Generalized Methods on Access Bank Share Price Changes and Variations in Nigeria Stock Market

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Abstract:

Purpose:
Stock market performance and operation have been widely recognized as a viable investment field in financial markets. This paper studied the share price movement of Access Bank, PLC.

Methodology:
The share price data was subjected to a 3-step transition matrix for independent share prices, which enabled us to proffer precise conditions for obtaining future share price changes and placed criteria that enabled us to come up with a 2x2 matrix solution of Principal Component Analysis (PCA) on the share price of Access bank.

Findings:
The solution matrix of the stochastic analysis showed that Access Bank PLC has the best probability of price increasing shortly by 12%, the best probability of reducing in the future by 21%, and the best probability of no change shortly by 20%.

Implication:
More so, an increase in the trading days also increases the value of future share price changes, and other statistical variables were also found. Finally, the influences of the relevant parameters of stock market variables were effectively discussed in this paper.

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INTRODUCTION

The stochastic process can be modeled on stock price changes over long or short trading periods for decision-making. Meanwhile, the most outstanding characteristics of the financial market in Nigeria are fluctuations in stock prices. The Nigerian Stock Exchange (NSE) plays a vigorous role in raising capital funds and acts as a medium between firms and the investors or owners of corporations. Consequently, observed studies of NSE show that results can be achieved when the stock price dynamic forces are well identified. Later, the stock market routine and its processes were accepted as a substantial workable investment field within the financial market. The following scholars have addressed the issue of stock market price fluctuations.

The stock market is one of the most vital components of a free-market economy. It is among the best options for various companies for expansion or setting up a new business venture. Investments can be made in stocks, bonds, and mutual funds. So, an increase in the price of stocks in the stock market indicates an increase in investments. However, the nature of stock prices has been unstable, seasonal, time-dependent, highly volatile, and unpredictable. It is primarily due to uncertainties that arise from natural disasters, global trends, and socio-political policies, which may have unprecedented impact on the demand and supply of stocks. Thus, because of this, investors now have to go beyond studying the company's history, performance, and development prospects of such fundamentals and also be familiar with the variety of technical analyses in order to win a massive return on investment and become a successful investor. Stock trend analysis plays a vital role in practical stock trading. Fundamental factors affect the stock price depending on a company's earnings and profitability from producing

and selling goods and services. These include the level of the earnings base (represented by measures such as earnings per share, cash flow per share, and dividends per share), the expected growth in the earnings base, the discount rate, which is itself a function of inflation and the perceived risk of the stock.

On the other hand, the price development of risky assets is typically demonstrated as the route of risky assets that are of a Markov process defined on some underlying transition probability state space. However, the scholar has written a lot on modeling stock prices using the Markov chain, and results are obtained in various ways. For example, measured stochastic analysis of share prices. Results showed the precise conditions for determining the expected mean return time for stock price, improving investment decisions based on the highest transition probabilities. In the same manner, stock market prices are due to their fluctuations and influences on the financial lives and economic health of a country. Their discoveries showed that stock price is a random work and no investor can alter the fairness and unfairness of a stock price as defined by expectation.

More so, the works studied the behavior of the stock market using the Markov chain. The study reveals that regardless of the bank's current share price, steady-state probabilities of share price remain the same throughout the iteration. Introduced a Markov chain model for stock market trend forecasting. The study revealed that the Markov chain model was more effective in analyzing and predicting the stock market index and closing stock price under the market mechanism. [12] Studied long-run prospects of security prices in Nigeria, where the data were collected from the randomly selected banks from the banking sector of Nigeria. The analysis suggested that the price level of Nigerian bank were likely to remain relatively stable in the long run, irrespective of the current situation.[13] examined the long-run behavior of the closing price of shares of eight Nigerian banks using the Markov chain model. They computed a limiting distribution transition probability matrix of the share price and found that despite the current situation in the market, there is hope for Nigerian bank stocks. It was concluded that the results derived from the study will be helpful to investors.

Previous studies have, therefore, studied the share price movement of Access and Fidelity banks but did not incorporate PCA to determine the proportion of share price by first PC accurately.

