identified different factors that can likely affect share price behaviour. For instance, Tan *et al.* (2007), Boyacioglu and Avci (2010) and Wang *et al.* (2011) opine that the movement of share prices is determined by factors such as investors' psychological impulses, institutional choice and expectations; commodity price index; firm policies; political occurrences and activities as well as general economic situations. According to Choji *et al.* (2013), share prices can be determined by various factors. For example, wrong information (artificial movement of stock prices as a result of acting on information that is not true by investors and other users of financial information), industry participation (the higher the stock trading volume, the higher the stock price, all things being equal), business situation (the share price of a firm serves as an indicator of its performance. Therefore, investors will be willing to invest their funds in firms with a better performance, which can lead to a rise in the price of the company's share), and government policies (interest rate, exchange rate, money supply among others in a country is a reflection of government policies; favourable change in these macroeconomic indicators can greatly influence investors' decision to buy or sell stocks).

Abugri's (2008) perspective on stock price movement is that stock market volatility is determined by the market's level of development. Furthermore, stock returns of developed markets are not as volatile as that of emerging markets. Osamwonyi and Igbinosa (2012) also opined that a clear understanding of the factors determining share price performance of a firm is germane in forecasting the direction of stock price changes. This will help in ascertaining if such stocks are worth the values attributed to them.

Several studies have been done on share price movement using different methodological approaches. The focus of this section is to review empirical studies on share price modelling using the Markov chain model. Idolor (2011) established the long-run prospect of selected stocks listed on the Nigerian Stock Exchange (NSE) using the Markov chain model. The study focused on five randomly selected stocks from the banking industry. Data used for the study covered the period from 4^{th} January 2005 to 30^{th} June 2008. The different states of the stocks were categorized into the rise, drop and stable to fit in into the Markovian framework. The study found that the price levels of the evaluated shares are likely going to be stable in the long run despite the global economic meltdown experienced at the time of the study. The study recommended that the Markovian approach should be used in the evaluation of long-range prediction of stock prospects in the future.

Choji *et al.* (2013) applied a Markov chain model to study the share price behaviour of Guaranty Trust Bank (GTB) and First Bank of Nigeria (FBN). Data were collected on the share price of the selected banks for a period of six years ranging from 2005 to 2010. The finding of the study showed that the probability of the states (depreciate, stable and appreciate) of the share prices of the selected banks will be 0.4229, 0.2072 and 0.3699, respectively. The study also found that the probability of the share of each of the two banks appreciating is on the increase, with GTB taking the lead. Similarly, Onwukwe and Samson (2014) predicted the long-run behaviour of selected banks listed in the Nigerian Stock Exchange. Data on daily closing share prices were collected to compute the transition probability matrix used for further analyses. The outcome shows that the Markov chain model is potent in predicting share price behaviour. The study concludes that results obtained using a Markov chain model can be reliably used by investors in making investment decisions.

Ogbeide (2017) examined the share price behaviour of randomly selected five quoted manufacturing firms in Nigeria. Data on the firms were collected covering 2^{nd} June 2014 to 2^{nd} June 2017. A Markovian framework was used to categorize the behaviour of the shares into a drop, stable and rise for estimating the expected duration of staying and recurrence time as well as the long-run behaviour of share prices over the period. The study found that in the long run, the share prices of manufacturing firms in Nigeria are likely to appreciate. The study concluded that investors' understanding and familiarity with a variety of stock analyses are important in winning huge returns on their investment. Similarly, Amiens (2018) conducted a study on the application of Markov chain to stock price behaviour in Nigeria. The study examined nine randomly selected companies in the manufacturing sector (industrial and consumer goods firms) of the NSE. The study found that all the equities investigated showed a relatively high probability of stable prices in the long run. The study concluded that the behaviour of stocks in the manufacturing sector exhibits similar pattern which can be used to enhance the re-orientation of investors in making critical stock investment decisions such as "buy, hold and sell".

