Measurement of Value at Risks of NIFTY Stocks Using Historical Simulation & Monte Carlo Simulation During COVID Pandemic-2020

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ABSTRACT

"Not taking risks one doesn't understand is often the best form of risk management."

— Raghuram G. Rajan

Risk management plays a vital role in today's scenario as firms are exposed to various types of risk. In this context the concept of value at risk examines to understand the probability of losses on a portfolio under a stated level of confidence .This paper aims to understand the underlying concept of VAR and discusses various methods used for calculation of value of risk. For understanding the Historical simulation & Monte Carlo simulation approach for VAR, two year prices of top ten stocks for NIFTY based on market capitalization are chosen and for each of the stock a comparative analysis is being done for 1 day VAR at 95% confidence interval for each stock respectively.

Keywords: Risk, Value at risk, Portfolio, Historical simulation, Market capitalization.

1. INTRODUCTION

Risk is defined as an uncertainty in any transaction or business operations. This key parameter helps in understanding the volatility of a portfolio and predicting the future returns based on external and internal risk factors. To safeguard a business enterprise and to hedge against the probable losses risk management has emerged as a powerful tool of identifying and assessing the occurrence of an uncertain event. It is also needed to update the current risk management strategies and techniques and to undertake risk transfer measures. In the light of global uncertainties emerging in financial markets risk management strategies are being adopted by various asset management companies, financial institutions, non financial institutions and regulatory authorities.

1.1 VALUE AT RISK

VAR emerged in the year 1993 as a powerful tool for measuring market risk. It has both financial as well as non financial applications. Value at risk can be defined as a technique of measuring probable losses on a

portfolio over a period of time. This technique can be used to rank portfolios in order of their risk profile. At a given level of probability 'p' and holding period 't' a portfolio with larger VAR percentage would indicate a greater amount of risk. It can also be used to predict maximum loss on a portfolio and lastly value of risk also determines regulatory capital required by banks for exposure to risk.

1.2 VAR MODELS

Traditional Value at risk can be calculated with the help of three methods

Historical Simulation method: This method is considered as the simplest approach towards calculation of value of risk as it relies on the past historical data for forecasting of future returns on a portfolio. Historical simulation works on the principle that future probability distribution will follow past distribution. Generally all the financial theories consider asset prices to follow bell/Normal distributed curve. But Historical simulation consider the probability of occurrence of fat tail probability in the bell curve which was primarily considered invisible during year 2008 financial crisis. The major disadvantage associated with historical simulation is its inability to forecast future prices for those financial assets which have been introduced recently in the market because for such asset there is a scarcity of historical data for calculating Value at Risk. The method to calculate VAR using historical simulation is as follows:

1. Download adjusted closing price of stock and Sensex for a certain holding period.
2. Simulate the Index returns: By Calculation of log returns given by the security.

   Returns=Ln(Closing Price/Opening price)
3. Calculate value of beta.
4. Simulate stock return
5. Distribution of stocks gains/losses.
6. Calculate Value of risk at certain confidence interval by taking percentile of returns given by stocks and multiplying it by amount invested and square root of holding period.

MONTE CARLO SIMULATION

Monte Carlo simulation is another non-parametric technique of calculating value at risk. In this method, random numbers are generated to create an array of future possible prices. After simulating the price of securities hypothetical profit and losses are generated. Lastly VAR is calculated by taking a percentile of returns under a given confidence interval. Monte Carlo method is based on the assumption that the share price (or value of the total portfolio) is governed by a geometric Brownian motion(Peter Adamko,Erika Spuchľáková,Katarína Valáško,2015). The major advantages of this method are that it is very extensive in nature. Some of the disadvantages of Monte Carlo simulation is that this techniques requires large number of samples so as to obtain an accurate description of the distribution moreover it is considered to be computationally intensive as there is a presence of large number of risk factors.

