THE RETURN PREDICTION OF THE COCA - COLA STOCK IN NIGERIA THROUGH STOCHASTIC ANALYSIS

Abstract

This Paper emphasizes on the stock market price' evaluation of Coca-Cola Company with a view to providing useful financial guidance to investors and investments. A Seven-year Stock Price Data was collected from Coca-Cola Historical Annual Stock Price Data between the periods 2016 -2022. A three - step transition probability matrix was generated from the collected data which was originally in a 'Count Matrix' form. An n x 1 column vector of ones was used to generate the mean vector by multiplying with the transpose of the 'count matrix' and dividing the result by the number of rows of the 'count matrix'. The Percentage Rate of Return (PROR) for each priced year was calculated to aid the Company and Investors determine the effectiveness of their investments. The rate of return is a metric that informs the business owners and investors of the state of their businesses; whether it is worth venturing or not by exposing their profit capacities. Also, the work calculated the anticipated price movements for the Company to help them in terms of decision making in the nearest future.

The transition probability matrix predicted the future stock prices of the company while considering the first rows thus the company would have a 0.3255 probability of reducing its price,0.3423 probability of increasing its price and lastly a 0.3322 probability of stabilizing or normalizing its profit.

KEYWORDS: Stock Market Price (SMP), Markov Chain, Price Movement and Rate of Return.

INTRODUCTION

The Coca - Cola Company is one of the major beverage companies in Nigeria whose major interest is to maintain a healthy relationship with her customers, investors and the general public while striving to make profit. Every Company is profit oriented, likewise the investors in the Company but only good business decision-making can guarantee that.

A Company's Stock Price is the current trading price per share of the Stock in the market.

This price fluctuates; it goes up and down at will depending on certain controllable and uncontrollable factors like changes within the economy, outbreak of wars, political events, environmental changes and law of demand and supply.

The investors should be familiar with the volatility of the Stock Price and the attendant factors that drive it, thus, should device some proactive measures in terms of decision making, because when the right decisions are implemented on time, the business and its financial strength will grow to an enviable status.

It is in this background that the study seeks to evaluate the stock market price of the Coca-Cola Company with a view to guide both the investors and the Company Management on this random phenomenon called 'Stock Price'. To achieve the above, a Stochastic model called the Markov Chain was chosen as a suitable model to evaluate random behavior of the Stock Price.

Stock prices are random hence fluctuate, and it is not within the powers of any investor to influence the fairness or unfairness of a stock price (Agwuegbo et al., 2010).

The Stochastic analysis of the Markov chain in finite states were explored by Amadi et al., (2022). They applied a three-state transition probability matrix to propose conditions for obtaining the mean rate of return for each stock.

Agbam and Udo (2022) examined the Markov chain model for forecasting stock prices in Nigeria. Their results showed that they were able to obtain the Markov model via probability transition matrix.

A group of Scholars; Lakshmi et al., (2020) found that oil prices in India presented a higher probability of being stable with no significant increase or decrease in their study on stock market prices using Markov Chain.

Mettle et al., (2014) worked on a stochastic analysis of share prices and their results showed the exact condition for determining the expected mean return time for stock prices, improving investment decisions based on the highest transition Probabilities.

Davou et al., (2013) also compared Guaranteed Trust Bank (GTB) with First Bank of Nigeria (FBN) in terms of Share Prices Movement (SPM) using Markov Chain and they concluded that there were many variations in the shares of Guarantee Trust Bank than in First Bank of Nigeria.

Davies et al., (2019) discovered that Nigeria banks' share prices were relatively stable according to the result of their research on stock prices.

Ofomata et al., (2017) assessed the stock prices of eight Nigerian Banks for long-term trading using Markov chain. They found the limiting distribution probability matrix of the shares in the banks to be relevant to investors.

Zhang and Zhang (2009) countered strong features of disorder and randomness of stock market fluctuation in China using a Markov process model and Markov Chain mathematical model of the stock market trend forecasting.

Adenuga (2010) worked on stock market development indicators using Vector Error Correction Model.

Their result showed that large number of profitable investments require a long - term commitment of capital but investors were often reluctant to relinquish control of their savings for long periods.

They also found that liquid equity markets made investments less risky and more attractive.

Olusola et al., (2006) examined the relationship between stock market capitalization rate and interest rate using Ordinary Least Square (OLS) regression method. It was revealed that the prevailing interest rate exerted positive influence on the stock market capitalization rate.

They also suggested that operators of the Nigeria capital market should increase the level of awareness to enable investors be acquainted with the happenings of the market.

