**Contents**

[**CHAPTER 1** 3](#_Toc171001429)

[**An Overview of the Financial Market** 3](#_Toc171001430)

[**1.1 FINANCIAL MARKET** 3](#_Toc171001431)

[**1.2 STOCK MARKET** 3](#_Toc171001432)

[**1.3 REVIEW OF LITERATURE** 4](#_Toc171001433)

[**1.4 RESEARCH GAP AND MOTIVATION** 5](#_Toc171001434)

[**1.5 OBJECTIVES** 5](#_Toc171001435)

[**1.6 ORGANISATION OF THE PROJECT** 6](#_Toc171001436)

[**CHAPTER-2** 9](#_Toc171001437)

[**Mathematical Model** 9](#_Toc171001438)

[**2.1 STOCHASTIC MODEL** 9](#_Toc171001439)

[**2.2 TRANSITION PROBABILITY MATRIX (TPM)** 9](#_Toc171001440)

[**2.3 INITIAL PROBABILITY VECTOR (IPV)** 9](#_Toc171001441)

[**2.4 PROBABILITY DISTRIBUTION FOR INCREMENT STATE** 10](#_Toc171001442)

[**2.4.1 STATISTICAL CHARACTERISTICS OF PROBABILITY DISTRIBUTIONS OF INCREMENT STATE** 10](#_Toc171001443)

[2.4.1.1 Average number of times happening of Increment state 10](#_Toc171001444)

[2.4.1.2 Variance of Increment state 11](#_Toc171001445)

[2.4.1.3 Third Central Moment for Increment state 11](#_Toc171001446)

[2.4.1.4 Pearson’s Coefficient of Skewness for Increment state 11](#_Toc171001447)

[2.4.1.5 Pearson’s coefficient of kurtosis for Increment state 11](#_Toc171001448)

[2.4.1.6 Coefficient of variation for Increment state 11](#_Toc171001449)

[**2.5 PROBABILITY DISTRIBUTION FOR REMAIN SAME STATE** 11](#_Toc171001450)

[**2.5.1 STATISTICAL CHARACTERISTICS OF PROBABILITY DISTRIBUTIONS OF REMAIN SAME STATE** 11](#_Toc171001451)

[2.5.1.1 Average number of times happening of Remain same state 11](#_Toc171001452)

[2.5.1.2 Variance of Remain same state 11](#_Toc171001453)

[2.5.1.3 Third Central Moment for Remain same state 11](#_Toc171001454)

[2.5.1.4 Pearson’s Coefficient of Skewness for Remain same state 11](#_Toc171001455)

[2.7.2.5 Pearson’s coefficient of kurtosis for Remain same state 12](#_Toc171001456)

[2.5.1.6 Coefficient of variation for Remain same state 12](#_Toc171001457)

[**2.6 PROBABILITY DISTRIBUTION FOR DECREMENT STATE** 12](#_Toc171001458)

[**2.6.1 STATISTICAL CHARACTERISTICS OF PROBABILITY DISTRIBUTIONS OF DECREMENT STATE** 12](#_Toc171001459)

[2.6.1.1 Average number of times happening of Decrement state 12](#_Toc171001460)

[2.6.1.2 Variance of Decrement state 12](#_Toc171001461)

[2.6.1.3 Third Central Moment for Decrement state 12](#_Toc171001462)

[2.6.1.4 Pearson’s Coefficient of Skewness for Decrement state 12](#_Toc171001463)

[2.6.1.5 Pearson’s coefficient of kurtosis for Decrement state 12](#_Toc171001464)

[2.6.1.6 Coefficient of variation for Decrement state 12](#_Toc171001465)

[**2.7 STATIONARY MATRIX** 13](#_Toc171001466)

[**CHAPTER-3** 14](#_Toc171001467)

[**Data Description and Methodology** 14](#_Toc171001468)

[**3.1 TPM MATRICES CALCULATION AND ANALYSIS** 16](#_Toc171001469)

[**3.1.1 Transition Probability Matrix for opening and closing prices of SBI** 17](#_Toc171001470)

[**3.1.2 Transition Probability Matrix for opening and closing prices of HDFC** 19](#_Toc171001471)

[**3.1.3 Transition Probability Matrix for opening and closing prices of TCS** 21](#_Toc171001472)

[**3.2 STATIONARY MATRIX** 24](#_Toc171001473)

[**3.2.1 SBI OPEN PRICE STATIONARY MATRIX** 24](#_Toc171001474)

[**3.2.2 SBI CLOSE PRICE STATIONARY MATRIX** 24](#_Toc171001475)

[**3.2.3 HDFC OPEN PRICE STATIONARY MATRIX** 25](#_Toc171001476)

[**3.2.4 HDFC CLOSE PRICE STATIONARY MATRIX** 26](#_Toc171001477)

[**3.2.5 TCS OPEN PRICE STATIONARY MATRIX** 26](#_Toc171001478)

[**3.2.6 TCS CLOSE PRICE STATIONARY MATRIX** 27](#_Toc171001479)

[**3.3 Initial Probabilities (IPs) for opening and closing prices of SBI, HDFC, and TCS** 28](#_Toc171001480)

[**3.3.1 Initial Probabilities (IPs) for opening prices of SBI, HDFC, and TCS** 28](#_Toc171001481)

[**3.4 Probability Distributions for SBI** 30](#_Toc171001482)

[**3.4.1 Statistical Measures for SBI** 31](#_Toc171001483)

[**3.5 Probability Distributions for HDFC** 34](#_Toc171001484)

[**3.5.1 Statistical Measures for HDFC** 34](#_Toc171001485)

[**3.6 Probability Distributions for TCS** 38](#_Toc171001486)

[**3.7.1 Statistical Measures for TCS** 39](#_Toc171001487)

[**CHAPTER-4** 42](#_Toc171001488)

[**SUMMARY AND CONCLUSION** 42](#_Toc171001489)

[**4.1 SUMMARY** 42](#_Toc171001490)

[**4.2 Conclusion** 43](#_Toc171001491)

# **CHAPTER 1**

# **An Overview of the Financial Market**

## **1.1 FINANCIAL MARKET**

The financial market is a dynamic environment where organisations, governmental entities, and individuals engage in transactions involving various financial assets like derivatives, stocks, bonds, currencies, and commodities. It serves as a crucial system for managing risk and efficiently allocating capital across different sectors of the economy.

In India, the financial market consists primarily of two segments: the primary market and the secondary market.

The primary market acts as the initial source for new securities, allowing companies, governments, and other entities to raise funds through debt or equity securities. This process is facilitated by underwriting groups, such as investment banks, which set initial price ranges for securities and oversee their sale to investors. Investors can directly participate in the primary market through mechanisms like initial public offerings (IPOs) or private sales.

Conversely, the secondary market functions as a platform where investors trade previously issued securities among themselves. Securities that were initially sold in the primary market become available for trading on secondary markets, including stock exchanges like NASDAQ and NYSE. Through secondary market transactions, investors determine the true value of securities, thereby enhancing liquidity and enabling broader participation in the market.

## **1.2 STOCK MARKET**

Stock markets play a pivotal role within the financial industry by providing platforms for corporations to offer shares for trading and investors to buy and sell, facilitating capital formation and investment opportunities. Key components of the stock market include regulated venues like the over-the-counter (OTC) market, Nasdaq, and the New York Stock Exchange (NYSE), where trading occurs under established frameworks.

Participants in the stock market, such as market makers, specialists, traders, and investors, collectively contribute to maintaining liquidity and facilitating transactions. Various factors influence stock market performance, including government policies and regulations, global economic trends, supply and demand dynamics, monetary policies set by regulatory bodies like the Reserve Bank of India (RBI) and Securities and Exchange Board of India (SEBI), and the activities of Foreign Institutional Investors (FIIs) and Domestic Institutional Investors (DIIs).

Furthermore, external factors such as natural calamities, currency exchange rates, technological advancements, and economic indicators like GDP and oil prices also impact market dynamics and investor sentiment.

The Bombay Stock Exchange (BSE) and the National Stock Exchange of India (NSE) are key players in the Indian financial market, providing platforms for trading and contributing significantly to the development of capital markets in the country. The Securities and Exchange Board of India (SEBI) plays a crucial role in regulating market participants and ensuring investor protection, despite criticisms regarding transparency and accountability. Overall, the financial market in India functions as a vital component of the economy, facilitating efficient capital allocation and risk management.

## **1.3 REVIEW OF LITERATURE**

Researchers have employed a variety of mathematical models and techniques to analyse and forecast stock market behaviour across different regions and markets. Deju Zhang (2009) utilized the Markov model to examine fluctuations in China's share market volatility, while Xiangyi Meng et al. (2015) applied diverse mathematical models for stock movement analysis. Rene D. Estember and Michael John R. Marana (2016) employed geometric Brownian motion (GBM) and Monte Carlo simulation to forecast share prices, asserting GBM's accuracy over techniques like Artificial Neural Network (ANN). Priti Mohite et al. (2018) utilized the Markov chain model to analyse optimal investment strategies in the financial market.

Additionally, Wajeeh Mustafa Sarsour and Shamsul Rijal Muhammad Sabri (2019) used the Markov chain approach to analyse the behaviour of the Malaysian stock market. Nopmanee Parungrojrat and Akaranant Kidsom (2019) employed Brownian motion process and Monte Carlo simulation to forecast selected stocks in SET50. Azubuike Samuel & Ephraim Okon (2020) utilized the Markov model to analyse share market trends, while Azubuike Samuel (2020) focused on the Nigerian Stock Market using the Markov chain model. Siti Raihana Hamzah et al. (2021) applied the Brownian motion model to assess Nestle stock prices.

