Predicting Stock Market Trends through Monte Carlo Simulation

1st Annajiat Alim Rasel
Department of Computer Science and Engineering
BRAC University
Dhaka, Bangladesh
annajiat@gmail.com

2nd Anwar Kamal Sadat
Department of Computer Science and Engineering
BRAC University
Dhaka, Bangladesh
anwar.kamal.sadat@g.bracu.ac.bd

3rd Arian Wazed
Department of Computer Science and Engineering
BRAC University
Dhaka, Bangladesh
arian.wazed@g.bracu.ac.bd

4th Moinul Hossain Bhuiyan
Department of Computer Science and Engineering
BRAC University
Dhaka, Bangladesh
moinul.hossain.bhuiyan@g.bracu.ac.bd

5th Nazia Ahmed Nijhum
Department of Computer Science and Engineering
BRAC University
Dhaka, Bangladesh
nazia.ahmed.nijhum@g.bracu.ac.bd

***Abstract*—The stock market, often seen as a realm of boundless opportunities for those with average incomes to build their wealth, is notorious for causing financial losses for many investors. The present research uses the Python programming language to collect and evaluate data from financial websites in order to analyze the market's volatility. The strategy used is simulating stock prices in the company Samsung using the Geometric Brownian Motion (GBM) mathematical model. These areas' stocks are used as the dataset for simulations that are carried out over a thousand cycles. The average return of a stock and the standard deviation of past returns are the two most important factors in these simulations. This study provides insightful information for retail traders through the implementation of Monte Carlo Analysis in finance.**

***Index Terms*—Stock Market, Volatility, Python Programming Language, Geometric Brownian Motion (GBM), Dataset, Simulations, Cycles, Average Return, Standard Deviation, Retail Traders, Monte Carlo Analysis**

I. Introduction

Has anyone ever thought about how researchers predict where stock values will go in the future? Monte Carlo Simulation is one method they use to do this. It's similar to a super-smart computer game that predicts what might occur based on many scenarios. Monte Carlo Simulation is a fancy name for a process that simulates many scenarios using numbers that are randomly generated. Assume you want to determine your odds of winning a game that requires some luck. Rather than simply guessing, Monte Carlo Simulation allows a computer to play the game several times with varying luck results. By repeating this process, we may have a decent understanding of the probable outcomes. Basically, Monte Carlo Simulation is a powerful tool in finance that helps predict stock prices by considering various factors like company performance, market trends, and economic changes. It generates thousands or millions of predictions, each based on slightly different circumstances. This approach helps experts understand potential risks and rewards, enabling investors to make more informed decisions.

A great representation of a challenging dynamic system is the financial market. A tremendously helpful approach in many fields, such as the study of operations, theoretical gaming, physics, business, and finance, is the Monte Carlo simulation. It is a method for comprehending how risk and uncertainty affect a decision while making such. Due to fluctuations on a daily basis in both the supply and the demand of stock prices brought on by the avarice and fear of traders and investors from all over the world, the market is very volatile and random. The efficient market hypothesis (EMH) states that in situations when share prices represent a corresponding value, the market discounts every detail that is accessible [1]. As an outcome, conquering the market over time is unfeasible. Hedge funds, despite this, may often outperform the market. In this context, Berkshire Hathaway, a holding firm led by the legendary investor Warren Buffett, returned an average of 20.5% a year, while the S&P 500 index returned an aggregate of just 8% on an annual basis.

Some financiers relentlessly generate a profit in the market year after year. Mathematicians consequently created a number of scientific models in the hope to predict future stock values.

Neural networks, fuzzy inference systems, machine learning methods, different ARIMA models, Monte Carlo simulation, and GARCH models constitute some of the models [2], [3]. Robert Brown designed the Geometric Brownian Motion (GBM) model in 1827. It is a concrete instance of this kind of a model. In order to determine the anticipated return and volatility, this study uses the GBM to investigate and assess data from the previous ten years' historical closing prices of the S&P 500 (SPX) and Kuala Lumpur Composite Index (KLCI) [4]. Samsung was the primary focus of this study. GBM was implemented for this study because it makes use of the Monte Carlo Simulation to forecast future stock price movement based on the indices' historical performance.

Studying the performance of stock markets is of the utmost significance because, as Albert Einstein once said, "Small sums snowball into huge amounts." This phenomenon is known as the power of compounding. The abstract, introduction, literature review, problem statement, aims and objectives, research questions, importance of the study, research methodology, system overview, and conclusion make up the framework of this article.