This paper examined the share price movement of Access Bank, PLC. The share price data was subjected to a 3-step transition matrix for independent share prices, which enabled us to proffer precise conditions for obtaining future share price changes and place criteria, which enabled us to come up with a 2x2 matrix solution of PCA. This paper extends the work of Osu et al. (2019) by relating Principal Component Analysis (PCA) to study the share price variations of Access Bank. To the best of our knowledge, this is the first to apply stochastic analysis of the Markov chain and PCA to consider the share price changes of Access Bank PLC.

This paper is arranged as follows: Section 2 presents the mathematical framework; the problem formulation is seen in Subsection 2.1; the result and discussion are presented in Section 3.1; and the paper is concluded in Section 4.1

METHODS

Mathematical Framework. From the stochastic point of view, the method of the Markov chain stipulates a system of the transition matrix of an element beginning from one state to another, ascertaining the transition as a random process showing the memory-less property of the Markov chain. The future state of any process strictly depends on its current state rather than its past series of ideas acquired over time. Markov chain is one of the most well-developed theories of a stochastic process with its applications in the growing field of science and technology. Because a stochastic process is a relation of random variables, its requirement is similar to that for random vectors. It can also be seen as a statistical event that evolves by probabilistic laws. Mathematically, a stochastic process may be defined as a collection of random variables ordered in time and defined at a set of time points, which may be continuous or discrete.

Definition 1: A stochastic process is said to be a Markov chain if the Markov property is satisfied:

$$P\left(X_{n+1} = j \mid X_0, X_1, \cdots, X_n\right) = P\left(X_{n+1} = j \mid X_n\right)$$

For all $n \geq 0$ and $i, j \in S\left(\text{state space}\right)$.

It is sufficient to know that the Markov property given (1) is equivalent to the ease of the following for each.

$$P\left(X_{n+1} = j \, / \, X_{n1}, X_{n2}, \cdots, X_{nk}\right) = P\left(X_{n+1} = j \, / \, X_{nk}\right)$$

$$\left(\text{for any } n_1 < n_2 <, \cdots, n_k \leq n\right)$$

Assuming implies that the chain is in the state at the step. It can also be said that the chain' having the value i' or 'being in state i'. The idea behind the chain is described by its transition probabilities:

$$P\left(X_{n+1} = j \, / \, X_n = i\right)$$

They are dependent on *i, j, and n.*

Definition 2: The chain is said to be homogeneous if the following are stated below

$$P\left(X_{n+1} = j \, / \, X_n = i\right) = P\left(X_1 = j \, / \, X_0 = i\right)$$

For all *n, i, and j*

The transition matrix $\mathbf{P} = \left(P_{ij}\right) n \times n$ is a matrix of transition probabilities.

$$P_{ij} = P\left(X_{n+1} = j \, / \, X_n = i\right)$$

Hence, the transition probabilities with a homogenous Markov chain are always stationary at a point.

Theorem 3: Suppose   is a stochastic matrix, which implies the following:

i)   Has non-negative entries or (ii)

$$\sum_j P_{ij} = \sum_j P\left(X_{n+1} = j \, / \, X_n = i\right) = \sum_j P\left(X_1 = j \, / \, X_0 = i\right)$$

Which is stationarity or point of convergence.

Proof:(i) Each associated entry is a transition probability and is probability.

$$(ii) \quad \sum_j P_{ij} = \sum_j P\left(X_{n+1} = j \, / \, X_n = i\right) = \sum_j P\left(X_1 = j \, / \, X_0 = i\right)$$

Which is stationarity.

$$P\left(X_i \in S \, / \, X_0 = i\right) = 1.$$

Theorem 4 :(Chapman-Kolmogorov Equations).

$$P_{ij(m+n)} = \sum_{r=i}^{n} P_{ir(m)} \, P_{rj(n)} \quad \text{Since } \mathbf{P}_{m+n} = \mathbf{P}_m \mathbf{P}_n \text{ and so on } \mathbf{P}_n = \mathbf{P}^n \text{, the } nth \text{ power } \mathbf{P}.$$

$$P_{ij(m+n)} = P\left(X_{m+n} = j \, / \, X_0 = i\right)$$

Proof:
$$\sum_r P\left(X_{m+n} = j, X_m = r \, / \, X_0 = i\right)$$

$$\sum_r P\left(X_{m+n} = j \, / \, X_m = i \, / \, X_0 = i\right) P\left(X_m = r \, / \, X_0 = i\right)$$

Using the following probability rule:

$$P(A \cap B / C) = P(A / B \cap C) P(B / C)$$ and setting $A = \{X_{m+n} = j\}$, $B = \{X_m = r\}$, and $C = \{X_0 = i\}$

Using Markov property yields

$$P_{ij(m+n)} = \sum_r P(X_{m+n} = j / X_m = r) P(X_m = r / X_0 = i)$$

$$\sum_r P_{rj(n)} P_{ir(m)}$$

$$\sum_r P_{1r(m)} P_{r1(n)}$$

Hence $P_{m+n} = P_m P_n$ and so $P_n = P^n$, the power of P.