Furthermore, Padi T. R. et al. (2022) employed Markov models to analyze the spread of COVID-19 in neighbouring Southern states. Tong Wang et al. (2022) utilized a hidden Markov model to assess the performance of companies like Apple and Google. Ranganath Kanakam et al. (2022) utilized machine learning tools for historical data analysis and future performance prediction of shares. Shuaiqi Zhou (2023) adopted the Brownian Motion process for an optimal investment policy, and David Umoru (2023) examined the link between exchange rate devaluation and stock prices in African stock markets.

Moreover, Zebin Guo (2024) employed various statistical techniques for share performance evaluation, while Riza Demirer et al. (2024) used forecasting techniques for predicting aggregate stock market prices in Borsa Istanbul. Lu Xu et al. (2024) explored the connection between investor sentiment and China's stock market, and Tran Phuoc et al. (2024) utilized statistical techniques like simple moving averages and convergence divergence moving average for share price prediction in the financial market.

## **1.4 RESEARCH GAP AND MOTIVATION**

Through the extensive literature it is noted that most of the research work done either classical approach or applying the existing models to analyse or forecast the behaviour of market trend. However, there is a notable absence of studies focusing on extracting parameters, developing models, and computing statistical characteristics for these models. This observation serves as a driving force behind the consideration of this study.

The present study adopts a Markov model as its analytical framework. Our investigation is primarily focused on two key aspects. Firstly, we concentrate on constructing two fundamental parameters essential for the Markov model: the Transition Probability Matrix (TPM) and the Initial Probability Vector (IPV). These parameters are formulated to establish probability distributions within the model. Secondly, we collect real-time data from two distinct sectors: public and private banking, along with data from an Information Technology (IT) company. We conduct numerical illustrations utilizing the developed model and subsequently engage in comparative analysis of the results obtained from the two banking sectors and the IT company.

## **1.5 OBJECTIVES**

The main objectives of this project are

1. To Construct the parameters of the model.
2. To formulate the probability distributions using the parameters.
3. To constructed Statistical characteristics using formulated probability distribtutions.
4. To collect the real-time data of SBI, HDFC, and TCS (IT) the internet source, segregated data set into three types based on before, after, and during COVID-19 data sets.
5. After segregation each data set, probability distribution have been explored for each data set separately.
6. To compute the Statistical characteristics of the probability distribution, generated from different data sets.
7. To illustrate of results

## **1.6 ORGANISATION OF THE PROJECT**

* **Chapter 1: An Overview of the Financial Market**

In this chapter, we discuss the financial market in India, which primarily consists of two segments: the primary market and the secondary market. The Indian stock market, with key players such as the Bombay Stock Exchange (BSE) and the National Stock Exchange of India (NSE), plays a pivotal role in the financial industry by providing platforms for corporations to offer shares for trading and for investors to buy and sell, thus facilitating capital formation and investment opportunities. Through extensive literature review, we gather information on the stock market and Markov models. This study identifies a research gap and is motivated by the need to understand stock market behaviour. The present study adopts a Markov model as its analytical framework.

* **Chapter 2: Mathematical Model**

In this chapter, we rigorously explore the foundations of the stochastic model applied in our study. We start by detailing the Transition Probability Matrix (TPM) and its role in defining state transitions over time. The Initial Probability Vector (IPV). We extensively cover the probability distributions for states of increment, remind same, and decrement, crucial for understanding market dynamics. Statistical characteristics derived from these distributions provide deeper insights into market behaviour under varying conditions. Finally, we elucidate the stationary matrix, revealing the long-term equilibrium states of the system.

* **Chapter 3: Data Description and Results**

We thoroughly investigate the effects of COVID-19 on the Indian stock market by analysing the historical stock prices of SBI, HDFC, and TCS. We segment the dataset into three distinct periods before, during, and after COVID-19 employing used 3-sigma limits for data segregation. Our study focuses on calculating Transition Probability Matrices (TPM) for computed for both opening and closing prices each company, which illustrate how stock price states evolve over time. Initial Probabilities (IPs) are computed for both opening and closing prices to establish baseline conditions. Furthermore, we conduct stationary matrix analysis to uncover the stable, long-term states of stock prices for SBI, HDFC, and TCS. The results include detailed probability distributions and statistical measures. This chapter provides a comprehensive overview of our methodology and empirical findings, contributing to a deeper understanding of market dynamics amidst significant economic disruptions.

* **Chapter 4: Summary and Conclusion**

Finally summarizes the project's findings, focusing on transition probabilities and statistical insights into stock movements of SBI, HDFC, and TCS before, during, and after COVID-19. The analysis offers tailored suggestions for investors and portfolio managers based on observed market trends. Specific actions are recommended for each company to navigate market dynamics effectively and mitigate risks. This chapter aims to provide concise, actionable insights to inform strategic decision-making in the Indian stock market context.

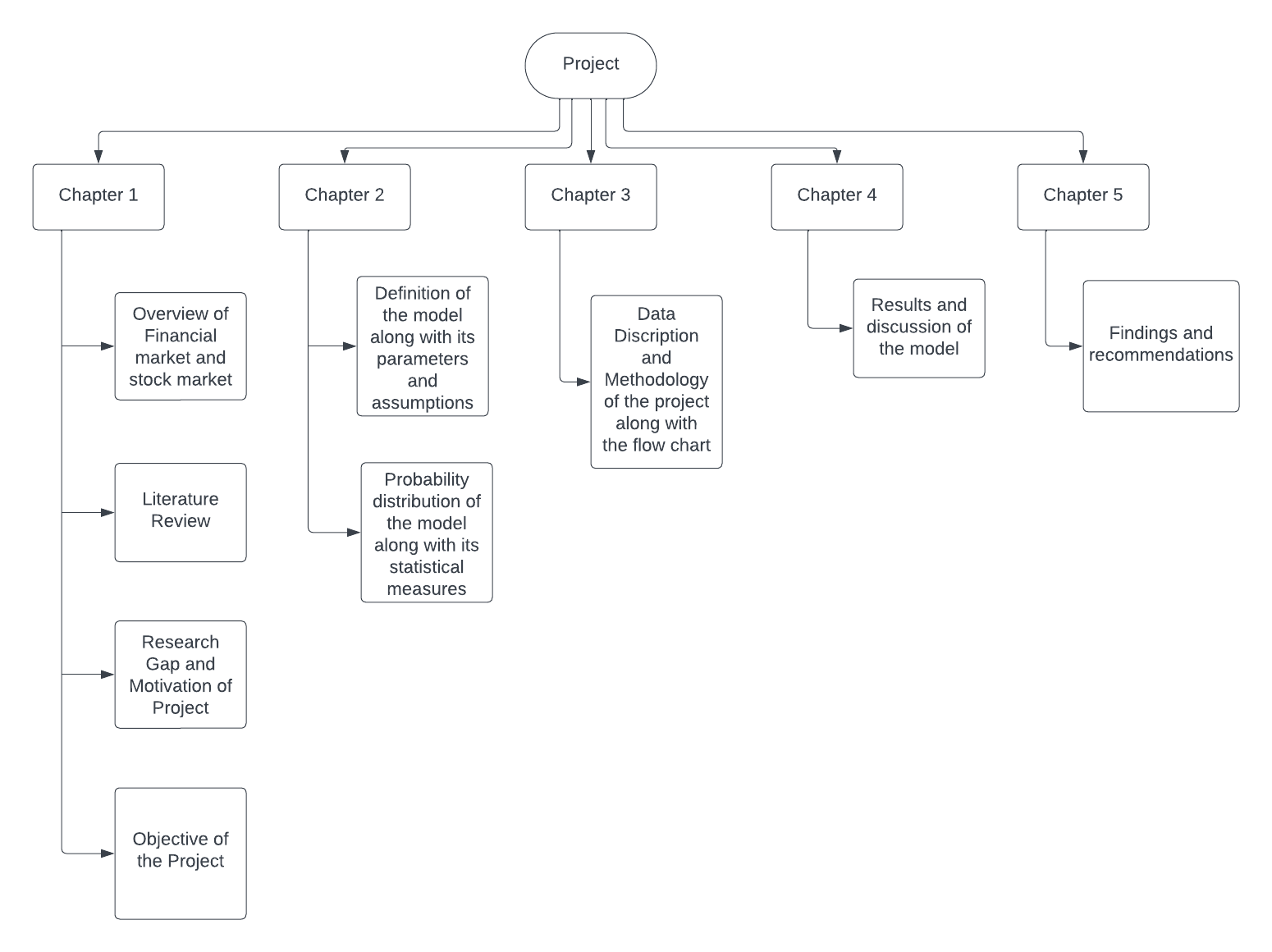
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Figure 1: Organisation of Project

# **CHAPTER-2**

# **Mathematical Model**

## **2.1 STOCHASTIC MODEL**

Markov model is a kind of stochastic model. The basic essence of the Markov chains is that the future is not affected by the past but by the current happening only. This model consists of two parameters namely Transition Probability Matrix and Initial Probability Vector.