2. REVIEW OF LITERATURE

Christopher Marshall&Michael Siegel(1996) in their study gave identical portfolios of instruments of varying complexity to Different leading risk management systems' vendors were and were asked to assess the value at risk according to one common model, JPMorgan's Risk Metrics™. They found that Risk Metrics™ provides a useful benchmark for FX forwards, money markets, and FRAs, somewhat less useful for bonds and swaps, and has major weaknesses dealing with non-linear instruments such as FX options and interest rate capsand floors.

Zvi Wiener(1997)described concept of Value-at-Risk and discussed how risk characteristic can be used for supervision and for internal control. Both parametric and non-parametric methods are backtested to measure Value-at-Risk.

Victor Makarov (1997) in his article described approaches to value at risk and specifically historical simulation method and stated that the attractive feature of historical simulation is that the approach produces the P&L portfolio distribution, which explicitly incorporates all the statistical properties of itscomponents, including fat tails and correlations. As a result, historical simulation performs a very accurate evaluation of all marketvalue distributions on all levels of aggregationfrom individual instruments to total portfolio.

On the Validity of Value-at-Risk :Comparative Analyses with Expected Shortfall(2002)examined the problems associated with VaR, and proposed the use of expected shortfall. In this paper, they provide an overview of studies comparing VaR and expected shortfall to draw practical implications for financial riskmanagement. They illustrated how tail risk can mislead investors.

Šime Čorkalo(2011) compared the main approaches of calculating VaR andimplements Variance-Covariance, Historical and Bootstrapping approach on stock portfolio. Finally resultsof empirical part were compared and presented using histogram.Portfolio consists of five stock listed on Zagreb stock exchange.

G. P. Samanta, Prithwis Jana, Angshuman Haitand Vivek Kumar(2010) This papermade an empirical attempt to select suitable VaR model for government security market inIndia. Their results show that returns on these bonds do not follow normal distributionthe distributions possess fat-tails and at times, are skewed. They have tried to addressnon-normality of returns suitablywhile estimating VaR and used number of non-normal VaR models, such as, historicalsimulation, RiskMetric, hyperbolic distribution fit, method based on tail-index.

Peter Adamko ,Erika Spuchľáková&Katarína Valášková(2015) described how the VaR is computed in practice, and gave a short overview of value at risk history. Their study gave insight on the basic types of methods of calculation of VAR and compared their similarities and differences

Stephen Opoku Oppong,Dominic Asamoah,Emmanuel Ofori Oppong(2016) analysed VaR methodologies Historical Simulation and MonteCarlo Simulation are discussed. After analysing ten stocks on the Ghana Stock Exchange, author came to conclusion that Monte Carlo Simulation provides a better VaRestimate than the Historical Simulation.

Samet Gunay(2017) In his study used different value at risk models (VaR), which were used tomeasure downside investment risk and have been analyzed under different methods andstylized facts of financial time series. The assets of the portfolio were BIST100 index, Dollar/TLcurrency rate, Euro/TL currency rate, Brent Oil, and gold.All the data used in the study is derivedfrom Central Bank of Turkey and the FED.

Kushagra Goel, Sunny Oswal (2019) in their study attempts to rank the overall predictive ability of select value at riskmodels in estimating market risks of Indian financial markets. The study investigates three markets: equity, currency and commodity for a period of 20 years so as to incorporate different economic conditions.The results proved thatparametric model using normal distribution with GARCH (1,1) fits best forestimating value at risk.

Aleksandra Helena Pasieczna(2019) applied the algorithmto the WIG20 and mWIG40 stock indices, and performed simulations for the Value at Risk at 95%and 99% confidence intervals over six estimation periods ranging from 1 trading day to 250 tradingdays. This approach was evaluated using the percentage failures and the Kupiec Proportion of Failurestest. Results indicated that this method is highly influenced by the choice of past historical andestimation period lengths considered. Finally the author observed that the Monte Carlo computational schemeis a reliable method for quantifying VaR.

3. RESEARCH METHODOLOGY

Research Methodology is a systematic or step by step procedure to carry out the research process. Varieties of research methods like qualitative and quantitative techniques are used to achieve research objectives. It can also be defined as the way to find out solution to a research problem.