Based on the review of the above empirical studies, it can be deduced that the application of the Markov chain model in stock price prediction is commonly used in the Nigerian banking and manufacturing sectors. This study investigates the performance of listed oil and gas firms using the Markovian approach. The choice of the sector is based on the strategic role it plays in generating revenues for the Nigerian government to meet her statutory obligations (Adam *et al.*, 2019). The sector is contributing substantially to the Nigerian economy in different ways such as job creation, revenue generation, boosting gross domestic products, energy supply, foreign exchange reserve, among others (Sani, 2014; Anfofum *et al.,*2018). The sector also provides raw materials that serve as input for other industries in the country (Osakwe *et al.*, 2019). Through this, jobs are created for many stakeholders as well as having a multiplier effect on the economy. The sector has engaged several persons in Nigeria in the clearing of drilling sites, construction of roads and bridges, distribution of products across different parts of the country, construction of staff housing and recreational facilities, among others.

Most of the financial resources used in funding recurrent and capital expenditure are substantially sourced from the revenues generated from the oil and gas sector. Statistics show that between 1972 and 2010, 73.8% of total government receipts come from the oil sector (Sani, 2014). The sector has added value to the economy through different payments to the government in terms of rents, royalties, profit taxes, harbour dues, among others; the wages and salaries of employees paid locally; and any net retained earnings (Sani, 2014). To harness the investment potentials inherent in the sector, there is a need for more empirical studies on how investors can make informed investment decisions. This study attempts to contribute to knowledge in the area of investment management by examining the share price behaviour of all the quoted oil and gas firms in the sector.

3. Data and Methodology

3.1 Data

Time series data on the share prices of seven quoted oil and gas firms on the Nigeria Stock Exchange were collected on the 5^{th} February 2020. The oil and gas firms include Conoil, Forte Oil, Mobil, MRS, Oando, Total and Seplat. The daily closing share price data collected spanned from 5^{th} April 2017 to 31^{st} January 2020.

The data were sourced from the web page of Cashcraft Asset Management Limited (https://www.cashcraft.com/pmovement.php).

The data obtained for each firm were categorized into three groups namely: decrease, increase and stable to form 3 x 3 matrix. The frequencies obtained for each firm were converted to percentages to form transition probabilities matrices used for the estimation of the Markov chain model.

3.2 Theoretical Framework

The Markov chain model is a form of a stochastic process developed by a Russian mathematician called Andreic Markov in 1905. The model is a mathematical technique based on probability theory and matrix algebra for forecasting the future occurrence of events (Ky & Tuyen, 2018; Nagarajan *et al.*, 2020). The basic assumption of the model is that the current event depends on the immediately preceding event (Sharma, 2007; He & Jiang, 2018). The choice of the Markov chain model in this study is based on the potency of the model to guide in making a decision under uncertainty as well as making probabilistic statements about the dynamic behaviour of stock price levels over time (Amiens & Oisamoje, 2020).

Markov chain is a form of stochastic method that changes at routine or uneven intervals randomly between different states (Ross, 2014). Markov chain has been extensively used in predicting stock market price due to its useful complement to technical analyses, enhanced decision making under uncertain environment, as well as its ability to make probabilistic statements about the dynamic behaviour of share price level over time (Amiens & Oisamoje, 2020).

3.3 Model Specification

Transition Probability: This is the matrix of conditional probabilities of being in a future state given a current state (Carle & Fogg, 1996). Generally, Markov chain state transition probabilities are written as P_{ij} denoting the likelihood of moving from state i to j (Ross, 2014). This is mathematically expressed as:

$$P_{ij} = P\{X_{n+i} = j \mid X_n = i\} \tag{1}$$

In matrix form, where rows and columns are represented by i and j respectively. X is the state of time while n is the period. The state transition probabilities are shown as:

$$P = \begin{bmatrix} p_{11} & p_{12} & p_{13} & \cdots & p_{1j} \\ p_{21} & p_{22} & p_{23} & \cdots & p_{2j} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ p_{i1} & p_{i2} & p_{i3} & \cdots & p_{ij} \end{bmatrix} \quad (2)$$