## **2.2 TRANSITION PROBABILITY MATRIX (TPM)**

A transition probability matrix (TPM), also known as a stochastic matrix. The state transition probability matrix of a Markov chain gives the probabilities of transition from one state to another in a single time unit. The TPM assumptions while constructing the TPM are,

1. The TPM must be a square matrix
2. The elements in TPM must be probabilities, and
3. Each row sum should be equal to 1

Whenever, the row and column sum equal to 1; that kind of matrix in known as a doubly Stochastic matrix. The TPM’s mathematical notation is given below

P =

Where ‘i’ is the original state, ‘j’ is the destination state in the transition states.

## **2.3 INITIAL PROBABILITY VECTOR (IPV)**

The IPV in Markov model represents the chance of likelihood of happening particular state in the process. The total of all likelihood in the IPV must be 1.

=1

The mathematical notation of Markov model is as follows:

.

.e

The focus of the study on the current research project is to understand the effect of COVID-19 on stock values. In this connection, we have considered three states namely, State-1 as Increment, State-2 as Remain Same, and State-3 as Decrement state. Figure 2 represents the schematic diagram of the Markov model.

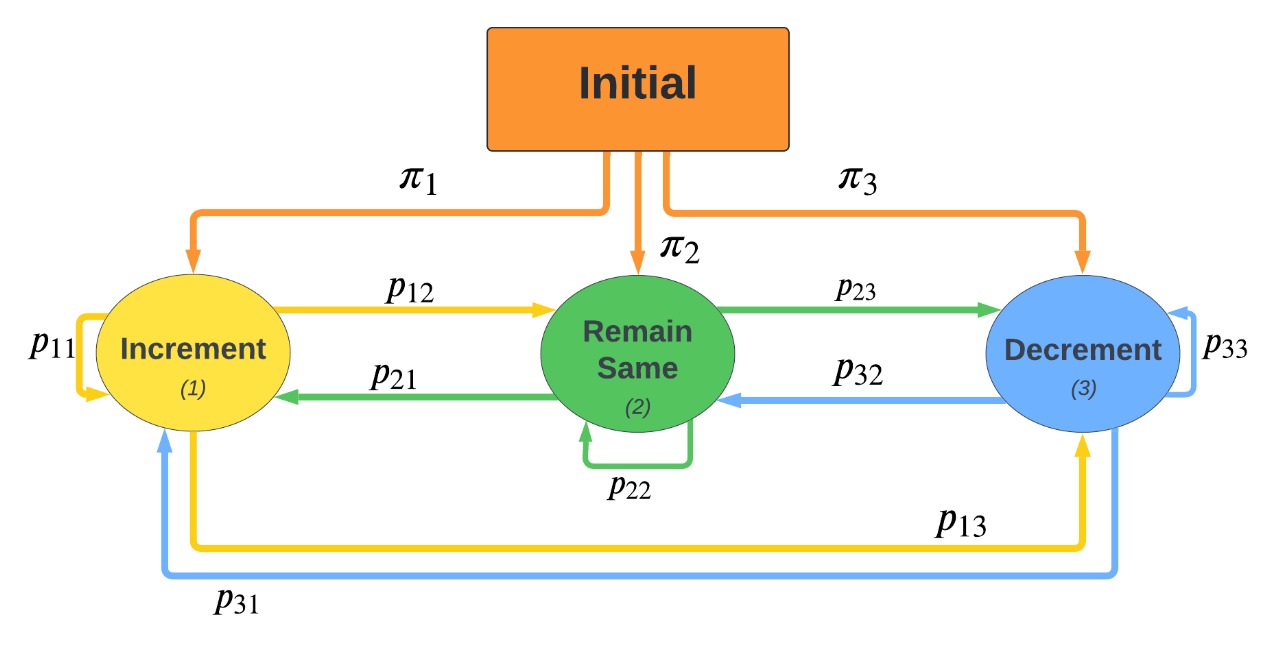


Figure 2: Schematic Diagram for Markov model

Here,

, indicates that likelihood of Increment state.

, indicates that likelihood of Remain Same state.

, indicates that likelihood of Decrement state.

## **2.4 PROBABILITY DISTRIBUTION FOR INCREMENT STATE**

### **2.4.1** **STATISTICAL CHARACTERISTICS OF PROBABILITY DISTRIBUTIONS OF INCREMENT STATE**

This section describes the statistical measures or metrics of developed probability distributions placed in the equations 2.1,2.2, and 2.3 respectively.

### 2.4.1.1 Average number of times happening of Increment state

=

### 2.4.1.2 Variance of Increment state

### 2.4.1.3 Third Central Moment for Increment state

### 2.4.1.4 Pearson’s Coefficient of Skewness for Increment state

### 2.4.1.5 Pearson’s coefficient of kurtosis for Increment state

### 2.4.1.6 Coefficient of variation for Increment state

CV =

## **2.5 PROBABILITY DISTRIBUTION FOR REMAIN SAME STATE**

### **2.5.1 STATISTICAL CHARACTERISTICS OF PROBABILITY DISTRIBUTIONS OF REMAIN SAME STATE**

This section describes the statistical measures or metrics of developed probability distributions placed in the equations 2.1,2.2, and 2.3 respectively.

### 2.5.1.1 Average number of times happening of Remain same state

() =

### 2.5.1.2 Variance of Remain same state

### 2.5.1.3 Third Central Moment for Remain same state

### 2.5.1.4 Pearson’s Coefficient of Skewness for Remain same state

### 2.7.2.5 Pearson’s coefficient of kurtosis for Remain same state

### 2.5.1.6 Coefficient of variation for Remain same state

CV =

## **2.6 PROBABILITY DISTRIBUTION FOR DECREMENT STATE**

### **2.6.1 STATISTICAL CHARACTERISTICS OF PROBABILITY DISTRIBUTIONS OF DECREMENT STATE**

This section describes the statistical measures or metrics of developed probability distributions placed in the equations 2.1,2.2, and 2.3 respectively

### 2.6.1.1 Average number of times happening of Decrement state

; =

### 2.6.1.2 Variance of Decrement state

### 2.6.1.3 Third Central Moment for Decrement state

### 2.6.1.4 Pearson’s Coefficient of Skewness for Decrement state

### 2.6.1.5 Pearson’s coefficient of kurtosis for Decrement state

### 2.6.1.6 Coefficient of variation for Decrement state

CV =

## **2.7 STATIONARY MATRIX**

A higher-order transition probability matrix is used in the context of Markov chains and represents the probabilities of transitioning between states over multiple steps or periods. Here’s a formal definition:

Let P be the one-step transition probability matrix of a Markov chain. The higher-order transition probability matrix, , represents the probabilities of transitioning between states over *n* steps. It is defined as follows:

* **One-Step Transition Probability Matrix**:

*P =*

where is the probability of transitioning from state *i* to state *j* in one step.

* **Higher-Order (n-step) Transition Probability Matrix**:

=

where is the matrix obtained by multiplying the one-step transition matrix *P* by itself *n* times. Mathematically:

*= P.P.P……P* (n time)

Each element of represents the probability of transitioning from state *i* to state *j* in *n* steps.

# **CHAPTER-3**

# **Data Description and Methodology**

This study investigates the impact of COVID-19 on the Indian stock market by analysing the historical opening and closing stock prices of three major companies: State Bank of India (SBI), Housing Development Finance Corporation Bank (HDFC), and Tata Consultancy Services (TCS). The stock price data were obtained from finance.yahoo.com and segmented into three periods: before COVID-19 (November 1, 2017, to October 31, 2019), during COVID-19 (November 1, 2019, to October 31, 2021), and after COVID-19 (November 1, 2021, to November 31, 2023). To assess the stock price movements, the study employs the method of first order finite differences, defined as i.e., = . where ​ represents the stock price (either opening or closing) on day t and represents the price on the previous day.

The finite differences ​ where then classified into three states to determine the nature of stock price movements. State-1(Increment) is defined as indicating a significant positive change in stock prices, where μ is the mean and σ is the standard deviation of the differences over the period, and n is the number of observations. State-2 (Remain Same) covers the range if , representing typical fluctuations within three standard deviations of the mean, indicating stability or normal market volatility. State-3 (Decrement) is defined as , indicating a significant negative change in stock prices.

By comparing the opening and closing prices, this classification framework allows for a detailed analysis of the stock price behaviour in different periods relative to the COVID-19 pandemic. It helps identify significant trends and anomalies in the stock market by comparing the frequency and magnitude of Increments, Decrements, and stable periods across the three defined time frames. This analysis provides valuable insights into how the pandemic has affected market behaviour and helps in understanding the broader economic impacts. Additionally, it aids in developing future market predictions and investment strategies by highlighting how major financial events influence stock prices.

In the below table 1 t, Ot, and dot represents the date, opening price and finite difference in the opening price of SBI respectively.

In the below table 2 t, Ct, and dct represent the date, closing price and finite difference in the closing price of SBI respectively.