The purpose of this paper is to acquaint the investors on likely future investment changes by fitting the stock price movements using Markov Chain Process in finite states and then vary the future price change of the stock price for a duration of twelve months.

PROBLEM DESCRIPTION

A Markov Process is a Stochastic process with the property that given the current state of a process the probability of its future behavior is not altered by additional knowledge of its past behavior.

A Stochastic process is a collection of discrete or continuous random variables ordered and defined in time and at a set of time points respectively.

DEFINITION 1

A Markov Chain is a stochastic model that describes a sequence of possible events in which the probability of each event depends only on the state attained in the previous event.

Let K_n denote the possible position of the random movement at time n, then the equation becomes

$$P(k_{n+1}=j|K_n=i) - P_{ij} \quad \ldots\ldots 1.1$$

Where P_{ij} is independent of K_{n-1}, K_{n-2}, $K_{n-3}, \ldots, K_0$ so that the state K at time $(n+1)$ depends only upon the state of K at time n

This implies that each P_{ij} for $j = 1,2,3,4,\ldots,N$ is a probability row vector describing every possible transition from state 1 to any other existing N possible states in the process.

DEFINITION 2

A stochastic process $K(t)$ can be a relation of random variables $\{K, (\varphi), t=T, \varphi=\delta\}$ for each t in the index set T,$K(t)$ is a random variable. This implies that t is taken as time and $K(t)$ as the state of the process at time t.

DEFINITION 3

A random walk or a stochastic process is said to exhibit the Markov property if the position of the movement at time $n + 1$ depends only upon the position of the movement at n.

$$P(K_{n+1}= j \mid k_0,k_1,\ldots, k_n) = P(K_{n+1}= j|k_n) \ldots\ldots (1.3)$$

For all $n \geq 0$ and $i, j, = S$ where S is the state space.

From equation 1.3, it can be concluded that:

$$P(K_{n+1}= j \mid K_{n1}, K_{n2}, \ldots K_{nc}) = P(K_{n+1}= j \mid K_{nc}) \ldots\ldots (1.4)$$

For any $n_1 \leq n_2 < ,\ldots n_c \leq n$

This Markov Property also explains that if $K_n = i$, the chain becomes in the state i otherwise called the ith state and at step n or nth step.

The transition probability summarizes the chain as below:

$$P(K_{n+1} = j \mid K_n = i) \quad \ldots\ldots (15)$$

Where the chain is dependent on i,j and n

This chain can also be said to be homogeneous if and only if:

$$P(K_{n+1} = j \mid K_n = i) = P(K = j \mid K_0 = i) \quad \ldots\ldots (16)$$

For all i, j and n.

The transition probability matrix $P = (P_{ij})$ is an $n \times n$ matrix of transition probabilities.

$$P_{ij} = P(K_{n+1} = j \mid K_n = i) \quad \ldots\ldots (1.7)$$

It should be mentioned and proven here that the transition probabilities with homogeneous Markov Chain converges and becomes stationary at given point.

Case 1

$P_{ij} \geq 0$ where P has no negative entries.

$$\sum_j^n P_{ij} = \sum_j^n P(K_{n+1} = j \mid K_n = i) = \sum_j^n P(K_1 = j \sum_j^n P(K_1 = j \mid K_0 = i))$$

The convergence or stationary behavior of the transition probabilities with homogeneous Markov Chain has been displayed above and also below:

$$\sum_j P_{ij} = \sum_j P(K_{n+1} = j \mid K_n = i) = \sum_j P(k_1 = j \mid k_0 = i) \text{ where } P(K_1 = S \mid k_0 = i) = 1$$

The Chapman -Kolmogorov equation can also be used to fortress this claim:

$$P_{ij(m+n)} = \sum_{r=1}^{n} P_{ir(m)} \, P_{rj(n)}$$

Since $P_{m+n} = P_m \, P_n$ thus $P_n = P^n$ to the nth power of P.

$$P_{ij(m+n)} = P(K_{m+n} = j \mid K_0 = i)$$

$$\sum_r P(K_{m+n} = j, \, K_m = r \mid K_0 = i)$$

$$\sum_r P(k_{m+n} = j, j \mid k_m = i \mid K_0 = i) P(k_m = r \mid K_0 = i)$$

FORMULATION OF PROBLEM ONE

The closing stock price data in Naira of the Coca-Cola Company for seven years was collected and arranged in a 'count matrix form' which was later used to form a three-state transition probability matrix. The three - state transition probability matrix represented an $N \times N$ data matrix that evaluated the changes in the stock prices at time (t) where $t = 0, 1, 2, 3, \ldots, N$ and t was measured in weekly intervals and $t \in T$.