The transition from one state to another from the data obtained for the different firms for the period under consideration can be represented as follows:

Table 1: Decrease_Increase_Stable matrix

State	Decrease (D)	Increase (I)	Stable (S)
Decrease (D)	P_{DD}	P_{DI}	P_{DS}
Increase (I)	P_{ID}	P_{II}	P_{IS}
Stable (S)	P_{SD}	P_{SI}	P_{SS}

where:
P_{DD} = Probability of drop in share price trailed by share price drop;
P_{DI} = Probability of a drop in share price trailed by rise in the share price;
P_{DS} = Probability of drop in share price trailed by steady share price;
P_{ID} = Probability of rise in share price trailed by drop in the share price;
P_{II} = Probability of rise in share price trailed by a rise in the share price;
P_{IS} = Probability of rise in share price trailed by steady price in the share price;
P_{SD} = Probability of steady share price trailed by a drop in the share price;
P_{SI} = Probability of steady share price trailed by a rise in the share price;
P_{SS} = Probability of steady share price trailed by a steady share price;

Steady-State Distribution: It is assumed that the states are collectively exhaustive and mutually exclusive. By collective exhaustive, it implies that all possible states of the system or process can be listed. Hence, in this research model, it is assumed that there is a finite number of states for the system. Mutually exclusive implies that a system can be in only one state at any point in time. The stable probability condition of the Markov chains π_i, denotes the chance of the process being in state, i, in the long run. These probabilities are alternatively called stationary probabilities. Given that π_i= stationary probabilities; i = 1, 2, 3, . . ., N as elements of a vector, π P = Stochastic transition matrix;

$$\pi = \pi P \text{ where } \sum_{i=1}^{N} \pi_i = 1. \tag{3}$$

Mean Reversion Time: This is the time a variable spends in a state before moving to another state (Poterba and Summers, 1988). To obtain the mean reversion time (MRT), the reciprocals of the steady-state probabilities were taken. Therefore, the mean reversion time is obtained as:

$$MRT = \frac{1}{\pi} \tag{4}$$

3.4 Estimation Procedure

Microsoft Excel software was used to carry out all the analyses. First, the data obtained for each company were organized and programmed to capture the different states (DD, DI, DS, ID, II, IS, SD, SI, and SS) expressed in a matrix to form the transition probabilities matrices. Second, n-step transition probabilities were computed until stationary probabilities were obtained. Finally, the rate of turnover was computed by multiplying the steady-state probabilities by the total number of entries (day) which is 627.

4.0 Results and Discussion

This section contains the descriptive statistics of the variable, test of Markov property, individual firm's transition probabilities matrix, mean reversion time, steady-state distribution, rate of return and the overall transition probabilities matrix and steady-state distribution of all the quoted oil and gas firms under investigation. Table 2 shows the descriptive statistics of the variable and companies of interest.

Table 2: Descriptive analysis of share prices of oil and gas companies

Statistics	Conoil	Forte	Mobil	MRS	Oando	Total	Seplat
Average	26.41	33.33	186.24	26.77	5.59	197.77	567.35
Std. Deviation	6.84	13.08	43.90	6.65	1.45	50.06	99.16
Maximum	44.56	64.30	360.00	39.03	9.60	282.55	785.00
Minimum	15.15	14.00	139.00	15.30	3.11	96.50	345.80
Range	29.41	50.30	221.00	23.73	6.49	186.05	439.20

The results show that the average share prices of the seven companies: Conoil, Forte Oil, Mobil, MRS, Oando, Total and Seplat are 26.41, 33.33, 186.24, 26.77, 5.59, 197.77 and 567.35, respectively. The results show that Seplat had the highest average share price while the company with the least average share price was Oando for the period under consideration. Similarly, the results show that the range of the Seplat's share price is 43.9.20 (Maximum = 567.35, Minimum = 345.80) while that of Oando is 6.49 (Maximum = 9.60, Minimum = 3.11) for the period under investigation.