**Specimen Data of SBI open price (source: finance.yahoo.com)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No.** | **t** |  |  | **state** |
| 1 | 01-11-2017 | 309.4 | - | - |
| 2 | 02-11-2017 | 320 | 10.60001 | Increment |
| 3 | 03-11-2017 | 315.45 | -4.54999 | Decrement |
| 4 | 04-11-2017 | 323.6 | 8.149994 | Increment |
| .  .  . | .  .  . | .  .  . | .  .  . | .  .  . |
| 488 | 27-10-2019 | 284.95 | 19.15002 | Increment |
| 489 | 29-10-2019 | 283.15 | -1.80002 | Decrement |
| 490 | 30-10-2019 | 283 | -0.14999 | Remain Same |
| 491 | 31-10-2019 | 293.35 | 10.35001 | Increment |

Table 1: Specimen data of SBI open price

**Specimen Data of SBI close price (source: finance.yahoo.com)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No.** | **t** |  |  | **state** |
| 1 | 01-11-2017 | 319.85 | - | - |
| 2 | 02-11-2017 | 314.35 | -5.5 | Decrement |
| 3 | 03-11-2017 | 325 | 10.64999 | Increment |
| 4 | 04-11-2017 | 329 | 4 | Increment |
| .  .  . | .  .  . | .  .  . | .  .  . | .  .  . |
| 488 | 27-10-2019 | 281.8 | 0.25 | Remain Same |
| 489 | 29-10-2019 | 280.65 | -1.14999 | Decrement |
| 490 | 30-10-2019 | 289.9 | 9.25 | Increment |
| 491 | 31-10-2019 | 312.4 | 22.50001 | Increment |

Table 2: Specimen data of SBI close price

**Data Collection**

The data collected includes the historical stock prices, specifically the opening and closing prices for SBI, HDFC, and TCS, across the specified periods. This data forms the basis for understanding the stock price movements and their response to the pandemic.

**Data Analysis**

* First Order Finite Differences:

To analyse the stock price movements, the first order finite differences method is used. This involves calculating the difference between the stock prices of consecutive days:

​ =

​where is the stock price on day t and is the stock price on the previous day.

* **Classification of Stock Movements**

The stock movements are classified into three states based on the first order finite differences and their relation to the mean (μ) and standard deviation (σ) of the differences over a given period. This classification is as follows:

* **States Classification:**

State-1 (Increment): If

State-2 (Remain Same): If

State-3 (Decrement): If

I calculated the TPM matrix using the formulas described above, and applied this methodology to assess the TPM matrices for SBI, HDFC, and TCS during three distinct periods: before, during, and after the COVID-19 pandemic.

## **3.1 TPM MATRICES CALCULATION AND ANALYSIS**

Understanding transition trends in stock movements is crucial for investors and portfolio managers, especially during volatile times like the COVID-19 pandemic. Let's delve into the transition probabilities observed in prominent stocks such as SBI, HDFC, and TCS.

### **3.1.1 Transition Probability Matrix for opening and closing prices of SBI**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **(1,1)** | **(1,2)** | **(1,3)** | **(2,1)** | **(2,2)** | **(2,3)** | **(3,1)** | **(3,2)** | **(3,3)** |
| **Open** | Before |  |  |  |  |  |  |  |  |  |
| During |  |  |  |  |  |  |  |  |  |
| After |  |  |  |  |  |  |  |  |  |
| **Close** | Before |  |  |  |  |  |  |  |  |  |
| During |  |  |  |  |  |  |  |  |  |
| After |  |  |  |  |  |  |  |  |  |

Table 3: TPM matrix of SBI open and close prize

Interpreting the transition probabilities in the Table 3 involves analysing how values change across the three time points (Before, During, and After) for both stock prices (Open, Close). The higher and lower transition probabilities indicate a higher likelihood or greater magnitude a lower likelihood or smaller magnitude of the measured variable.

**3.1.1.1 SBI Opening Share Price**

**Before COVID-19:**

Higher Values: Indicate stronger or more prevalent initial conditions for the variables. A value of 0.5502 at previous day's Increment to the current day's Decrement state (1,3) suggests a relatively strong initial state for this variable.

Lower Values: Indicate weaker or less prevalent initial conditions. A value of 0.1005 at previous day's Increment to the current day's Remine same state (1,2) suggests a relatively weak initial state for this variable.

**During COVID-19:**

Higher Values: Suggest an increase or sustained high levels of the variable. The value of 0.4901 at previous day's Increment to the current day's Decrement state (1,3) shows a slight decrease from Before but still a relatively high value, indicating sustained presence.

Lower Values: Suggest a decrease or low levels of the variable. The value of 0.1238 at previous day's Increment to the current day's Remind same state (1,2) shows a slight increase from Before but still remains relatively low.

**After COVID-19:**

Higher Values: Suggest that the variable has either remained high or increased from the initial state. A value of 0.4776 at previous day's Decrement to the current day's Increment state (3,1) indicates a higher value compared to the initial state, suggesting an overall increase.

Lower Values: Suggest that the variable has either remained low or decreased from the initial state. A value of 0.1095 at previous day's Decrement to the current day's Remind same state (3,2)indicates a lower value compared to the initial state, suggesting an overall decrease.

By examining the higher and lower values of the opening price of SBI before, during, and after COVID-19, we can observe trends in how the variables were impacted, identifying areas of resilience, growth, decline, or recovery.

**3.1.1.2 SBI Closing Share Price**

**Before COVID-19:**

Higher Values: Indicate stronger or more significant initial conditions for the variables. A value of 0.4848 at previous day's Remind same to the current day's Decrement state (2,3) suggests a strong initial state for this variable.

Lower Values: Indicate weaker or less significant initial conditions. A value of 0.1364 at previous day's Remind same to the current day's Remind same state (2,2) suggests a relatively weak initial state for this variable.

**During COVID-19:**

Higher Values: Suggest an increase or sustained high levels of the variable. The value of 0.5075 at previous day's Remind same to the current day's Increment state (2,1) indicates an increase from Before, showing an upward trend.

Lower Values: Suggest a decrease or low levels of the variable. The value of 0.1179 at previous day's Increment to the current day's Remind same state (1,2) indicates a slight decrease from Before, showing a downward trend.

**After COVID-19:**

Higher Values: Suggest that the variable has either remained high or increased from the initial state. A value of 0.4848 at previous day's Remind same to the current day's Decrement state (2,3) suggests a sustained high value or a return to a high state after a temporary change.

Lower Values: Suggest that the variable has either remained low or decreased from the initial state. A value of 0.1212 at previous day's Remind same to the current day's Remind same state (2,2) suggests a decrease or sustained low value after a temporary change.

By examining the higher and lower values of the closing price of SBI before, during, and after COVID-19, we can observe trends in how the variables were impacted, identifying areas of resilience, growth, decline, or recovery.

### **3.1.2 Transition Probability Matrix for opening and closing prices of HDFC**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **(1,1)** | **(1,2)** | **(1,3)** | **(2,1)** | **(2,2)** | **(2,3)** | **(3,1)** | **(3,2)** | **(3,3)** |
| **Open** | Before |  |  |  |  |  |  |  |  |  |
| During |  |  |  |  |  |  |  |  |  |
| After |  |  |  |  |  |  |  |  |  |
| **Close** | Before |  |  |  |  |  |  |  |  |  |
| During |  |  |  |  |  |  |  |  |  |
| After |  |  |  |  |  |  |  |  |  |

Table 4: TPM matrix of HDFC open and close prize

Interpreting the transition probabilities in the Table 3 involves analysing how values change across the three time points (Before, During, and After) for both stock prices (Open, Close). The higher and lower transition probabilities indicate a higher likelihood or greater magnitude a lower likelihood or smaller magnitude of the measured variable.

**3.1.2.1 HDFC Opening Share Price**

**Before COVID-19:**

Higher Values: Indicate stronger or more prevalent initial conditions for the variables. A value of 0.48 at previous day's Remind same to the current day's Decrement state (2,3) suggests a relatively strong initial state for this variable.

Lower Values: Indicate weaker or less prevalent initial conditions. A value of0.1294 at previous day's Increment to the current day's Remind same state (1,2) suggests a relatively weak initial state for this variable.

**During COVID-19:**

Higher Values: Suggest an increase or sustained high levels of the variable. The value of 0.4315 at previous day's Increment to the current day's Decrement state (1,3) shows a slight decrease from Before but still a relatively high value, indicating sustained presence.

Lower Values: Suggest a decrease or low levels of the variable. The value of 0.1489 at previous day's Remind same to the current day's Remind same state (2,2) shows a slight increase from Before but still remains relatively low.

**After COVID-19:**

Higher Values: Suggest that the variable has either remained high or increased from the initial state. A value of 0.4923 at previous day's Remind same to the current day's Increment state (2,1) indicates a higher value compared to the initial state, suggesting an overall increase.

Lower Values: Suggest that the variable has either remained low or decreased from the initial state. A value of 0.1131 at previous day's Increment to the current day's Remind same state (1,2)indicates a lower value compared to the initial state, suggesting an overall decrease.

By examining the higher and lower values of the opening price of HDFC before, during, and after COVID-19, we can observe trends in how the variables were impacted, identifying areas of resilience, growth, decline, or recovery.

**3.1.2.2 HDFC Closing Share Price**

**Before COVID-19:**

Higher Values: Indicate stronger or more significant initial conditions for the variables. A value of 0.4808 at previous day's Remind same to the current day's Increment state (2,1) suggests a strong initial state for this variable.

Lower Values: Indicate weaker or less significant initial conditions. A value of 0.0893 at previous day's Increment to the current day's Remind same state (3,2) suggests a relatively weak initial state for this variable.

**During COVID-19:**

Higher Values: Suggest an increase or sustained high levels of the variable. The value of 0.4598 at previous day's Remind same to the current day's Increment state (2,1) indicates an increase from Before, showing an upward trend.