3.1 OBJECTIVES

1. To understand the concept of Value at Risk.
2. To calculate and compare Value of risk for select stocks using historical simulation and Monte Carlo technique.

3.2 STATEMENT OF THE PROBLEM

The purpose of the study is to analyze the VAR of select stocks listed in NIFTY and compare their VAR with each other.

3.3 SCOPE OF THE STUDY

- This study will be helpful to introduce VAR method of risk management ,
- This study will give an insight to the techniques/methods which are used to calculate VAR.
- This study will also be helpful in understanding correlations between various factors like returns, beta etc. which effects decision making process in choosing and constructing portfolio of securities.

3.3 LIMITATIONS OF THE STUDY

- The sample size is limited as this study will focus on 10 stocks listed in NIFTY.
- The time period under study is for the period of 2 years.

3.4 DATA COLLECTION

Primary data

Primary data is the first hand data/information which is collected through methods like interview, survey, feedback, discussion etc. For this study primary data is not taken into consideration.

Secondary data

This study is based on historical prices of securities collected through yahoo finance for two years holding period. Other sources like Thesis, reports, journals, books and magazines were also considered for the study.

3.4 SAMPLE SIZE

For this study top ten performing stocks listed in NIFTY-50 Index (as per market capitalization) are used to calculate and compare value at risk using Historical & Monte Carlo Simulation. Stocks under analysis are ***Reliance Industries Ltd., Asian Paints, ONGC, Sun Pharmaceuticals, Bajaj Finance, Titan Industries, Bharti Airtel, Maruti Suzuki, Hindustan Unilever and Tata Consultancy Services.***

The period undertaken for the study is for a span of two years from April 3rd 2018 to April 4th 2020.Continous returns given by the Stocks & Sensex is calculated as follows:

$$\text{Return}=\text{Log}(\text{Opening Price}/\text{Closing price})$$

3.5 STATISTICAL TOOLS USED

Microsoft Excel was used for the analysis of the data.

4. DATA INTERPRETATION

The VAR was calculated for one day (1) at 95% confidence interval level for retail investors, traders and stock exchanges where trading happens on a daily basis. In the calculation, the amount invested by an investor is assumed to be 1.

- **RELIANCE INDUSTRIES LIMITED**

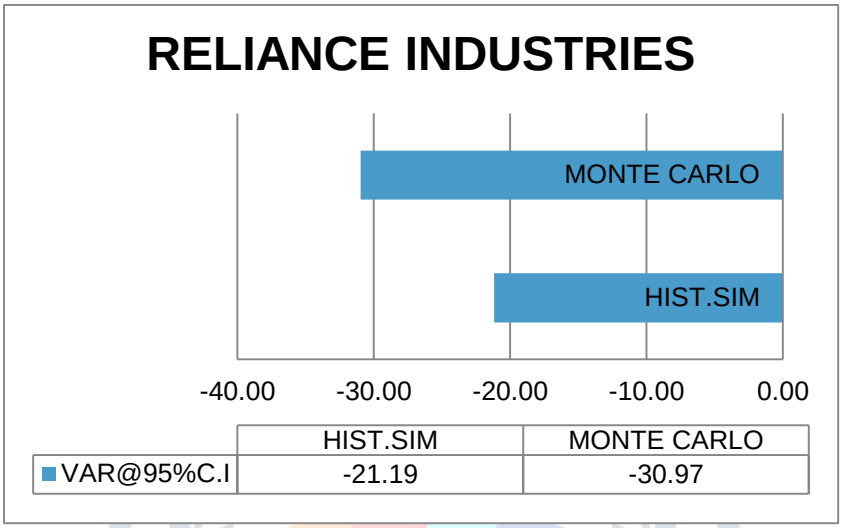

Figure 1: VAR estimate for Reliance Industries.