II. Problem Statement

Hedge funds that receive clients' money use models to predict and forecast the future movement of stock prices. As the scientific models yielded consistent results, extensive research regarding the use of these models in this field may be necessary. Monte Carlo Simulation is a mathematical approach that uses probability modeling to analyze data of the stock market. It can be used to analyze business risks and generate potential returns. Using a set of assumptions and random variables, Andrea and Juan (2019) implemented the Simulating Profit Loss in Behavioral Newsvendor Problems model to compute the probability for multiple outcomes [5]. The results from the model aids in producing better paths for the simulation.

Albeit not as relevant in finance and business, Monte Carlo Simulation can also have a large scope for applications in computational biology and physical sciences. It may as well be applied to analyze data of the stock market, which is utilized to analyze business risks and generate potential returns. Researchers Zawin, Siti and Mohd (2020) have successfully used Monte Carlo Simulation to model Malaysian gold prices using a combination of random variables [6]. This study aims to incorporate the GBM model and data analysis into Monte Carlo Simulation leading to forecast future stock prices in the stock market. The general public has a negative perception of the stock market due to the uncertainty involved as well as the likelihood for significant financial loss. According to client data obtained from renowned stock broker Etoro, 67% of consumers who trade are prone to losing money. [7]. The objective of this study is to improve consumer traders' performance by relying on existing knowledge of Monte Carlo analysis from other studies and applying it to the field of finance to create alpha. The study concludes that Monte Carlo Simulation can be applied to analyze data of the stock market, such may then be used to evaluate business risks and generate potential returns.

Based on the research, Monte Carlo Simulation is an effective technique for analyzing data from the stock market. It improves in gaining an understanding of the threats and potential benefits of business. Despite the fact that a large number of investors lose money, amateur investors might benefit from adopting Monte Carlo. This investigation demonstrates that Monte Carlo Simulation is a helpful tool for understanding and forecasting potential events in the stock market by utilizing concepts from earlier analysis and applying them to the field of financial matters. Monte Carlo simulation is a reliable approach with an extensive variety of possibilities. A feasible approach toward advancing the area of financial analysis and improving results for shareholders is its integration with the GBM model and data analysis in the context of forecasting stock prices.

III. Research Aims, Objective & Research Questions

A widely used approach for implementing unpredictability to financial simulations is the Monte Carlo technique, which is based on principles of probability. That's why in order to predict stock values, this paper is going to use comprehensive Monte Carlo Analysis with Python. By executing several simulations, emphasizing on Samsung's stock over the next year. Drift and shock values were the two key parameters for the Geometric Brownian Motion (GBM) model. The whole data was obtained using market data from stooq.com throughout the last several years. In order to simulate future market stock movements based on historical volatility, the outputs of the GBM model were merged into the Monte Carlo Analysis. The research study nevertheless chose to emphasize the need for caution when interpreting the data, highlighting the fallacious assumption of predictability and established probability distributions in price developments.

The implementation kicked off with an assessment and transfer of data, and then the GBM model emerged with significant features including projected annual return and predicted annual volatility. The research aimed to forecast Samsung's stock price through 1000 simulations. It highlighted how crucial it was to choose a timeframe that closely matched the projection period or manually set figures for the expected annual volatility and predicted annual return.

The main emphasis was the Monte Carlo Simulation approach, which generated a list of results by recording each iteration over the specified function a certain number of times. Equations from a 2016 study article were included into the GBM approach to generate a more comprehensive data model. Detailed calculations involving the expected annual rate of return, annualized expected annual volatility, and random volatility were used to make the appearance at the final stock price.

With the goal to gain perspective into a stock's potential future performance, the research examined probability distributions, mean distributions, and standard deviation distribu-

tions. Because an investor might consider both before and after buying a stock. The model's robustness, sensitivity to changes in input parameters, and discrepancies between simulated and real market behavior were all extensively evaluated throughout the discussion phase. The successful implementation of the Monte Carlo simulation strategy in stock price prediction scenarios was validated via comparisons with other prediction methods, giving investors a comprehensive grasp of likely future events in the dynamic and unpredictable financial market environment.