Problem Formulation. Let $S_i(t)$ $(i = 1, 2, ..., N, t = 1, 2, ..., n)$ the daily closing share price data of Access Bank selected years at a time be defined as three-state Markov processes in finite states. Let the data matrix be associated. We consider closing share prices over months and time horizons.

To obtain an estimate of the transition probability as follows:

$$P_{ij} = P(X_t = j / X_{t-1} = i), \; for \; j = 0, 1, 2, 3, \cdots, N$$

$$P_{ij} = \begin{cases} P \; if \; j = 1 + j \\ q = 1 - P \; if \; j = i - j \\ 0 \; \text{otherwise} \end{cases}$$

Where is the number of states?

$$\left. \begin{array}{l} n_{ij} = \sum_{i=1}^{n} P_{ij} \; \text{for i } j = 0, 2, 3 \\ \dfrac{n_{ij}}{n_i} \; \text{for } i \; j = 0, 1, \cdots k \end{array} \right\}$$

However, it is an estimate of the transition matrix.

$$\hat{P}ij(\text{ACCESS})_{2016-2022} = \begin{pmatrix} \hat{P}_{00} & \hat{P}_{01} & \hat{P}_{03} \\ \hat{P}_{10} & \hat{P}_{11} & \hat{P}_{12} \\ \hat{P}_{20} & \hat{P}_{21} & \hat{P}_{22} \end{pmatrix}$$

Setting $i \; j = 0, 1, 2$ for $k = 3$

Developing Markov Chain Model for Stochastic Analysis of Access Share Price. For suitable accuracy of the Markov chain model for future events, it must be developed to predict share price movement. The initial share prices need to be in three finite states as follows:

R: represents the probability of share price reduction shortly
I: represents the probability of share price increasing shortly
NO-change: represents the probability of share price not changing shortly

However, the probability of the transition matrix shows the proper explanation of the Markov chain. Every element in the matrix communicates. In order to form three states of the Markov process, we need to have the following table below:

Table 1. Transition Probability Matrix

State	1	2	3	Total of Row
1	P_{11}	P_{12}	P_{13}	T_1
2	P_{21}	P_{22}	P_{23}	T_2
3	P_{31}	P_{32}	P_{33}	T_3

Each entry indicates the number of times a transition is made from one state to another. The transition matrix is computed by simply dividing every element in each row through the total of each row. Nevertheless, this project studies Access share price data collected from [14]

Principal component Analysis of the stock variables, Definition 3. Suppose $\underline{X}$ has a joint distribution that has a variance matrix $\sum$ with eigenvalues $\lambda_1, \geq \lambda_2 \geq ... \geq \lambda_p \geq 0.$. Consider the random variables $y_1...y_p$, which are linear combinations of the $X_1's$ ie:

$$y_1 = \underline{l}'\underline{X} = l_{11}X_1 + ... + l_{p_1}\lambda_p$$
$$\vdots$$
$$y_p = \underline{l}'\underline{X} = l_1 pX_1 + ... + l_{p_1}\lambda_p$$

They $y_i's$ will be PC if uncorrelated, and the variances are as significant as possible. Recall that if $y_i = l_i'X$. In order to look at the amount of information that is y_1. We can consider the proportion of the total population variance due to y_i

$$\frac{\lambda_i}{\lambda_1 + \lambda_2 + \cdots + \lambda_p}, i = 1,...,p$$

Hopefully, the proportion is large for eg =1,2, 3,

RESULTS AND DISCUSSION

The data for this paper is obtained from the work. In order to display Access Bank PLC's closing share market prices in specific regions. The share price covers 2016-2022, retrievable from the Nigeria Stock Exchange (NSE).