- **TITAN COMPANY LTD.**

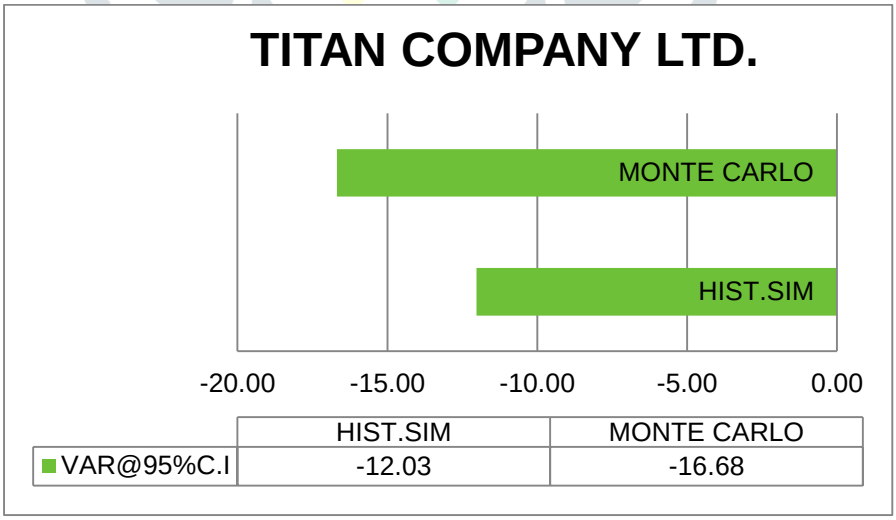

Figure 2:VAR estimate for Titan company Limited.

- **TATA CONSULTANCY SERVICES**

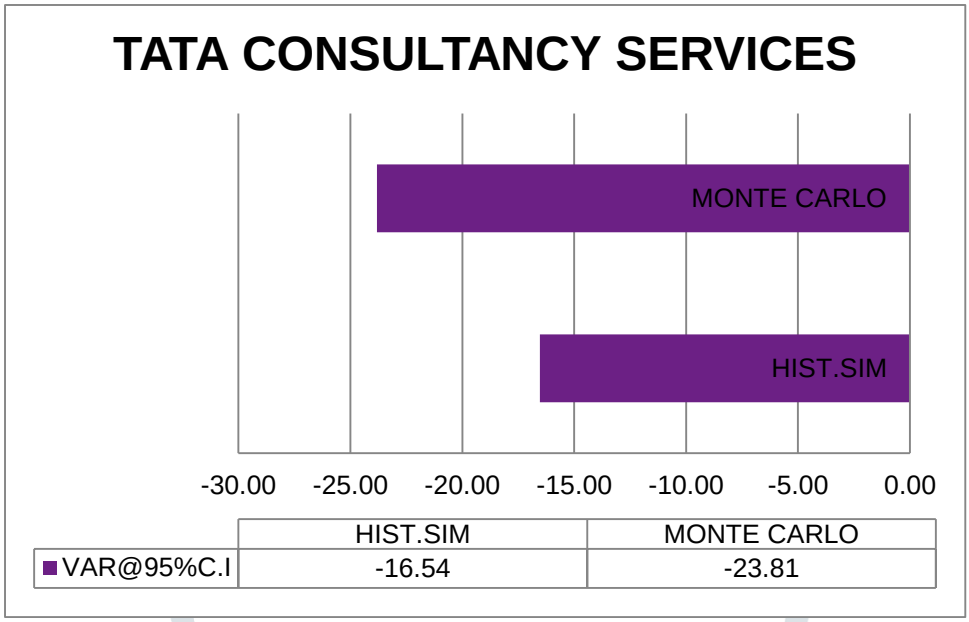

Figure 3: VAR estimate for Tata Consultancy services.