Lower Values: Suggest a decrease or low levels of the variable. The value of 0.0943 at previous day's Remind same to the current day's Remind same state (2,2) indicates a slight decrease from Before, showing a downward trend.

**After COVID-19:**

Higher Values: Suggest that the variable has either remained high or increased from the initial state. A value of 0.4888 at previous day's Increment to the current day's Increment state (1,1) suggests a sustained high value or a return to a high state after a temporary change.

Lower Values: Suggest that the variable has either remained low or decreased from the initial state. A value of 0.1144 at previous day's Remind same to the current day's Decrement state (3,2) suggests a decrease or sustained low value after a temporary change.

By examining the higher and lower values of the closing price of HDFC before, during, and after COVID-19, we can observe trends in how the variables were impacted, identifying areas of resilience, growth, decline, or recovery.

### **3.1.3 Transition Probability Matrix for opening and closing prices of TCS**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **(1,1)** | **(1,2)** | **(1,3)** | **(2,1)** | **(2,2)** | **(2,3)** | **(3,1)** | **(3,2)** | **(3,3)** |
| **Open** | Before |  |  |  |  |  |  |  |  |  |
| During |  |  |  |  |  |  |  |  |  |
| After |  |  |  |  |  |  |  |  |  |
| **Close** | Before |  |  |  |  |  |  |  |  |  |
| During |  |  |  |  |  |  |  |  |  |
| After |  |  |  |  |  |  |  |  |  |

Table 5: TPM matrix of TCS open and close prize

Interpreting the transition probabilities in the Table 3 involves analysing how values change across the three time points (Before, During, and After) for both stock prices (Open, Close). The higher and lower transition probabilities indicate a higher likelihood or greater magnitude a lower likelihood or smaller magnitude of the measured variable.

**3.1.3.1 TCS Opening Share Price**

**Before COVID-19:**

Higher Values: Indicate stronger or more prevalent initial conditions for the variables. A value of 0.4516 at previous day's Decrement to the current day's Decrement state (3,3) suggests a relatively strong initial state for this variable.

Lower Values: Indicate weaker or less prevalent initial conditions. A value of 0.106 at previous day's Decrement to the current day's Remind same state (3,2) suggests a relatively weak initial state for this variable.

**During COVID-19:**

Higher Values: Suggest an increase or sustained high levels of the variable. The value of 0. at previou5143s day's Increment to the current day's Decrement state (1,3) shows a slight decrease from Before but still a relatively high value, indicating sustained presence.

Lower Values: Suggest a decrease or low levels of the variable. The value of 0.0905 at previous day's Increment to the current day's Remind same state (1,2) shows a slight increase from Before but still remains relatively low.

**After COVID-19:**

Higher Values: Suggest that the variable has either remained high or increased from the initial state. A value of 0.5161 at previous day's Remind same to the current day's Increment state (2,1) indicates a higher value compared to the initial state, suggesting an overall increase.

Lower Values: Suggest that the variable has either remained low or decreased from the initial state. A value of 0.1221 at previous day's Decrement to the current day's Remind same state (3,2) indicates a lower value compared to the initial state, suggesting an overall decrease.

By examining the higher and lower values of the opening price of SBI before, during, and after COVID-19, we can observe trends in how the variables were impacted, identifying areas of resilience, growth, decline, or recovery.

**3.1.1.2 TCS Closing Share Price**

**Before COVID-19:**

Higher Values: Indicate stronger or more significant initial conditions for the variables. A value of 0.4493 at previous day's Increment to the current day's Increment state (1,1) suggests a strong initial state for this variable.

Lower Values: Indicate weaker or less significant initial conditions. A value of 0.1111 at previous day's Increment to the current day's Remind same state (1,2) suggests a relatively weak initial state for this variable.

**During COVID-19:**

Higher Values: Suggest an increase or sustained high levels of the variable. The value of 0.4595 at previous day's Remind same to the current day's Decrement state (2,3) indicates an increase from Before, showing an upward trend.

Lower Values: Suggest a decrease or low levels of the variable. The value of 0.1216 at previous day's Remind same to the current day's Remind same state (2,2) indicates a slight decrease from Before, showing a downward trend.

**After COVID-19:**

Higher Values: Suggest that the variable has either remained high or increased from the initial state. A value of 0.5 at previous day's Remind same to the current day's Decrement state (2,3) suggests a sustained high value or a return to a high state after a temporary change.

Lower Values: Suggest that the variable has either remained low or decreased from the initial state. A value of 0.1202 at previous day's Increment to the current day's Remind same state (3,2) suggests a decrease or sustained low value after a temporary change.

By examining the higher and lower values of the closing price of TCS before, during, and after COVID-19, we can observe trends in how the variables were impacted, identifying areas of resilience, growth, decline, or recovery.

**3.1.4 Implications for Investors and Portfolio Managers**

Before-COVID, investors should monitor transitions from Increment to Decrement states in SBI and TCS for potential downturns. During-COVID, amid market uncertainties, the focus should be on shifts from Increment to Decrement states across all stocks. After-COVID, attention should be given to transitions from Remain same to Increment states, indicating potential growth opportunities in HDFC and TCS. By understanding these transition probabilities, investors and portfolio managers can make informed decisions to optimize their portfolios and navigate through various market conditions effectively.

Understanding transition probabilities can empower investors and portfolio managers in several crucial ways. Firstly, it facilitates risk assessment and management by providing insights into the likelihood of different stock price states before, during, and after the COVID-19 pandemic. This knowledge enables stakeholders to gauge and mitigate risks associated with individual stocks. Secondly, it aids in portfolio allocation and strategy formulation, allowing managers to adjust allocations and formulate investment strategies based on expected transitions in stock price states. This optimization maximizes growth opportunities while minimizing risks. Lastly, continuous monitoring and adjustment based on observed market conditions and deviations from expected trends are vital. By staying vigilant and adapting investment strategies accordingly, investors can ensure that their portfolios remain aligned with market dynamics. Ultimately, by leveraging these insights, investors and portfolio managers can make informed decisions to optimize their portfolios and navigate through various market conditions effectively.

## **3.2 STATIONARY MATRIX**

### **3.2.1 SBI OPEN PRICE STATIONARY MATRIX**

Before-COVID in SBI; ; at n = 7

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 7, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 45.98% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

During-COVID in SBI; ; at n = 4

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 4, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 45.03% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

After-COVID in SBI; ; at n = 6

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 4, the TPM reaches its stationary state. In this stationary state, the Increment state has a significantly high probability of 43.91% compared to the other states. This indicates to investors that sales the product is a favorable decision.

### **3.2.2 SBI CLOSE PRICE STATIONARY MATRIX**

Before COVID in SBI; ; at n = 6

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 6, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 44.28% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

During COVID in SBI; ; at n = 10

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 10, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 43.61% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

After COVID in SBI; ; at n = 4

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 4, the TPM reaches its stationary state. In this stationary state, the Increment state has a significantly high probability of 44.61% compared to the other states. This indicates to investors that sales the product is a favorable decision.

### **3.2.3 HDFC OPEN PRICE STATIONARY MATRIX**

Before COVID; ; at n = 6

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 6, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 43.76% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

During COVID; ; at n = 4

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 4, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 41.47% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

After COVID; ; at n = 4

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 4, the TPM reaches its stationary state. In this stationary state, the Increment state has a significantly high probability of 44.43% compared to the other states. This indicates to investors that sales the product is a favorable decision.

### **3.2.4 HDFC CLOSE PRICE STATIONARY MATRIX**

Before COVID; ; at n = 5

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 5, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 45.81% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

During COVID; ; at n = 8

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 8, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 45.23% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

After COVID; ; at n = 5

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 4, the TPM reaches its stationary state. In this stationary state, the Increment state has a significantly high probability of 45.05% compared to the other states. This indicates to investors that sales the product is a favorable decision.

### **3.2.5 TCS OPEN PRICE STATIONARY MATRIX**

Before COVID; = ; at n = 6

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 6, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 44.17% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

During COVID; = ; at n = 5

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 5, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 45.59% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

After COVID; = ; at n = 5

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 5, the TPM reaches its stationary state. In this stationary state, the Increment state has a significantly high probability of 454.23% compared to the other states. This indicates to investors that sales the product is a favorable decision.

### **3.2.6 TCS CLOSE PRICE STATIONARY MATRIX**

Before COVID; = ; at n = 5

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 5, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 43.35% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

During COVID; = ; at n = 4

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 4, the TPM reaches its stationary state. In this stationary state, the Decrement state has a significantly high probability of 43.14% compared to the other states. This indicates to investors that purchasing the product is a favorable decision.

After COVID; = ; at n = 7

In the given Transition Probability Matrix (TPM), the matrix becomes stationary at Specifically, at n = 7, the TPM reaches its stationary state. In this stationary state, the Increment state has a significantly high probability of 44.05% compared to the other states. This indicates to investors that sales the product is a favorable decision.

## **3.3 Initial Probabilities (IPs) for opening and closing prices of SBI, HDFC, and TCS**

The IPs indicates the chance of occurrence of the particular state, which is placed in the Table 3.