The time horizon consisted of N stocks over N trading days where the last three months of the trading periods were used to form the 'mean column vector' for each year throughout the seven years. The mean column vector was denoted as:

$$\begin{pmatrix} NBC_{11} \\ NBC_{12} \\ NBC_{13} \end{pmatrix}$$

FORMULATION OF PROBLEM 2

The Paper also calculated the future price change of the stock market by multiplying the transition probability matrix of P by the mean Vector as follows:

The company's percentage rate of return was also calculated using the formular below:

$$R_t = \left(\frac{C_{ir} - O_{ir}}{O_{ir}}\right)100$$

Where R_t, C_{ir} and O_{ir} denotes rate of return, closure time for investment and opening time for investment respectively.

The behavior of the stock market price was represented by the transpose of the future price change (FPC) denoted by: $(\varphi_1 \quad \varphi_2 \quad \varphi_3)$.

The Phi subscript one (φ_1), Phi subscript two φ_2 and Phi subscript three φ_3 represent stock price reduction, increase and steadiness respectively.

DATA ANALYSIS

$$\boldsymbol{P} = \begin{pmatrix} 97.01 & 102.00 & 99.00 \\ 100.00 & 101.00 & 99.00 \\ 99.00 & 101.00 & 97.10 \end{pmatrix}$$

$$\boldsymbol{P_{NBC}} = \begin{pmatrix} 0.3255 & 0.3423 & 0.3322 \\ 0.3333 & 0.3367 & 0.3300 \\ 0.3332 & 0.3400 & 0.3268 \end{pmatrix}$$

Mean Vector ($\bar{V}_{NBC}$) = $\frac{1}{n}P^1 j$ where n = number of rows of matrix P , P^1 = transpose of matrix P and j = column Vector of order one.

$$\bar{V}_{NBC} = \frac{1}{3}\begin{pmatrix} 97.01 & 100.00 & 99.00 \\ 102.00 & 101.00 & 100.00 \\ 99.00 & 99.00 & 97.10 \end{pmatrix}\begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$$

$$\bar{V}_{NBC} = \frac{1}{3}\begin{pmatrix} 97.01 + 100.00 + 99.00 \\ 102.00 + 101.00 + 100.00 \\ 99.00 + 99.00 + 97.10 \end{pmatrix}$$

$$\bar{V}_{NBC} = \frac{1}{3}\begin{pmatrix} 296.01 \\ 303.00 \\ 295.10 \end{pmatrix}$$

$$\therefore \quad \bar{V}_{NBC} = \begin{pmatrix} 98.70 \\ 101.00 \\ 98.37 \end{pmatrix} = \begin{pmatrix} NBC_{11} \\ NBC_{12} \\ NBC_{13} \end{pmatrix}$$

The above implies that the mean vector of the first, second and third columns of the Matrix P are 98.70, 101.00 and 98.37 respectively. The future price changes were calculated by multiplying the transition probability Matrix of P by the mean Vector hence:

$$\widehat{FPC} = \bar{\bar{P}}_{NBC}\begin{pmatrix} NBC_{11} \\ NBC_{12} \\ NBC_{13} \end{pmatrix} = \begin{pmatrix} 0.3255 & 0.3423 & 0.3322 \\ 0.3333 & 0.3367 & 0.3300 \\ 0.3345 & 0.3375 & 0.3280 \end{pmatrix}\begin{pmatrix} 98.70 \\ 101.00 \\ 98.37 \end{pmatrix}$$

$$\widehat{FPC} = \begin{pmatrix} 0.3255 \times 98.67 + 0.3423 \times 101.00 + 0.3322 \times 98.37 \\ 0.3333 \times 98.67 + 0.3367 \times 101.00 + 0.3300 \times 98.37 \\ 0.3345 \times 98.67 + 0.3375 \times 101.00 + 0.3280 \times 98.37 \end{pmatrix}$$

$$\widehat{FPC} = \begin{pmatrix} 32.1171 + 34.5723 + 32.6785 \\ 32.8867 + 34.0067 + 32.4621 \\ 33.0051 + 34.0875 + 32.2654 \end{pmatrix}$$