- **HINDUSTAN UNILEVER**

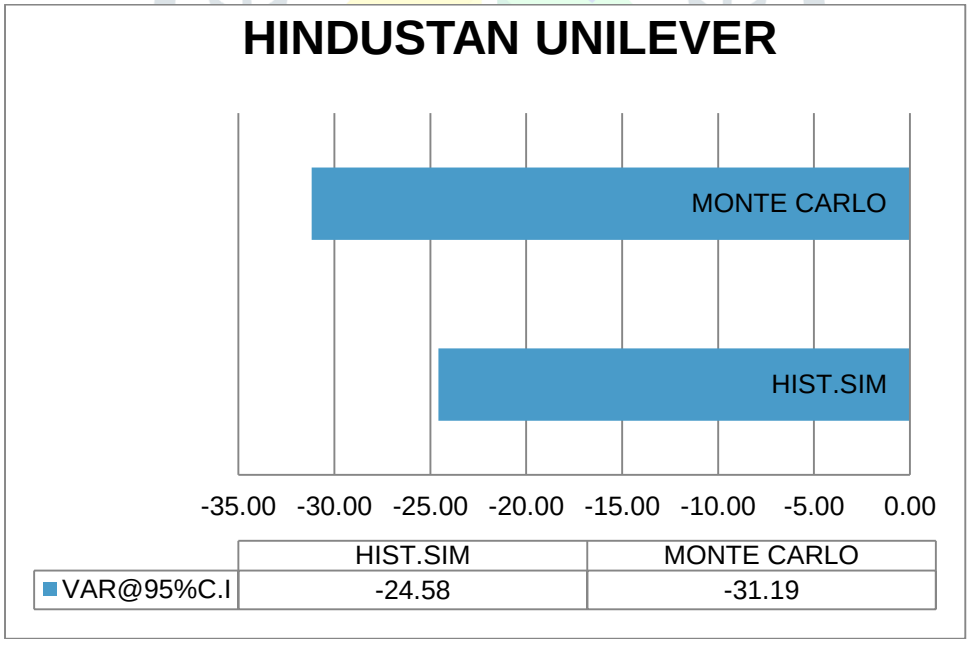

Figure 4: VAR estimate for HUL.

- **BHARTI AIRTEL**

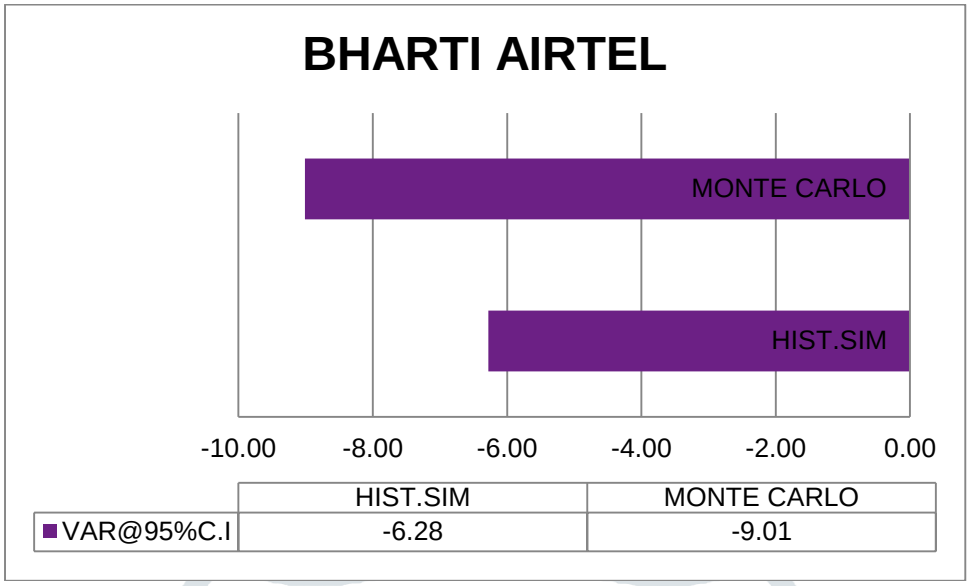

Figure 5: VAR estimate for Bharti Airtel.