### **3.3.1 Initial Probabilities (IPs) for opening prices of SBI, HDFC, and TCS**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Opening price | | | Closing price | | |
|  | | Increment | Remine same | Decrement | Increment | Remine same | Decrement |
| SBI | Before | 0.427403 | 0.112474 | 0.460123 | 0.421268 | 0.137014 | 0.44172 |
| During | 0.407258 | 0.143145 | 0.449597 | 0.427419 | 0.137097 | 0.435484 |
| After | 0.440404 | 0.153535 | 0.406061 | 0.446465 | 0.135354 | 0.418182 |
| HDFC | Before | 0.410204 | 0.153061 | 0.436735 | 0.436735 | 0.106122 | 0.457143 |
| During | 0.396378 | 0.189135 | 0.414487 | 0.449597 | 0.118712 | 0.452716 |
| After | 0.445565 | 0.131048 | 0.423387 | 0.449597 | 0.145161 | 0.405242 |
| TCS | Before | 0.436735 | 0.120408 | 0.442857 | 0.422449 | 0.144898 | 0.432653 |
| During | 0.424547 | 0.118712 | 0.45674 | 0.418511 | 0.148893 | 0.432596 |
| After | 0.443548 | 0.125 | 0.431452 | 0.441532 | 0.137097 | 0.421371 |

The Table 3 provides the resultant IPs of SBI, HDFC, and TCS.

Table 6:Initial Probabilities (IPs) for opening and closing prices of SBI, HDFC, and TCS

The results placed in Table 3 provides insights into the behavior of stock prices for two major bank - SBI, HDFC, and one IT company – TCS: before, during, and after the COVID-19 pandemic. The probabilities associated with the states of price changes (Increment, remain same, Decrement) offer valuable information for investors and portfolio managers.

#### **3.3.1.1 Observation of Initial Probabilities of SBI**

* Before COVID-19: There's a higher probability of price Decrement both at opening and closing, signaling caution for investors considering purchasing the stock.
* During COVID-19: Similar to pre-pandemic, the probabilities favor Decrement, suggesting continued caution.
* After COVID-19: The probabilities lean towards price Increment, indicating a potential opportunity for investors to consider selling the stock.

#### **3.3.1.2 Observation of Initial Probabilities of HDFC**

* Before COVID-19: Again, there's a higher likelihood of price Decrement, urging investors to exercise caution.
* During COVID-19: Similar to SBI, the probabilities still favor Decrement, emphasizing a conservative approach.
* After COVID-19: Interestingly, there's a shift towards Increment probabilities, suggesting a potential opportunity for investors to consider selling the stock.

#### **3.3.1.3 Observation of Initial Probabilities of TCS**

* Before COVID-19: The probabilities are relatively balanced between Increment and Decrement, but slightly favor Decrement, suggesting a cautious approach.
* During COVID-19: The probabilities indicate a higher likelihood of Decrement, reinforcing the need for vigilance.
* After COVID-19: Once again, there's a tilt towards Increment probabilities, indicating a potential opportunity for investors to consider selling the stock.

#### **3.3.1.4 Implications for Investors and Portfolio Managers**

* Before COVID-19: Caution is advised due to the higher likelihood of price Decrement across all companies.
* During COVID-19: The caution remains as the probabilities continue to favor price Decrement, indicating ongoing market volatility and uncertainty.
* After COVID-19: There's a notable shift towards Increment probabilities for most companies, signaling a potential opportunity for investors to consider selling their holdings.

Overall, this detailed analysis of initial probabilities offers valuable insights for investors and portfolio managers to make informed decisions based on the probabilities associated with different states of stock price changes before, during, and after the COVID-19 pandemic.

## **3.4 Probability Distributions for SBI**

The probability distributions of opening and closing prices of SBI placed in the Table 4.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Opening Price | | | Closing Price | | |
|  | | Increment | Remain same | Decrement | Increment | Remain same | Decrement |
| Before | P(0) | 0.571613 | 0.887185 | 0.541203 | 0.580002 | 0.862707 | 0.557291 |
| P(1) | 0.428387 | 0.112815 | 0.458797 | 0.419998 | 0.137293 | 0.442709 |
| During | P(0) | 0.59395 | 0.856537 | 0.549513 | 0.571558 | 0.864588 | 0.563854 |
| P(1) | 0.40605 | 0.143463 | 0.450487 | 0.428442 | 0.135412 | 0.436146 |
| After | P(0) | 0.807404 | 0.680014 | 0.338981 | 0.832912 | 0.636908 | 0.33819 |
| P(1) | 0.105795 | 0.233186 | 0.574219 | 0.071092 | 0.267097 | 0.565815 |

Table 7: Probabilities of Before, During, and After COVID of SBI

The analysis of opening and closing prices before, during, and after the COVID period provides valuable insights for investors.

For the opening prices, it's notable that before and during COVID, there's a higher likelihood of a decrease in SBI stock prices. This suggests that purchasing SBI stocks during these periods could lead to optimal returns, especially for daily traders, investors, or portfolio managers.

However, after the COVID period, there's a shift. The probability of the Increment state (likely indicating a rise in stock prices) becomes more prominent. This signals to traders that buying SBI stocks could be advisable during this time.

Turning to the closing prices, before COVID, the probabilities of different outcomes are fairly balanced. There's a slightly higher chance of an Increment, but it's not significantly different from other states. This suggests that purchasing SBI stocks might not yield optimal returns during this period.

During COVID, the probability of a Decrement state (likely indicating a decrease in stock prices) is higher. This implies that purchasing SBI stocks could be advisable during this period, aligning with the opening price analysis.

After COVID, however, the landscape changes again. The probability of an Increment state becomes more dominant. This suggests that selling SBI stocks might be advisable during this time, as it could yield favorable returns.

In summary, the opening and closing price analyses provide nuanced guidance for investors. Before and during COVID, purchasing SBI stocks might be favorable, while after COVID, selling could be more advantageous. These insights can aid investors in making informed decisions to optimize their returns.

### **3.4.1 Statistical Measures for SBI**

The statistical measures for SBI placed in below Table 5.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Opening Price | | | Closing Price | | |
|  | Statistical Measure | Increment | Remain same | Decrement | Increment | Remain same | Decrement |
| Before COVID | Mean | 0.428387 | 0.112815 | 0.458797 | 0.419997521 | 0.137293 | 0.442709 |
| Variance | 0.244872 | 0.100088 | 0.248302 | 0.243599603 | 0.118444 | 0.246718 |
|  | 0.035072 | 0.077505 | 0.020461 | 0.038977144 | 0.085921 | 0.028269 |
|  | 0.083772 | 5.991209 | 0.027348 | 0.038977144 | 0.085921 | 0.028269 |
|  | 1.083772 | 6.991209 | 1.027348 | 1.105096996 | 5.442825 | 1.053214 |
| C.V | 1.155134 | 2.804291 | 1.086099 | 1.175145282 | 2.506728 | 1.121971 |
| During COVID | Mean | 0.40605 | 0.143463 | 0.450487 | 0.428442 | 0.135412 | 0.436146 |
| Variance | 0.241173 | 0.122881 | 0.247548 | 0.24488 | 0.117075 | 0.245923 |
|  | 0.045316 | 0.087624 | 0.024514 | 0.035046 | 0.085369 | 0.031406 |
|  | 0.146394 | 4.137929 | 0.039613 | 0.083641 | 4.541509 | 0.066319 |
|  | 1.146394 | 5.137929 | 1.039613 | 1.083641 | 5.541509 | 1.066319 |
| C.V | 1.209442 | 2.443448 | 1.104455 | 1.155005 | 2.526834 | 1.137018 |
| After COVID | Mean | 0.105795 | 0.233186 | 0.574219 | 0.071092 | 0.267097 | 0.565815 |
| Variance | 0.094603 | 0.17881 | 0.244492 | 0.066038 | 0.195756 | 0.245668 |
|  | 0.074586 | 0.095418 | -0.03629 | 0.056649 | 0.091184 | -0.03234 |
|  | 6.570542 | 1.592524 | 0.09012 | 11.14272 | 1.108394 | 0.070529 |
|  | 7.569327 | 2.584497 | 0.932249 | 12.14216 | 2.095645 | 0.907505 |
| C.V | 2.907272 | 1.813402 | 0.861102 | 3.614718 | 1.656489 | 0.875992 |

Table 8: Statistical measures of Before, During, and After COVID of SBI

The provided data offers statistical insights into the opening and closing prices of SBI bank shares before, during, and after the COVID period.

Before COVID, the mean of both opening and closing prices demonstrate a higher probability of the Decrement state compared to the remaining two states. Similarly, during COVID, also the mean of both opening and closing prices demonstrate a higher probability of the Decrement state compared to the remaining two states. Consistently higher probabilities of price decline states (Decrement) before and during COVID suggest a prevalent market trend. Investors should consider strategies that account for and mitigate against downside risks, such as diversification and active risk management, in their investment approach.

After the COVID period, a notable decrease in the mean of Increment state than remaining two states of both opening and closing prices is observed. The notable decrease in the mean of the Increment state post-COVID suggests a potential shift in market dynamics, urging investors to reassess strategies for capturing growth opportunities amidst evolving conditions and to remain vigilant for new trends emerging in the post-pandemic landscape.

Regarding Variance, both opening and closing prices, there less variance observed in the Remain same state of both before and during COVID. But coming to the coefficient of variance there is less coefficient of variation observed in the Decrement state than the remaining two state. Hence, the lower variance in the Remain same state and the lower coefficient of variation in the Decrement state imply relative stability and predictability in these respective market conditions. Investors may find opportunities in strategies that capitalize on stability during uncertain times and prioritize risk mitigation in volatile markets.