The results also revealed that the share price behaviour shows a high level of stability. Based on the results in Table 3, stable_stable, stable_decrease, and decrease_stable share price movements account for 55.8%, 7.95% and 7.68%, respectively of the share price behaviour.

Table 3: Frequency of different states of share price movements

Share Price Movement	Conoil	Forte	Mobil	MRS	Oando	Total	Seplat	All Firms Sum	All Firms %
Decrease_Decrease	7	45	27	2	85	8	15	189	4.31
Decrease_Increase	2	43	16	1	88	22	20	192	4.37
Decrease_Stable	34	71	60	14	44	64	50	337	7.68
Increase_Decrease	4	40	16	0	84	18	16	178	4.06
Increase_Increase	13	50	15	0	65	19	25	187	4.26
Increase_Stable	26	51	45	4	34	38	64	262	5.97
Stable_Decrease	31	73	60	15	49	68	53	349	7.95
Stable_Increase	28	48	44	3	29	34	60	246	5.60
Stable_Stable	482	206	344	588	149	356	324	2449	55.8

In testing for the dependence of chain on the previous state, Chi-square was used as recommended by Anderson and Goodman (1957) and Fielitz and Bhargava (1973). The results as shown in Table 4 revealed that the test statistic (χ^2) value of each of the seven oil and gas firms is higher than the critical values of 9.485 or $\chi^2_{4,0.05}$. The result implies that the current state of share prices of the investigated oil and gas firms depends on their previous state. This fulfils the basic assumption for using the Markov chain model.

Table 4: Results of the Markov property test

S/N	Company	Test Statistic (χ^2)	Critical Value ($\chi^2_{4,0.05}$)	Comment
1	Conoil	2762.55	9.485	Chain depends on the previous state
2	Forte Oil	315.83	9.485	Chain depends on the previous state
3	Mobil	1252.85	9.485	Chain depends on the previous state
4	MRS	4342.31	9.485	Chain depends on the previous state
5	Oando	159.39	9.485	Chain depends on the previous state
6	Total	1372.36	9.485	Chain depends on the previous state
7	Seplat	1088.12	9.485	Chain depends on the previous state

Table 5 shows the frequencies of the different states which were used to form the transition probabilities matrix for the different firms.

Illustrating with Conoil, Table 5 shows that there were 7 days in which share price moves from state 1 to state 1 (DD), 2 days for movement from state 1 to 2 (DI), and 34 days for movement from state 1 to 3 (DS). Since the total for the decrease row is 43 days, the respective probabilities of P_{DD}, P_{DI} and P_{DS} are 0.163, 0.047 and 0.791, respectively. Similarly, the movements for ID, II and IS are 4 days, 13 days, and 26 days, respectively for the increase row with an overall total of 43days. Therefore, the probabilities of P_{ID}, P_{II} and P_{ID} are 0.093, 0.302 and 0.605, respectively. Finally, the movements for SD, SI, and SS are 31days, 28days, and 482days, respectively. Since the total of the stable row is 541, the probabilities are 0.057, 0.052 and 0.891 for P_{SD}, P_{SI} and P_{SS}, respectively. For the other six companies, similar computations were conducted on their respective dataset. Equations (5)-(11) show the steady-state probabilities for all the investigated companies.