- ONGC

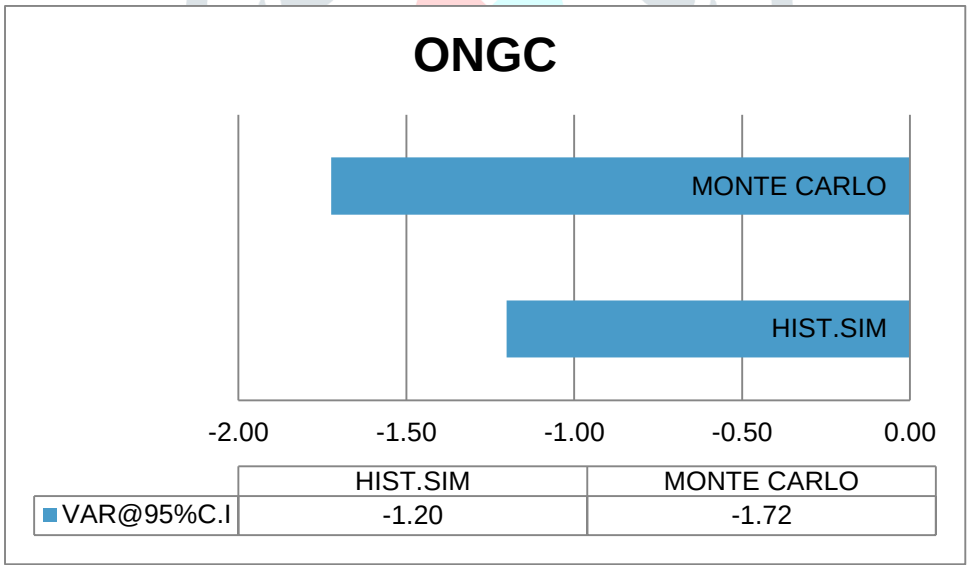

Figure 6: VAR estimate for ONGC.

- **SUN PHARMACEUTICAL INDUSTRIES LIMITED**

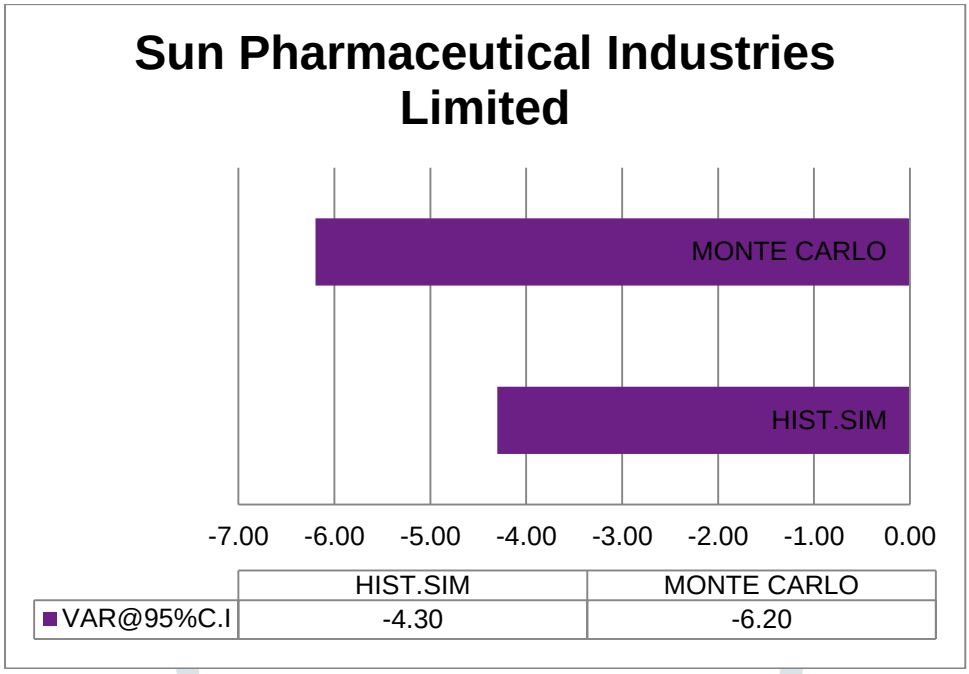

Figure 7: VAR estimate for Sun Pharmaceuticals Industries Limited.