After COVID both opening and closing prices, there is less variance observed in Increment state and least coefficient of variation observed in Remain same state. Hence, the decrease in variance in the Increment state and the least coefficient of variation in the Remain same state post-COVID suggest a potential shift towards more stable market conditions. Investors may find value in strategies that capitalize on stability while remaining vigilant for emerging growth opportunities amidst a more predictable environment.

|  |  |
| --- | --- |
| Figure 14: Opening price Before, During, and After COVID-19 of SBI (mean) | Figure 15: Opening price Before, During, and After COVID-19 of SBI (variance) |

|  |  |
| --- | --- |
| Figure 16: Closing price Before, During, and After COVID-19 of SBI (mean) | Figure 17: Closing price Before, During, and After COVID-19 of SBI (variance) |

The non-negative third central moment (skewness) in all states before, during, and after COVID, except for the Decrement state, indicates a generally positively skewed distribution of prices or returns. However, the negative third central moment (skewness) in the Decrement state suggests a distribution skewed towards lower values, indicating a potential for more pronounced downside movements or asymmetry in returns during periods of price decrease. This implies that investors may face greater risk of larger losses during declining market conditions compared to other states.

The kurtosis values exceeding 3 in the Remain same state before and during COVID imply occasional extreme price movements, signaling inherent market volatility. Post-COVID, a kurtosis value greater than 3 in the Increment state suggests an intensified frequency or magnitude of such extreme movements, prompting investors to exercise caution and consider robust risk management strategies to navigate heightened volatility.

## **3.5 Probability Distributions for HDFC**

The probability distributions of opening and closing prices of HDFC placed in the Table 6.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Opening price | | | Closing price | | |
|  | | Increment | Remain same | Decrement | Increment | Remain same | Decrement |
| Before | P(0) | 0.591061 | 0.846584 | 0.562355 | 0.562384 | 0.895679 | 0.541937 |
| P(1) | 0.408939 | 0.153416 | 0.437645 | 0.437616 | 0.104321 | 0.458063 |
| During | P(0) | 0.603997 | 0.810056 | 0.585947 | 0.571685 | 0.880846 | 0.547469 |
| P(1) | 0.396003 | 0.189944 | 0.414053 | 0.428315 | 0.119154 | 0.452531 |
| After | P(0) | 0.508659 | 0.820947 | 0.57572 | 0.487919 | 0.795129 | 0.59166 |
| P(1) | 0.444004 | 0.131716 | 0.376943 | 0.449435 | 0.142225 | 0.345694 |

Table 9: probabilities of Before, During, and After COVID of HDFC

The analysis of opening and closing prices before, during, and after the COVID period provides valuable insights for investors considering HDFC stocks.

For the opening prices, both before and during COVID, there's a higher probability of a decrease in HDFC stock prices compared to an increase. This indicates that purchasing HDFC stocks during these periods could potentially lead to optimal returns.

However, after the COVID period, there's a notable shift. The probability of an Increment state becomes more prominent, suggesting that selling HDFC stocks might be advisable during this time.

Turning to the closing prices, similar patterns emerge. Before and during COVID, there's a higher likelihood of no significant change in HDFC stock prices or a decrease, with the chance of a decrease being more pronounced. This again points towards purchasing HDFC stocks during these periods for potentially favorable returns.

After COVID, the landscape changes once more. The probability of an Increment state becomes more dominant, indicating that selling HDFC stocks might be more advisable during this period.

In summary, the analysis of both opening and closing prices provides nuanced guidance for investors. Before and during COVID, purchasing HDFC stocks could be favorable, while after COVID, selling might be more advantageous. These insights can help investors make informed decisions to optimize their returns.

### **3.5.1 Statistical Measures for HDFC**

The statistical measures for HDFC placed in below Table 7

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Opening Price | | | Closing Price | |  |
|  | Statistical Measure | Increment | Remain same | Decrement | Increment | Remain same | Decrement |
| Before COVID | Mean | 0.408939 | 0.153416 | 0.437645 | 0.437616 | 0.104321 | 0.458063 |
| Variance | 0.241708 | 0.129879 | 0.246112 | 0.246108 | 0.093438 | 0.248241 |
|  | 0.04402 | 0.090028 | 0.030693 | 0.030706 | 0.073943 | 0.020821 |
|  | 0.137224 | 3.699454 | 0.063193 | 0.063253 | 6.702254 | 0.028339 |
|  | 1.137224 | 4.699454 | 1.063193 | 1.063253 | 7.702254 | 1.028339 |
| C.V | 1.202227 | 2.349093 | 1.13356 | 1.133626 | 2.930151 | 1.087707 |
| During COVID | Mean | 0.396003 | 0.189944 | 0.414053 | 0.428315 | 0.119154 | 0.452531 |
| Variance | 0.239185 | 0.153865 | 0.242613 | 0.244861 | 0.104956 | 0.247747 |
|  | 0.049749 | 0.095414 | 0.041704 | 0.035106 | 0.079944 | 0.023521 |
|  | 0.180869 | 2.499203 | 0.121789 | 0.083944 | 5.5278 | 0.036381 |
|  | 1.180869 | 3.499203 | 1.121789 | 1.083944 | 6.5278 | 1.036381 |
| C.V | 1.235002 | 2.06512 | 1.189601 | 1.155304 | 2.71892 | 1.099906 |
| After COVID | Mean | 0.444004 | 0.131716 | 0.376943 | 0.449435 | 0.142225 | 0.345694 |
| Variance | 0.246864 | 0.114367 | 0.234857 | 0.247443 | 0.121997 | 0.22619 |
|  | 0.027647 | 0.084239 | 0.057802 | 0.025024 | 0.087295 | 0.069805 |
|  | 0.050806 | 4.743801 | 0.257911 | 0.041332 | 4.196939 | 0.421067 |
|  | 1.050806 | 5.743801 | 1.240585 | 1.041332 | 5.196939 | 1.40358 |
| Coefficient of variation | 1.119032 | 2.567509 | 1.28566 | 1.106804 | 2.455836 | 1.375765 |

Table 10: Statistical measures of Before, During, and After COVID of HDFC

The provided data offers statistical insights into the opening and closing prices of HDFC bank shares before, during, and after the COVID period.

Before COVID, the mean of both the opening and closing prices demonstrate a higher probability of Decrement state compared to the remaining two states. Similarly during COVID, the mean of both the opening and closing prices demonstrate a higher probability of Decrement state compared to the remaining two states. Consistently higher probabilities of price decline states (Decrement) before and during COVID suggest a prevalent market trend. Investors should consider strategies that account for and mitigate against downside risks, such as diversification and active risk management, in their investment approach.

After the COVID period, a notable decrease in the mean of Increment state than remaining two states of both opening and closing prices is observed. The notable decrease in the mean of the Increment state post-COVID suggests a potential shift in market dynamics, urging investors to reassess strategies for capturing growth opportunities amidst evolving conditions and to remain vigilant for new trends emerging in the post-pandemic landscape.

Regarding Variance, both opening and closing prices, there less variance observed in the Remain same state of both before and during COVID. But coming to the coefficient of variance there is less coefficient of variation observed in the Decrement state than the remaining two state. Hence, the lower variance in the Remain same state and the lower coefficient of variation in the Decrement state imply relative stability and predictability in these respective market conditions. Investors may find opportunities in strategies that capitalize on stability during uncertain times and prioritize risk mitigation in volatile markets.

After COVID both opening and closing prices, there is less variance observed in Increment state and least coefficient of variation observed in Remain same state. Hence, the decrease in variance in the Increment state and the least coefficient of variation in the Remain same state post-COVID suggest a potential shift towards more stable market conditions. Investors may find value in strategies that capitalize on stability while remaining vigilant for emerging growth opportunities amidst a more predictable environment.

|  |  |
| --- | --- |
| Figure 18: Opening price Before, During, and After COVID-19 of HDFC Bank (mean) | Figure 19: Opening price Before, During, and After COVID-19 of HDFC Bank (variance) |

|  |  |
| --- | --- |
| Figure 20: Closing price Before, During, and After COVID-19 of HDFC Bank (mean) | Figure 21: Closing price Before, During, and After COVID-19 of HDFC Bank (variance) |

The non-negative third central moment (skewness) in all states before, during, and after COVID, except for the Decrement state, indicates a generally positively skewed distribution of prices or returns. However, the negative third central moment (skewness) in the Decrement state suggests a distribution skewed towards lower values, indicating a potential for more pronounced downside movements or asymmetry in returns during periods of price decrease. This implies that investors may face greater risk of larger losses during declining market conditions compared to other states.

The kurtosis values exceeding 3 in the Remain same state before and during COVID imply occasional extreme price movements, signaling inherent market volatility. Post-COVID, a kurtosis value greater than 3 in the Increment state suggests an intensified frequency or magnitude of such extreme movements, prompting investors to exercise caution and consider robust risk management strategies to navigate heightened volatility.