Table 2. Share price of Access Bank, PLC from 2016-2022

Share price movements	Reducing(R) its share price	Increasing(I) its share price	No(N) change in price	Row totals
R	410	80	126	616
I	79	98	92	269
N	127	91	378	596

Transition probability matrix for Access bank.

$$ACCESS_{BANK}(P) = \begin{pmatrix} 0.6656 & 0.1299 & 0.2045 \\ 0.2937 & 0.3643 & 0.3420 \\ 0.2131 & 0.1527 & 0.6342 \end{pmatrix}$$

Access bank (2016-2022): Has a 67% of reducing its price shortly, a 13% chance of increasing its price shortly, 20% chance of no change in price. Also, in the same circumstances, there is a 29% chance of reducing its price, a 36% chance of increasing its price, and a 34% chance of no change in price. Finally, there is a 21% chance of reducing its price, a 15% chance of increasing its price, and a 63% Chance of no change in price. The above

assessments of the three companies provide an eye opener of this stochastic analysis that will enhance their investment decisions; the entire entry stipulates price changes for short and long-term business plans.

Minimum Access bank share prices of two elements:

$$A_{Access\ bank} = \begin{pmatrix} 0.129 & 0.2045 \\ 0.2131 & 0.1527 \end{pmatrix}$$

We formed the matrix from the estimates of the probability transition matrix of Access Bank, which information on the share price movements will account for the total proportion variability in the share price.

Table 3. Transition Probability Matrix of Access Bank Share Market Prices with Means, Standard Deviations, Kurtosis, and Skewness

a_{11}	a_{12}	a_{13}	Mean	Std	Kurtosis	Skewness
0.6656	0.1299	0.2045	0.3333	0.2902	1.500	0.6549
0.2937	0.3643	0.3420	0.3333	0.0361	1.500	-0.4157
0.2131	0.1527	0.6342	0.3333	0.2623	1.500	0.6652

In Table 3, the mean indicates the probability of share price changes on average of Access Bank, which shows 0.3333 throughout investments, see column 4. The standard deviations in column 5 indicate levels of different price changes, which are always affected by volatility. Then, kurtosis measures the tailedness of entire share prices. Finally, the share price skewness measures the level of distortion in the data set, which guides an investor based on decision-making.

Table 4. Variations of Access Bank future share prices according to the trading day

Training Day	0.129	0.2045	0.2131	0.1527
2	0.258	0.409	0.4262	0.3054
4	0.516	0.818	0.8524	0.6108
6	0.774	1.227	1.2786	0.9162
8	1.032	1.636	1.7048	1.2216
10	1.29	2.045	2.131	1.527
12	1.548	2.454	2.5572	1.8324
14	1.806	2.863	2.9834	2.1378
16	2.064	3.272	2.4096	2.4432
18	2.322	3.681	3.8358	2.7486
20	2.58	4.09	4.262	3.054

It can be perceived in Table 4 that an increase in the number of trading days also increases the future share prices of Access Bank. It also indicates that profit increases with time; that is to say that profit-making is time-dependent. The benefit of this assessment is to avert severe depletion of capital investments, which may endanger profit-making throughout the trading period of the capital investments.

In all, the above assessments of the Access Bank provide a template of this stochastic analysis that will enhance reliable investment decision-making; the entire entry stipulates price changes for short and long-term business plans.

Principle Component Analysis of Access Bank Share Price Movement Variations.
According to the minimum Access bank share prices of two elements

$$A_{Access\ bank} = \begin{pmatrix} 0.129 & 0.2045 \\ 0.2131 & 0.1527 \end{pmatrix}, \ A_{Access\ bank} - \lambda I = 0$$

Solving the above share price matrix gives:

$$\lambda_1 = -0.0682, \; \lambda_2 = 0.3499$$

Solving, $\lambda_1 = -0.0682,$ we have the following systems of equations.

$$0.1972K_1 + 0.2045K_2 = 0$$

$$0.2131K_1 + 0.2209K_2 = 0$$

From (10) $0.212K_1 = -0.2209K_2$, $K_2 = \dfrac{0.1972}{0.2045} = -0.9643$ putting K_2 in (11) gives

$0.2131K_1 - 0.2209(-0.9643) = 0,\; 0.2131K_1 = 0.21301387K_1 = \dfrac{0.21301387}{0.2131} = 0.9996$