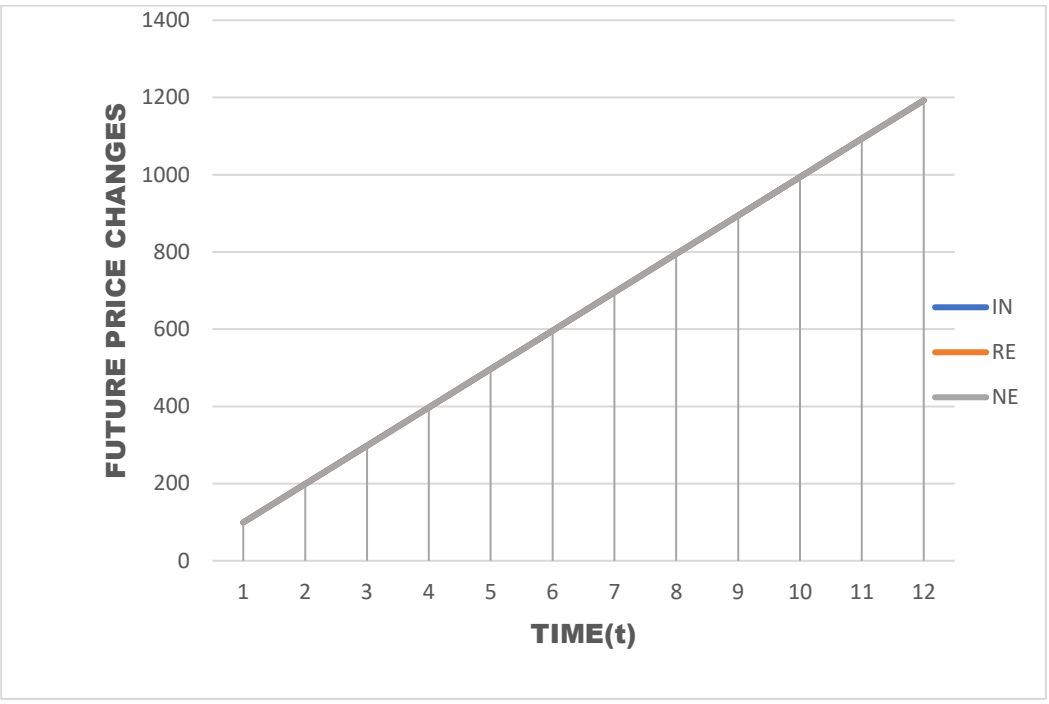
$$\widehat{FPC} = \begin{pmatrix} 99.3679 \\ 99.3555 \\ 99.3580 \end{pmatrix} = \begin{pmatrix} \varphi_{11} \\ \varphi_{12} \\ \varphi_{13} \end{pmatrix}$$

TABLE ONE OF DATA ANALYSIS

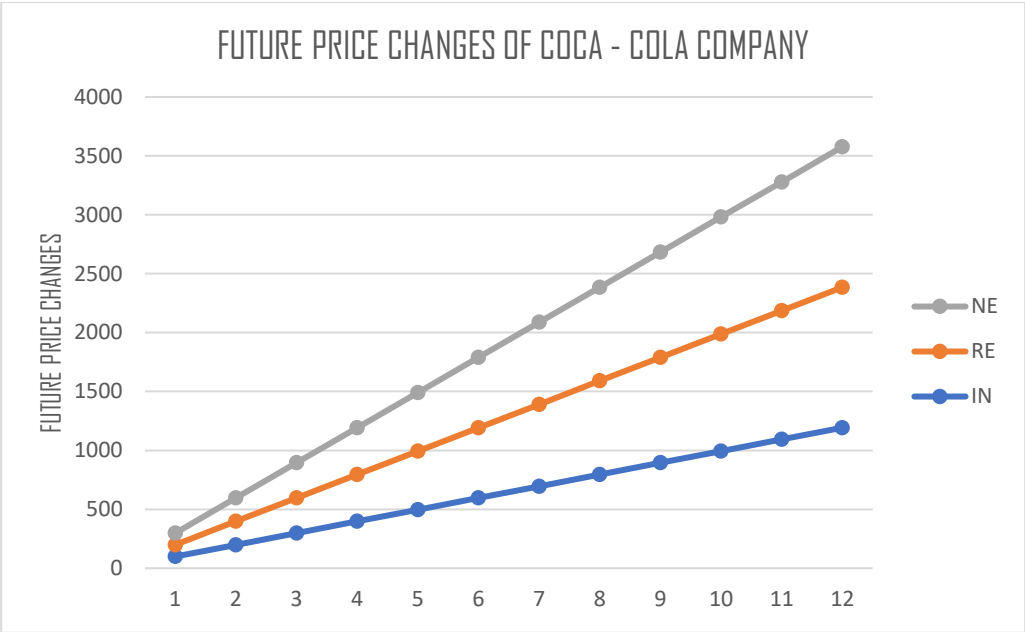
The table below shows the annual stock variations of the Coca-Cola Company.