IV. Significance Of The Research

In accordance with a JP Morgan survey, 53% of traders consider projected and real-time market conditions as the most important data tool, highlighting the importance of precise analysis of market trends [8]. This agreement emphasizes how important it is for traders to have access to legitimate predicted insights. A notable problem for individual traders is the absence of sophisticated instruments generally accessible to institutional hedge funds, which contributes to their vulnerability to stock market losses. To fill this void, the current study provides an important addition by providing exact information on Samsung using a scientific and quantitative methodology.

To give insights to retail traders, the study specifically takes advantage of Monte Carlo Simulation, an innovative modeling approach. This strategy goes beyond typical assessments, providing a more detailed insight of future market patterns. The study uses Monte Carlo Simulation to provide more accurate forecasts to retail traders, allowing them to make better-informed judgments. This emphasis on scientific and quantitative techniques not only fills a vital vacuum in the availability of sophisticated tools for retail traders, but it also corresponds with a rising realization of the essential role correct prediction plays in risk mitigation and overall trading results.

V. Literature Review

The Monte Carlo method is actively used for assessing price options, particularly considering the inherent uncertainty involved with financial assets like options [9]. While the Monte Carlo technique is well-known in option pricing, its application in forecasting stock returns is less common. Although some informal study has been undertaken in this area, most of it by amateur shareholders, the shortage of substantially published scholarly studies on the issue exposes a void in this particular aspect. Additionally, the current research tries to overcome the knowledge gap by incorporating ideas from domains other than just stock market simulation modeling. This paper attempts to contribute to a largely unexplored research subject by integrating information and approaches from relevant disciplines, bringing a new viewpoint on predicting stock returns through the use of the Monte Carlo methodology.

A. Current Stock Market Situation

The graphic above compares the cap-weighted results of the 10 largest stocks at the beginning of the year 2020 to the other

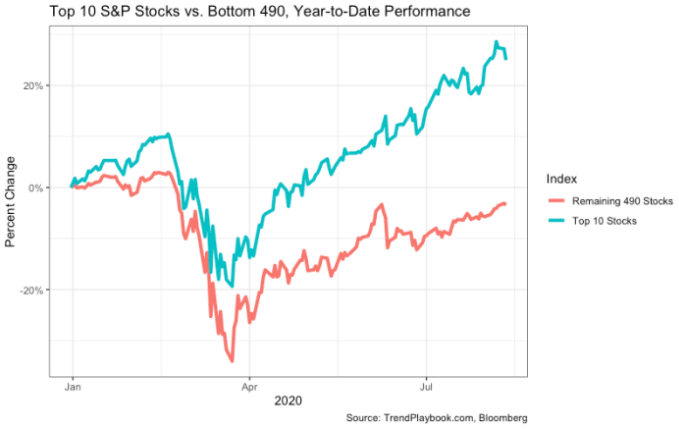

Fig. 1. Top 10 S&P stocks vs. bottom 490, year to date performance

490. The red line represents the S&P(Stocks and prices) 500 without those 10 stocks. At last count, the 10 largest S&P 500 equities had gained 25% on average this year. If they are excluded, the S&P 500 is down 3.4%. But what's most interesting is what's been occurring recently: while the largest stocks have been dragging the S&P to record highs since February 2020, the S&P minus those 10 names is still lower than it was only two months ago. Basically, the COVID-19 epidemic caused severe instability and disruption in the global stock market in 2020. The pandemic-driven sell-off in March 2020 prompted government intervention and incentive programs, which helped to stabilize markets. The technology and healthcare industries remained resilient, owing to rising demand for freelance solutions and healthcare advancements. Markets began to rebound in the second half of 2020, buoyed by encouraging news regarding vaccine research. Recovery times varied by region and country, with some Asian markets rebounding swiftly and others taking longer. A healthy IPO market was aided by tech stock booms and IPOs. However, continued uncertainties and geopolitical tensions exacerbated financial market concern [10].

Company	Ticker	S&P Weight at 1/1/20
Apple	AAPL	4.6%
Microsoft	MSFT	4.2%
Alphabet	GOOG, GOOGL	3.2%
Amazon.com	AMZN	3.2%
Facebook	FB	2.1%
Berkshire Hathaway	BRK.B	1.9%
JPMorgan	JPM	1.5%
Johnson & Johnson	JNJ	1.3%
Visa	V	1.3%
Walmart	WMT	1.2%

Fig. 2. Ten stocks that made up the "buy list" at the start of 2020

The 2020 COVID chaos was the quickest and biggest crash in stock market history. Based to the LPL Analysis illustration, the stock market has had 11 bear markets since 1956, including