Any vector of the form says form:

$$K_1 = \begin{pmatrix} 0.9996 \\ -0.9643 \end{pmatrix} = \begin{pmatrix} 0.999C \\ -0.9643C \end{pmatrix};\; say\; is\; an\; eigenvector\; corresponding\; to\; \lambda_1 = -0.0682$$

$$-0.2209K_1 + 0.2045K_2 = 0$$

$$0.2131K_1 - 0.1972K_2 = 0$$

From (12) $0.2209K_1 = -0.2244K_2$, $K_2 = \dfrac{0.2209}{0.2045} = 1.08020$, putting K_2 in (13) gives

$0.2131K_1 - 0.1972(-1.08020) = 0,\; 0.2131K_1 = 0.2130 = 0_1,\; K_1 = \dfrac{0.2130}{0.2131} = 0.9995$

Any vector of the form says form:

$$K_2 = \begin{pmatrix} 0.9995 \\ 1.08020 \end{pmatrix} = \begin{pmatrix} 0.9995C \\ 1.08020C \end{pmatrix};\; say\; is\; an\; eigenvector\; corresponding\; to\; \lambda_2 = 0.3499$$

To obtain normalized eigenvectors for the share price of Access Bank, we have the following:

$$K_1'K_1 = 1, \left(0.9996C \quad -0.9643C\right)\begin{pmatrix} 0.9996C \\ -0.9643C \end{pmatrix}, 0.99920016C^2 + 0.92987449C^2 = 1, 1.92907465C^2 = 1$$

$$C^2 = \frac{1}{1.92907465},\; C = \frac{1}{\sqrt{1.92907465}},\; e_1 = \begin{pmatrix} \dfrac{0.9996}{\sqrt{1.92907465}} \\ \dfrac{-0.9643}{\sqrt{1.92907465}} \end{pmatrix}, \begin{pmatrix} 0.7198 \\ -0.6943 \end{pmatrix}$$

$$K_2'K_2 = 1, \left(0.9995C \quad -1.08020C\right)\begin{pmatrix} 0.9995C \\ -1.08020C \end{pmatrix}, 0.99900025C^2 + 1.16683204C^2 = 1, 2.16583229C^2 = 1$$

$$C^2 = \frac{1}{2.16583229}, \quad C = \frac{1}{\sqrt{2.16583229}}, \quad e_1 = \begin{pmatrix} \dfrac{0.9997}{\sqrt{2.16583229}} \\ \dfrac{1.0869}{\sqrt{2.16583229}} \end{pmatrix}, \begin{pmatrix} 0.6792 \\ -0.7340 \end{pmatrix}$$

$$Y_1 = e_1'K = 0.7198K_1 - 0.6943K_2$$

$$Y_2 = e_2'K = 0.679K_1 - 0.7340K_2$$

To calculate the principal component of Access Bank share price accounted for

$$\lambda_1 = -0.0682, \quad \lambda_2 = 0.3499, \quad \frac{\lambda_1}{\lambda_1 + \lambda_2} = 0.1631 = 16.31\%$$

The two eigenvalues signify the total amount of Access share price variance that the principal component can describe. It signifies the levels of damages made all through the trading days by Access Bank PLC. So, it is greater than zero, which is a worthy sign of a high investment return on the side of Access Bank, whose aim and passion is to maximize profit. However, the eigenvectors regulate the route of the share price in terms of changes in the short-run and long-run correspondingly. The shows the levels of returns Access Bank will make in the future following their share price movements.

CONCLUSION

Stock market performance and operation have been widely recognized as a viable investment field in financial markets. The impression of the Markov chain is a powerful tool for studying the share price formation since each finite state converses for appropriate management decisions in Access Bank. Therefore, this project studied the stochastic analysis of the Markov chain and PCA in the closing share price data of Access (2016-2022) through the Nigeria Stock Exchange. The share price data was subjected to a 3-step transition matrix for independent share prices, which enabled us to proffer precise conditions for obtaining future share price changes and placed criteria that enabled us to come up with a 2x2 matrix solution of Principal Component Analysis (PCA) on the share price of Access bank. The solution matrix of the stochastic analysis showed that Access Bank PLC has the best probability of price increasing shortly by 12%, the best probability of reducing in the future by 21%, and the best probability of no change shortly by 20%. Moreover, an increase in the trading days also increases the value of future share price changes, and other statistical variables were also found, which is a tool for proper decision-making in the day-to-day running of the bank. Nevertheless, introducing the delay concept in studying share price movement will be an excellent area to explore.

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