- **ASIAN PAINTS**

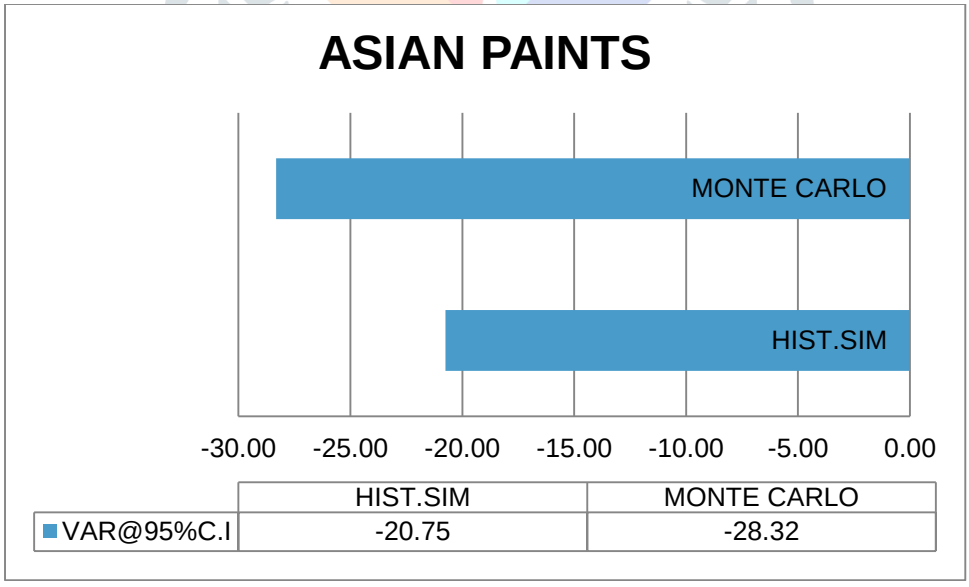

Figure 8: VAR estimate for Asian Paints.

- **MARUTI SUZUKI INDIA LTD.**

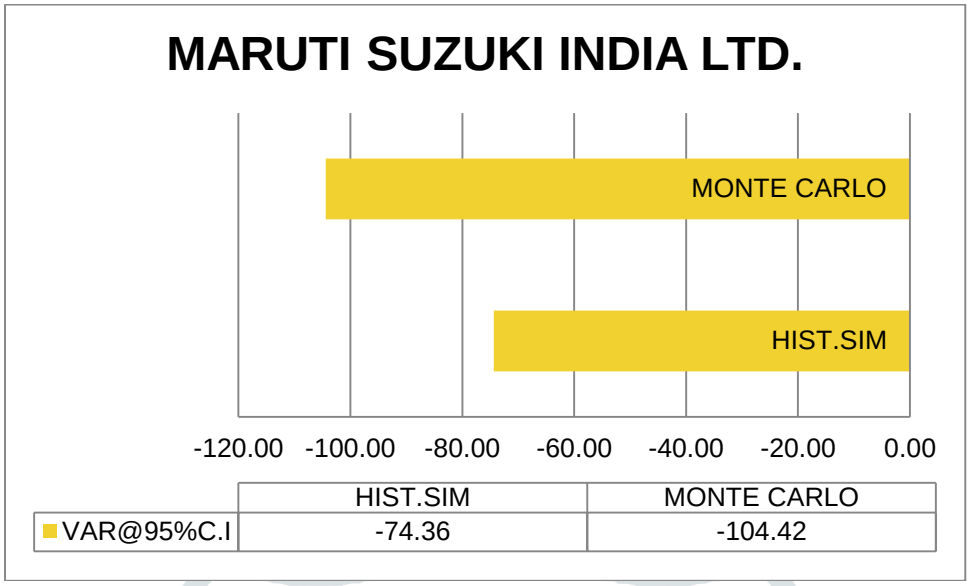

Figure 9: VAR estimate for Maruti Suzuki India Limited.