## **3.6 Probability Distributions for TCS**

The probability distributions of opening and closing prices of TCS placed in the Table 8.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Opening Price | | | Closing Price | | |
| Increment | Remain same | Decrement | Increment | Remain same | Decrement |
| Before | P(0) | 0.562384 | 0.879371 | 0.558245 | 0.57876 | 0.854764 | 0.566476 |
| P(1) | 0.437616 | 0.120629 | 0.441755 | 0.42124 | 0.145236 | 0.433524 |
| During | P(0) | 0.574657 | 0.881106 | 0.544237 | 0.580672 | 0.850747 | 0.568581 |
| P(1) | 0.425343 | 0.118894 | 0.455763 | 0.419328 | 0.149253 | 0.431419 |
| After | P(0) | 0.557578 | 0.874754 | 0.567668 | 0.559544 | 0.862661 | 0.577795 |
| P(1) | 0.442422 | 0.125246 | 0.432332 | 0.440456 | 0.137339 | 0.422205 |

Table 11: probabilities of Before, During, and After COVID of TCS

The analysis of opening and closing prices before, during, and after the COVID period offers key insights for investors, particularly in relation to TCS stocks.

In terms of opening prices, both before and during COVID, there's a higher probability of no significant change or decrease in TCS stock prices compared to an increase. This suggests that purchasing TCS stocks during these periods may not yield optimal returns.

Similarly, during the COVID period, the probability of no significant change remains higher, indicating that neither selling nor buying TCS stocks is advisable.

Looking at the closing prices, the trends remain consistent. Before and during COVID, there's a greater likelihood of no significant change or decrease in TCS stock prices. Again, this implies that purchasing TCS stocks during these periods may not lead to optimal returns.

Likewise, during the COVID period, the probability of no significant change remains higher, suggesting that neither selling nor buying TCS stocks is advisable.

In summary, the analysis of both opening and closing prices suggests that before, during, and after COVID, holding TCS stocks might be more prudent than actively buying or selling. These insights provide valuable guidance for investors in making informed decisions to optimize their returns.

### **3.7.1 Statistical Measures for TCS**

The statistical measures for TCS placed in below Table 9

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Opening Price | | | Closing Price | | |
|  | Statistical Measure | Increment | Remain same | Decrement | Increment | Remain same | Decrement |
| Before COVID | Mean | 0.437616 | 0.120629 | 0.441755 | 0.42124 | 0.145236 | 0.433524 |
| Variance | 0.246108 | 0.106077 | 0.246608 | 0.243797 | 0.124143 | 0.245581 |
|  | 0.030706 | 0.080485 | 0.028727 | 0.038403 | 0.088083 | 0.032651 |
|  | 0.0644 | 0.07232 | 0.064162 | 0.065486 | 0.077909 | 0.064651 |
|  | 0.063253 | 5.427088 | 0.055026 | 0.101776 | 4.055237 | 0.071978 |
| C.V | 1.063253 | 6.427088 | 1.055026 | 1.101776 | 5.055237 | 1.071978 |
| During COVID | Mean | 0.425343 | 0.118894 | 0.455763 | 0.419328 | 0.149253 | 0.431419 |
| Variance | 0.244426 | 0.104758 | 0.248043 | 0.243492 | 0.126977 | 0.245297 |
|  | 0.036496 | 0.079848 | 0.021945 | 0.039286 | 0.089073 | 0.033645 |
|  | 0.065194 | 0.071835 | 0.063467 | 0.065627 | 0.078607 | 0.064785 |
|  | 0.091213 | 5.545768 | 0.031557 | 0.106912 | 3.87547 | 0.076696 |
| C.V | 1.091213 | 6.545768 | 1.031557 | 1.106912 | 4.87547 | 1.076696 |
| After COVID | Mean | 0.442422 | 0.125246 | 0.432332 | 0.440456 | 0.137339 | 0.422205 |
| Variance | 0.246685 | 0.10956 | 0.245421 | 0.246455 | 0.118477 | 0.243948 |
|  | 0.028407 | 0.082116 | 0.033214 | 0.02935 | 0.085934 | 0.037956 |
|  | 0.053756 | 5.127459 | 0.07463 | 0.057543 | 4.440452 | 0.099236 |
|  | 1.053756 | 6.127459 | 1.07463 | 1.057543 | 5.440452 | 1.099236 |
| C.V | 1.122624 | 2.642779 | 1.145879 | 1.127108 | 2.506242 | 1.169838 |

Table 12: Statistical measures of Before, During, and After COVID of TCS

The provided data offers statistical insights into the opening and closing prices of TCS bank shares before during and after the COVID period

Before COVID, the mean of both the opening and closing prices demonstrate a higher probability of Decrement state compared to the remaining two states. Similarly during COVID, the mean of both the opening and closing prices demonstrate a higher probability of Decrement state compared to the remaining two states. Consistently higher probabilities of price decline states (Decrement) before and during COVID suggest a prevalent market trend. Investors should consider strategies that account for and mitigate against downside risks, such as diversification and active risk management, in their investment approach.

After the COVID period, a notable decrease in the mean of Increment state than remaining two states of both opening and closing prices is observed. The notable decrease in the mean of the Increment state post-COVID suggests a potential shift in market dynamics, urging investors to reassess strategies for capturing growth opportunities amidst evolving conditions and to remain vigilant for new trends emerging in the post-pandemic landscape.

Regarding Variance, both opening and closing prices, there less variance observed in the Remain same state of both before and during COVID. But coming to the coefficient of variance there is less coefficient of variation observed in the Decrement state than the remaining two state. Hence, the lower variance in the Remain same state and the lower coefficient of variation in the Decrement state imply relative stability and predictability in these respective market conditions. Investors may find opportunities in strategies that capitalize on stability during uncertain times and prioritize risk mitigation in volatile markets.

After COVID both opening and closing prices, there is less variance observed in Increment state and least coefficient of variation observed in Remain same state. Hence, the decrease in variance in the Increment state and the least coefficient of variation in the Remain same state post-COVID suggest a potential shift towards more stable market conditions. Investors may find value in strategies that capitalize on stability while remaining vigilant for emerging growth opportunities amidst a more predictable environment.

|  |  |
| --- | --- |
| Figure 22: Opening price Before, During, and After COVID-19 of TCS (mean) | Figure 23: Opening price Before, During, and After COVID-19 of TCS (variance) |

|  |  |
| --- | --- |
| Figure 24: Closing price Before, During, and After COVID-19 of TCS (mean) | Figure 25: Closing price Before, During, and After COVID-19 of TCS (variance) |

The non-negative third central moment (skewness) in all states before, during, and after COVID, except for the Decrement state, indicates a generally positively skewed distribution of prices or returns. However, the negative third central moment (skewness) in the Decrement state suggests a distribution skewed towards lower values, indicating a potential for more pronounced downside movements or asymmetry in returns during periods of price decrease. This implies that investors may face greater risk of larger losses during declining market conditions compared to other states.

The kurtosis values exceeding 3 in the Remain same state before and during COVID imply occasional extreme price movements, signaling inherent market volatility. Post-COVID, a kurtosis value greater than 3 in the Increment state suggests an intensified frequency or magnitude of such extreme movements, prompting investors to exercise caution and consider robust risk management strategies to navigate heightened volatility.

# **CHAPTER-4**

## **SUMMARY AND CONCLUSION**

## **4.1 SUMMARY**

The analysis presented focuses on the transition probabilities and statistical insights of stock movements for three prominent companies: SBI, HDFC, and TCS, before, during, and after the COVID-19 pandemic. Here's a summarized version along with suggestions for investors and portfolio managers:

**Before COVID-19:**

SBI and HDFC showed a higher likelihood of price Decrement in both opening and closing prices.

TCS displayed relatively balanced probabilities between Increment and Decrement states.

Overall market trend suggested caution due to prevalent price decline probabilities.

**During COVID-19:**

SBI and HDFC continued to exhibit higher probabilities of price Decrement.

TCS leaned towards Decrement probabilities.

Market volatility remained high, emphasizing the need for careful risk management.

**After COVID-19:**

SBI and HDFC saw a notable shift towards Increment probabilities, suggesting potential selling opportunities.

TCS showed a tilt towards Increment probabilities.

Market conditions appeared to stabilize, with opportunities for growth emerging.

Suggestions for Investors and Portfolio Managers:

**Risk Assessment and Management:**

Utilize the transition probabilities to assess and manage risk levels associated with each stock.

Implement robust risk management strategies to mitigate potential downside risks.

**Portfolio Allocation and Strategy Formulation:**

Adjust portfolio allocations and formulate investment strategies based on expected transitions in stock price states.

Optimize opportunities for growth while mitigating risks through diversification.

**Continuous Monitoring and Adjustment:**

Continuously monitor market conditions and adjust investment strategies accordingly.

Remain vigilant for emerging trends and adapt portfolios to align with changing market dynamics.

## **4.2 Conclusion**

Based on the analysis, here are the suggested actions for each company:

**SBI:**

Before and During COVID-19: Consider purchasing SBI stocks due to higher probabilities of price Decrement.

After COVID-19: Consider selling SBI stocks as there's a shift towards Increment probabilities, indicating potential growth opportunities.

**HDFC:**

Before and During COVID-19: Purchase HDFC stocks due to higher probabilities of price Decrement.

After COVID-19: Consider selling HDFC stocks as there's a notable shift towards Increment probabilities.

**TCS:**

Before and During COVID-19: Holding TCS stocks might be prudent as probabilities indicate no significant change or a slight decrease.

After COVID-19: Continue holding TCS stocks as there's a slight tilt towards Increment probabilities.

Overall, investors and portfolio managers should use these insights to optimize their portfolios and navigate through various market conditions effectively.