Prediction of Stock Market Performance using Markov Model

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ABSTRACT

Making precise predictions for the stock market has become quite challenging because of its non-linear and extremely volatile behavior. Many experts increasingly prioritize enhancing the effectiveness of forecasting. Researchers are dedicated to figure out the best feasible methods for precise predictions, from the conventional strategy of working with historical dossiers to applying the much more sophisticated machine learning and deep learning algorithms. Individual investors are interested in both the short-term next-day valuations as well as the long-term share prices. This paper will inspect one such algorithm commonly known as the Markov Model by analyzing the performance of different IT stocks of India and try to make a prediction of the upcoming stock values.

INTRODUCTION

India's thriving IT industry is one of the significant factors that has contributed to the country's global rise. The Indian economy has been experiencing exponential growth as a consequence of the IT sector's contributions to the GDP of the nation. From 1.2% of India's GDP in 1998 to over 8% in 2020–21, the industry has expanded its ownership stake. When the COVID-19 pandemic has affected the whole world, severely harming economies in the process, the Indian IT sector continued to demonstrate resilience and the potential to emerge from this catastrophic event.[1] In FY21, industry revenues increased by 2.3% to $194 billion.

Forecasting, the industry is anticipated to reach $227 billion in FY'22, demonstrating a 15.5 percent growth over the past decade. As investments ,
IT companies are acknowledged for having little to no debt on their balance sheets.They often ha ve few assets considering their primary focus is on providing services, which enables them to pro vide high return and profitability ratios for investors. [2]Hence, in this paper the closing prices of four significant stockholders in the IT sector—Tata Consultancy services (TCS), INFOSYS, WIPRO and HCL are analyzed to determine which has the
superior futuristic prospects. Markov chain modeling is used in this instance for the comparison since it is anticipated that the stock market's performance likely depend on immediate or recent historical events.

REVIEW OF LITERATURE

The volatility in the statistics makes it difficult to formulate the best predictions for financial stocks and returns. Time series modeling is the approximation method used in the majority of research studies. According to Yudong and Lenan(2009) , stock prices have a non-linear, nonparametric, convoluted, and predominantly dynamic character. Zhang (2009) examined further into assignment of predicting the stock prices using the Markov model technique. For predicting stock market movements in the Chinese stock market, they developed a Markov chain stochastic model. Their research revealed that the Markov process lacks the after-effect characteristic which has been used to forecast stock valuations. Norris (1998) investigated the discrete-time Markov chain's behavior and found that the Markov process has no memory. In some circumstances, it is possible to divide the Markov chain into smaller, more manageable chunks that, when put together, provide understanding of the entire system. Here identifying the chain's communicating classes helps. Autoregressive and heteroscedasticity models are typically used to analyze time series models on financial data. In a research published in Dr. Suresh (2016), conditional heteroscedasticity GARCH, a nonlinear model, was used to simulate the volatility of the S&P 500 index's market prices. Park et al (2009) suggested the application of HMM (Hidden Markov Model) to capture the dynamic nature of time series of stock prices. Now a days big data analysis is also grabbing attention in the stock market analysis. Well there are plethora of advance methodologies which can be implemented to predict the accuracy, this research will make use of the simple Markov model to analyze the behavior and compare the performances.

STRUCTURE AND METHODOLOGY OF THE STOCHASTIC MODEL

A stochastic model called a Markovian model is based on the Markovian property, which states that given the present state, the future is independent of the past. The Markov process' principal objective is to calculate the likelihood that a state will change from one state to another. One of Markov's primary arguments is that a stochastic variable's future state solely depends on its current state.

The initial step in the Markov chain is the generation of a Markov forecasting model, which predicts the state of an object in a future period of time using the variance of the likelihood vector of the underlying initial state vector and state transition probability matrix.

– Consider a discrete time stochastic process with discrete space. $X_n \in \{0, 1, 2 ...\}$. Thus, the Markovian property:-

$$\begin{aligned} &P\{X_{n+1} = j \mid X_n = i, X_{n-1} = i_{n-1}, \ldots, X_0 = i_0\} \\ &= P\{X_{n+1} = j \mid X_n = i\} = P_{i,j} \end{aligned}$$

Here, $P_{i,j}$ is the transition probability , as the state of the process may change in every step in time ,it is the likelihood that the process change from i^{th} state in the n trial to jth state in (n+1) trial , where $P_{ij} \geq 0,\ i,j \geq 0;\ \sum_{j=0}^{\infty} P_{ij} = 1,\ i = 0,1,2 \ldots$

The above stochastic process is known as a discrete time Markov Chain. This interprets that, conditional distribution of future state, given the present and past state is independent of the past states and depends only on current present state. All the possible states of Markov chain are depicted as rows and columns and the significant property of it is that the whole row’s summation is constantly one. This gives the transition probability matrix-

$$(P_{ij}) = \begin{matrix} p_{11} & p_{12} & \cdots & p_{1m} \\ p_{21} & p_{22} & \cdots & p_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ p_{m1} & p_{m2} & \cdots & p_{mm} \end{matrix}$$

The initial state vector at time n is given as $p^{(n)} = P[Xn = i]$. The initial state vector and the transition probability matrix together specifies a Markov chain {Xn}.