Table 5: Transition Probabilities Matrix

Company		**Frequency**			**Transition Probability Matrix**		
	State	**Decrease**	**Increase**	**Stable**	**Decrease**	**Increase**	**Stable**
Conoil	Decrease	7	2	34	0.163	0.047	0.791
	Increase	4	13	26	0.093	0.302	0.605
	Stable	31	28	482	0.057	0.052	0.891
Forte Oil	Decrease	45	43	71	0.283	0.270	0.447
	Increase	40	50	51	0.284	0.355	0.362
	Stable	73	48	206	0.223	0.147	0.630
Mobil	Decrease	27	16	60	0.262	0.155	0.583
	Increase	16	15	45	0.211	0.197	0.592
	Stable	60	44	344	0.134	0.098	0.768
MRS	Decrease	2	1	14	0.118	0.059	0.824
	Increase	0	0	4	0.000	0.000	1.000
	Stable	15	3	588	0.025	0.005	0.970
Oando	Decrease	85	88	44	0.392	0.406	0.203
	Increase	84	65	34	0.459	0.355	0.186
	Stable	49	29	149	0.216	0.128	0.656
Total	Decrease	8	22	64	0.085	0.234	0.681
	Increase	18	19	38	0.240	0.253	0.507
	Stable	68	34	356	0.148	0.074	0.777
Seplat	Decrease	15	20	50	0.176	0.235	0.588
	Increase	16	25	64	0.152	0.238	0.610
	Stable	53	60	324	0.121	0.137	0.741

The results in Equations 5-11 represent the proportion of times it takes for a particular share price to remain in a state in the long run. The existence of these probabilities shows that the Markov chain is ergodic, implying that each of the states can be attained from any of the states in a finite number of steps (Agbadudu, 1996; Amiens, 2018). The results further show that the share prices of all the investigated companies reveal high price stability in the long run. It is revealed that the probabilities that the share prices of the following companies: MRS, Conoil, Total, Mobil, Seplat, Forte Oil and Oando will remain stable are 0.967, 0.865, 0.730, 0.716, 0.699, 0.524 and 0.362, respectively.

$$P_{Conoil} = \begin{bmatrix} 0.066 & 0.069 & 0.865 \\ 0.066 & 0.069 & 0.865 \\ 0.066 & 0.069 & 0.865 \end{bmatrix} \quad (5)$$

$$P_{Forte\ Oil} = \begin{bmatrix} 0.251 & 0.225 & 0.524 \\ 0.251 & 0.225 & 0.524 \\ 0.251 & 0.225 & 0.524 \end{bmatrix} \quad (6)$$

$$P_{Mobil} = \begin{bmatrix} 0.165 & 0.119 & 0.716 \\ 0.165 & 0.119 & 0.716 \\ 0.165 & 0.119 & 0.716 \end{bmatrix} \quad (7)$$

$$P_{Oando} = \begin{bmatrix} 0.348 & 0.290 & 0.362 \\ 0.348 & 0.290 & 0.362 \\ 0.328 & 0.290 & 0.362 \end{bmatrix} \quad (8)$$

$$P_{Total} = \begin{bmatrix} 0.150 & 0.120 & 0.730 \\ 0.150 & 0.120 & 0.730 \\ 0.150 & 0.120 & 0.730 \end{bmatrix} \quad (9)$$

$$P_{Seplat} = \begin{bmatrix} 0.134 & 0.167 & 0.699 \\ 0.134 & 0.167 & 0.699 \\ 0.134 & 0.167 & 0.699 \end{bmatrix} \quad (10)$$

$$P_{MRS} = \begin{bmatrix} 0.027 & 0.006 & 0.967 \\ 0.027 & 0.006 & 0.967 \\ 0.027 & 0.006 & 0.967 \end{bmatrix} \quad (11)$$

Equations (5)-(11) are steady-state or long-run probabilities

The results represent the proportion of times it takes for a particular share price to remain in a state in the long run. The existence of these probabilities shows that the Markov chain is ergodic, implying that each of the states can be attained from any of the states in a finite number of steps (Agbadudu, 1996; Amiens, 2018). The results further show that the share prices of all the investigated companies reveal high price stability in the long run. It is revealed that the probabilities that the share prices of the following companies: MRS, Conoil, Total, Mobil, Seplat, Forte Oil and Oando will remain stable are 0.967, 0.865, 0.730, 0.716, 0.699, 0.524 and 0.362, respectively.