TIME (t)	φ_{11}	φ_{12}	φ_{13}	MEAN $(\overline{x})$	HIGH	LOW
1	99.3679	99.3555	99.3580	99.360	99.3679	99.3555
2	198.7358	198.711	198.716	198.721	198.7358	198.711
3	298.1037	298.0665	298.074	298.0814	298.1037	298.0665
4	397.4716	397.422	397.432	397.442	397.4716	397.422
5	496.8395	496.7775	496.79	496.802	496.802	496.7775
6	596.2074	596.133	596.148	596.1628	596.2074	596.133
7	695.5753	695..4885	695.506	695.5233	695.5753	695.4885
8	794.9432	794.844	794.864	794.8837	794.9432	794.844
9	894.3111	894.1995	894.222	894.2442	894.3111	894.1995
10	993.679	993.555	993.58	993.6047	993.679	993.555
11	1093.0469	1092.9105	1092.938	1092.9651	1093.0469	1092.9105
12	1192.4148	1192.266	1192.296	1192.3256	1192.4148	1192.266

THE PLOT OF FUTURE PRICE CHANGES OF COCA – COLA COMPANY



GRAPH OF FUTURE PRICE CHANGES OF COCA – COLA COMPANY



*NE: No change in Price, RE: Reduction in Price and IN: Increase in Price

TABLE TWO OF DATA ANALYSIS

The return rate and the mean return rate for the company were calculated in the table below.

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Years (t)	Beginning of the year stock price (BYP)	End of the year stock price (EYP)	Average Stock Price	% Return Rate
2016	32.3372	32.6536	32.4954	0.98
2017	32.9213	37.3467	35.134	13.44
2018	37.0700	39.8836	38.4768	7.59
2019	39.5299	48.1052	43.9049	21.69
2020	47.7923	49.2779	48.5351	3.108
2021	47.4088	54.8978	51.1533	15.80
2022	54.9812	60.7216	57.8514	10.44
Total Rate of Return	-	-	-	**73.048**
Average Rate of Return	-	-	-	**10.43**

RESULTS AND DISCUSSION

A three - state transition probability matrix was constructed with inscription; increase in price, reduction in price and steadiness in price (no change in price). The essence of this is to guide the management of Coca -Cola Bottling Company in taking financial decisions.

The transition probability matrix predicted the future stock prices of the company while considering the first rows. Thus, the company would have a **0.3255** probability of reducing its price in the near future, a **0.3423** probability of increasing its prIce and finally a **0.3322** of stabilizing the price or making no change in the price. Hence the limiting probability distribution for a 3 – state chain becomes 0.3255, 0.3423 and 0.3322.

The Company's rate of return for each investment year was calculated in table one. This would be an eye opener to investors and the Management because it was meant to expose the financial strength of the Company (whether it was worth investing on or not).

From the percentage rate of return investors would know the profit capacity of their investment and the Company. From table one the Company made the highest profit in the year 2019 followed by 2021 and the lowest profit was in 2016 and 2020 but in all there was no loss because there was no negative value.

The yearly mean in table two explained the overall performance of the Coca – Cola Company between 2016 to 2022. The high and low future prices were also indicated in the table to enable the company take proper decisions.

CONCLUSION

The fluctuations of stock prices have posed serious threats to investors and investments, and only models that study variables that change with time could be of help, hence Markov Chain Model was considered suitable for this.

With the volatile nature of stock prices, investors are at huge risk since their interest is usually to minimize risk and maximize profit. In as much as stock prices remain volatile, every investor is at risk of losing all or some of their investments without proper decision making. The findings of this research provide each investor a unique risk profile that exposes the willingness and ability to withstand risk.

The purpose of investing in stock market is to expect increase in value of the asset and this work has revealed that Coca-Cola Company has 34% chance of increasing price, 32% chance of reducing its price and a 33% chance of price stability in the near future.

The above findings would take effect if the company continues to produce goods that are highly necessary (stock price will increase), supply of the good balances out with the demand (reduction in stock price) and creating variation on an existing standard (stock price will stabilize).

RECOMMENDATIONS

We recommend that the investors in Coca-Cola Company understand the Company's long-term prospects, its major competitors and its position in the world market.

The Company should introduce unique products, highly desirable by the public to push the price of its stock up and to attract more investors.

We also recommend strict adherence to the findings of this work.

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