- **BAJAJ FINANCE**

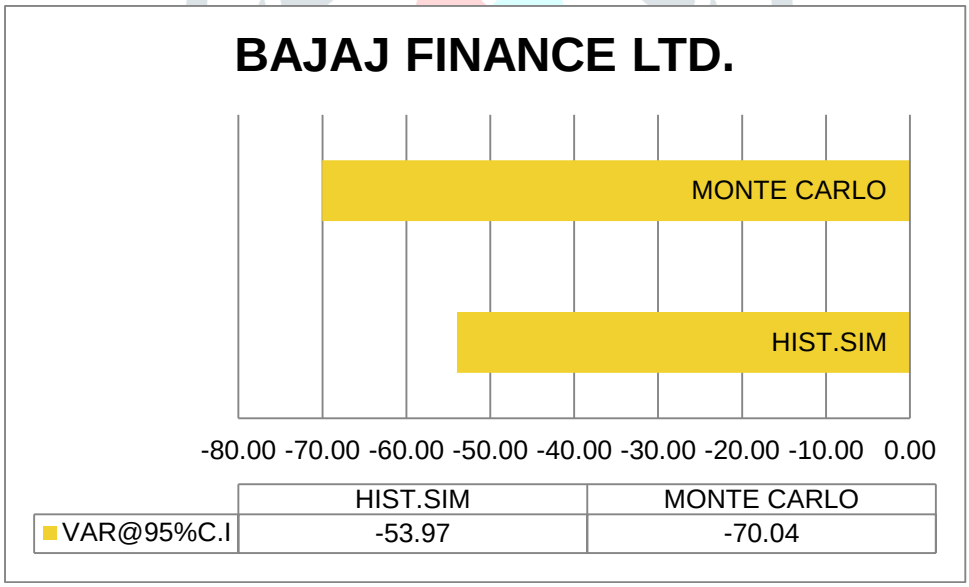

Figure 10: VAR estimate for Bajaj Finance Limited.

5. FINDINGS

1. Stocks of ONGC have shown better performance during times of financial crisis as the value of risk methods are laying in the same range. Moreover VAR values are less compared to other stocks considered in this study.
2. The difference between two methods is seen maximum in case of stocks of Maruti Suzuki India Limited where VAR is -74.36 using historical simulation & -104.42 using Monte Carlo simulation.
3. Bajaj Finance stock is also showing greater fluctuation in value of risk calculated using Historical (-53.97) & Monte Carlo Simulation (-70.04).

4. Reliance Industries is further affected in the present times,as the loss probability using Historical simulation is 21.19 and 30.97 using Monte Carlo simulation.
5. Stocks like Bharti Airtel,Sun Pharmaceuticals have VAR values less than -10 using both the methods.
6. In case of Hindustan Unilever the values obtained using historical simulation is -24.58 and through monte carlo simulation is -31.19.
7. Tata consultancy services are having loss of -16.54 using historical simulation & -23.81 using monte carlo simulation technique.

6. CONCLUSION

Stock markets have been hugely affected by COVID pandemic because the stock market indexes have fallen and so the stock prices have dipped beyond the expectations of the traders. Huge losses are faced by the financial markets across the globe as businesses have been shut down and there is a negative expectation of return. From the VAR Analysis in figure 1 to figure 10, all the shares have higher chances of losses as per Monte Carlo Simulation compared to Historical Simulation technique. So we can conclude that Monte Carlo Simulation has shown greater inverse sentiment of losses in the share prices of Maruti Suzuki India, Reliance Industries as well as Bajaj Finance. In case of stocks of ONGC, Bharati Airtel and few more Monte carlo values are higher than Historical Simulation but loss outcomes are stable. Further stress test can be performed in analysis of value for stocks in different sectors.

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