Table 6: Mean Reversion Time and Rate of Turnover

Company	Mean Reversion Time (MRT)			Rate of Turnover (Days)		
	Decrease	Increase	Stable	Decrease	Increase	Stable
Conoil	15.15	14.49	1.16	41	43	542
Forte Oil	3.98	4.44	1.91	157	141	329
Mobil	6.06	8.40	1.40	103	75	449
MRS	37.04	166.67	1.03	17	4	606
Oando	2.87	3.45	2.76	218	182	227
Total	6.67	8.33	1.37	94	75	458
Seplat	7.46	5.99	1.43	84	105	438

The results of the mean reversion time show higher days of price increase for MRS, Mobil, Total, Forte Oil and Oando than price decrease. The results imply that the share prices of the companies often decrease more than they increase. However, the mean reversion time of Conoil and Seplat show opposite results. The results imply that the share prices of the two companies often increase than decrease.

The rate of turnover was computed by multiplying the steady-state probabilities by 627, to arrive at the number of times each of the events representing the states in the study take place. Table 6 shows that the share prices of the seven companies were stable for most of the days in the following order: MRS, Conoil, Total, Mobil, Seplat, Forte Oil and Oando with 606 days, 542 days, 458 days, 449 days, 438 days, 329 days and 227 days. Finally, Table 6 shows that Oando and Forte Oil have the highest number of days of a price increase. Comparing the results with their days of decrease, it is observed that the two companies have more days of price decrease than the price increase. In the same vein, Mobil, Total and MRS have more days of price decrease than the price increase.

Table 7 shows the combined frequency of each state, transition probability matrix and the steady-state distribution.

Table 7a: Frequency of the states of all quoted oil and gas companies

	Decrease	Increase	Stable
Decrease	189	192	337
Increase	178	187	262
Stable	349	246	2449

Table 7a shows the frequency of each state and they are used in computing the transition probabilities and steady-state distribution in Table 7b.

Table 7b: TPM and SSD for all firms

Transition probability matrix (TPM) for all quoted oil and gas companies	**Steady-state distribution (SSD) for all quoted oil and gas companies**
$P_{TPM} = \begin{bmatrix} 0.263 & 0.267 & 0.469 \\ 0.284 & 0.298 & 0.418 \\ 0.115 & 0.081 & 0.805 \end{bmatrix}$	$P_{SSD} = \begin{bmatrix} 0.163 & 0.142 & 0.695 \\ 0.163 & 0.142 & 0.695 \\ 0.163 & 0.142 & 0.695 \end{bmatrix}$

Table 7b reveals that the probabilities of stable price, price decrease and price increase are 0.695, 0.163 and 0.142, respectively. It can, therefore, be deduced from the steady-state probability that the share price of the sector is relatively stable.

5.0 Conclusion and Policy Recommendations

The study utilized the Markovian approach to model the share price behaviour of seven quoted oil and gas firms on the Nigerian Stock Exchange. It illustrated the potency of the Markov chain model to examine and appreciate the movement of share prices. Transition probabilities were obtained for each firm as well as for the entire sector to compute their respective steady-state probabilities. The steady-state probabilities were used to estimate the mean reversion time and the rate of turnovers (in days). From the study, it was found that Seplat had the highest average share price while Oando had the least average share price for the period under consideration. It was also found that share price behaviours in the oil and gas sector are relatively stable as movement from a stable state to another stable state accounts for 55.8%. The existence of steady-state probabilities for all the firms investigated shows that the Markov chain is ergodic implying that each of the states can be attained from any of the states in a finite number of steps. The mean-reversion time results show that the share price of MRS, Mobil, Total, Forte Oil and Oando decreases more than they increase while that of Conoil and Seplat often increases than they decrease. Finally, the results show that Oando, Forte Oil, Mobil, Total and MRS have more days of price decrease than price increase.

Based on the findings, the study recommends that investors with diverse attitudes to risk-taking can explore the estimated long-run prospect of the investigated stocks in making guided investment decisions. The limitation of this study is that only quoted oil and gas firms were examined. It is therefore suggested that future studies on the subject matter should investigate as many sectors as possible to have results that may be more encompassing.

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