The probability of moving from i state to j in n steps is denoted by:-

$P_{i}{}^{n}{}_{j} = P(X_{n+m} = \text{j} \mid Xm = i).$

It can be explicitly explained by Chapman-Kolmogorov

$$P_{i,j}^{n+m} = \sum_{k=0}^{\infty} P_{i,k}^{n} P_{k,j}^{m}, \quad n, m \geq 0 \text{ for all } i, j.$$

- ***Proof by Total probability formula:***

$$\begin{aligned} P_{i,j}^{n+m} &= P(X_{n+m} = j | X_0 = i) \\ &= \sum_{k=0}^{\infty} P(X_{n+m} = j, X_n = k | X_0 = i) \\ &= \sum_{k=0}^{\infty} P(X_n = k | X_0 = i) \cdot \\ &\quad P(X_{n+m} = j | X_n = k, X_0 = i) \\ &= \sum_{k=0}^{\infty} P_{i,k}^{n} P_{k,j}^{m} \end{aligned}$$

If P is the transition probability matrix of homogeneous Markov chain, then the n-step transition probability matrix $P^{(n)}$is same as P^n . The framework's underlying state is a line matrix presented by the likelihood vector, and the transfer matrix is all that is needed for the typical Markov chain transition process. The fundamental Markov chain could be arranged in any way, and the yields from its states could be a multivariate random process with a continuous joint probability distribution.

CALCULATIONS AND RESULT

For the analysis, the closing price changes of 36 trade months from November-2019 to October2022 of top four IT sector are considered. It is segregated into three states: Bull, Bear and stagnant. Bull market prices normally rise, Bear market prices typically fall and stagnant markets price neither drop nor increase, a difference in 10 points in the closing price is taken here. Constructing the state vector accounting the initial state of each stock in its respective states out of sample points.

Table- 1 State vector of four stock indices

	TCS	Infosys	Wipro	HCL
Bull	0.5	0.555556	0.388889	0.444444
Stagnant	0.027778	0.055556	0.333333	0.194444
Bear	0.472222	0.388889	0.277778	0.361111

Now, computing total number of bull, bear, stagnant from each stock state to find the state transition probability matrix along with its corresponding probabilities.

Table – 2 State transition probability matrices

TATA CONSULTANCY SERVICES			
	Bull	**Stagnant**	**Bear**
Bull	0.388889	0.055556	0.555556
Stagnant	0	0	1
Bear	0.647059	0	0.352941

INFOSYS			
	Bull	**Stagnant**	**Bear**
Bull	0.5	0.05	0.45
Stagnant	1	0	0
Bear	0.571428	0.071429	0.3571428

WIPRO			
	Bull	**Stagnant**	**Bear**
Bull	0.428571	0.428571	0.142857
Stagnant	0.583333	0.166667	0.25
Bear	0.1	0.4	0.5

HCL			
	Bull	**Stagnant**	**Bear**
Bull	0.375	0.0625	0.5625
Stagnant	0.714286	0.28571429	0
Bear	0.384615	0.30769231	0.307692

Now, using table 1 – initial state vector and table -2 - State transition probability matrices, the forecasting of state likelihood of next month are calculated and predicted.
Let, I be the initial state, and P be the stochastic matrix,
Then the consecutive probabilities for succeeding months will be – I * P, I*P2, I * P3 …

Table-3 Prediction of the next 3 months performance of indices

TCS	**37th**	**38th**	**39th**
Bull	0.499999	0.5	0.500001
Stagnant	0.027779	0.027777	0.027778
Bear	0.472222	0.472223	0.472222

INFOSYS	**37th**	**38th**	**39th**
Bull	0.55555	0.555556	0.55566
Stagnant	0.05555	0.055556	0.0555
Bear	0.38888	0.388889	0.3888

WIPRO	**37th**	**38th**	**39th**
Bull	0.38888	0.38889	0.38888
Stagnant	0.33333	0.33333	0.33333
Bear	0.27777	0.27778	0.27778

HCL	**37th**	**38th**	**39th**
Bull	0.44443	0.44444	0.44444
Stagnant	0.19444	0.19444	0.19444
Bear	0.36111	0.36111	0.36111

From the above observation table , the closing prices of Infosys and HCL seems promising though there is no much changes , it is a safe play to buy these stocks because in the near future it might get increased and the closing price for stocks going down is also significantly low. WIPRO stocks are consistent throughout all the states, there growth and stagnant ratio is almost 1:1, and this stock would not be the best choice. The TCS has a steady increase in its bullish state, though its bullish and bearish percentage is at 50% and 47%, investors can surely take the risk and be profitable in the long run.

CONCLUSION

To sum up, the stock market prediction is a challenging one due to its unpredictable behavior. In this research Markov model is utilized to evaluate and compare the outcomes of four IT equities. The finding suggest that INFOSYS followed by HCL are the best stock to buy considering the lower percentage of bearish state and a steady growth. Other stocks probability of each state is pretty stable without any fluctuation. At the end of the day the investors can built their portfolios making use of any methodologies which works best for them.

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