

Stock Market Valuation using Monte Carlo Simulation

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Abstract— Stock markets for last hundred and fifty years has been used for wealth generation. Provided people participate as an investor and invest in stocks which show strong fundamental intrinsic values. Fundamental analysis is significant from the perspective of evaluation of stock market price for long term investment. This system provides a guidance mechanism based on monte carlo simulation and discounted cash flow analysis model which is used to evaluate the list of stocks under study what is their probability of becoming multibaggers, from a long term of investment perspective. The system is modeled to handle low debt companies for long term evaluation. Typically, companies having less than twenty five percent debt in their assets. The users of system are fundamental analysts i.e. chartered accountants, chartered financial planners, chartered financial analysts, credit risk analyst, financial analyst, and portfolio managers. Comparing statistically calculated intrinsic values and current market price, system will be able to add a robust statistical reasoning for investment decision. This reasoning will have no human or emotional biases as there will be no human intervention involved for arriving to the final intrinsic value of stock. Monte carlo simulation is best suited solution for generating random scenarios that fall in line with brownian walk motion of stock prices, as in long term any stock price follows random path.

Keywords— *current market price; graphical visualization; intrinsic value; monte carlo simulation; return on equity; statistical analysis; stock market*

I. INTRODUCTION

In recent times predicting and providing guidance for stock market return has obtained significant importance, maybe because if direction of market is successfully predicted the investor may have better guidance. An investor interested to make an investment for long term in real assets that foster cash flow and income [1]. The profitability of investment in stock market immensely depends upon the prediction of companies that have strong chances to grow in near future. Stock market prediction has been great challenge for researchers

working in financial sector aiming at overcoming the accuracy, vote of confidence in picking up stock market that has a potential of becoming multibaggers. Due to globalization there has been a huge boom in number of investors and business over last few decades [2].

The financial researchers describe any organisations financial characteristics such as revenue generation, net working capital, depreciation, debt, earning per share, number of share holders etc [3]. There are two types of analysis significant in arena of stock market prediction: (a) fundamental analysis (b) technical analysis. Fundamental analysis is principally dependent on statistical data of company. It includes audit reports, current market price, profit and loss statements, dividends, debt, earnings per share etc. Vital parameters that strongly influence the stock price movement of a company are return on equity, debt to equity ratio, earning before income and tax, return on investment etc. are very carefully observed and studied to arrive at an estimate of future stock conditions.

Fundamental analysis finds intrinsic value of stock and based on this value it guides the user towards buying of stock for long term investment. Fundamental analysis is believed that ninety percent market is defined by logical and ten percent physiological factors. Fundamental analysis is used for long term investment. In technical analysis, the analysts try to find out stock market trend which is very difficult and complex to understand using artificial neural network. In this approach, quantitative parameters like trend indicators, daily movement of price, highest and lowest values of a day, volume of stock indices, put call ratio etc.

II. LITERATURE SURVEY

According to Leifer et.al [1][2], using monte carlo simulation technique random intrinsic values are derived from input vectors such as equity, operational profit after tax, earning before income and tax etc. large number of scenario generation results to large data points resulting effective guidance for investors towards companies having high probability to become potential multibaggers in near future. The automation of data input and random

scenario generation helps user of system to give a clear graphical analysis of investment decision based on the list of selected companies.

In the existing system only price movement is considered on regular basis, thus not providing strong confidence for investment decision making. Artificial intelligence and data analysis using stacked charts is available for individual or retail investor. For deep study of stock price and intrinsic value generated by the system various statistical parameters are considered such as mean, median, mode, kurtosis, delta. The current market price (CMP) is subtracted from the simulated price for arrival at detail price [1]. Statistical value and current market price adds upon a strong statistical reasoning for investment decision.

According to Ian Leifer et.al [2], after setting up simulation model, principal sources of uncertainty in cash flows has to be analyzed and then reduce the uncertainty by improving forecast of sales or costs. Author demonstrates how changes in model parameters influence cash flows. Valuation of business is done by several methods employed for cash flow forecasting. The methods can be separated into three main categories [2]:

- Heuristic Methods.
- Methods based on illustration of past data and trend detection using regression model, auto regressive models and learning models.
- Methods based on creation of imitational model, describing company parameters interconnection.

Stochastic model is used for analyzing risk and forecasting company's development that meets no primary difficulty. Meanwhile, practical implementation has number of technical difficulties connected with formularization of the problem [2].

According to Manasi Shah et.al [4], artificial neural networks (ANN) used for stock prediction provides better results compared to other techniques. Artificial neural network is implemented as an efficient data mining technique in the field of finance trying to emulate human behavioural pattern for stock market investment [16]. Distinct architectures of ANN, simple feed forward back propagation neural network (FFBPNN), elman recurrent network, radial basis function network (RBFNN) are implemented and tested to predict stock price [11]. Sneha Soni [5] has done a survey of current literature in the domain of machine learning techniques and algorithms [18], artificial intelligence is used to forecast stock market movements. Artificial neural networks are ascendant machine learning technique in stock market prediction area [6]. Support vector machine and neural networks techniques are methods used for stock market prediction [5] [15].

Neural networks could solve any machine learning problems using two vital techniques: (a) fundamental analysis [14] and (b) technical analysis [16]. Although neural networks do not have any proven track records of success for certain specific problem domains, as a user of machine learning technology humans are better in using approaches that have stronger theoretical reasons as follows [6].

- Neural Networks are too much of black box: It becomes difficult to train as training outcomes can be non-deterministic and depends crucially on the choice of initial parameters. It is hard to determine how problem is being solved as they are opaque.
- Neural Networks are not probabilistic: A neural network might give you a continuous number as its output but translating that into problem statement is often difficult.
- Neural Networks are not suitable for understanding problems deeply.
- As artificial neural networks are data-driven control procedure, it cannot be used for sensitive or risky applications where trial error cannot be done when investing in a company or evaluating intrinsic value of company.

Mr. James D. Whiteside II [7] demonstrates empirical implementation of the Brownian-walk Monte Carlo simulation in forecasting. Simple spreadsheet and time-dependent historical data is used in forecasting. Historical data cannot be modelled using standard data regression techniques. It outlines a more robust methodology (no human intervention and works on random data sets) i.e. Monte Carlo simulation. Monte Carlo is efficiently used in data extrapolation (process of estimating beyond original observation in statistics) or forecasting that exceeds the known data points and interpreting the range of outcomes expected [7]. Model used for forecasts are not statements of what will happen, but what might happen given a specific data, presumptions, and analytical methodologies used. They are notion of market, regulatory activities, and producer and consumer behaviour. Trends illustrated in forecasts are indicative tendencies in real world rather than representations of specific real-world outcomes. Monte Carlo simulation is a practiced mathematical technique for analysis of uncertain scenarios and providing probabilistic analysis of different situations [9]. Monte Carlo simulation is specifically used for probability-based application that is an equation where variables have been replaced with a random number generator. A Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model is complex, nonlinear, or involves more than just a couple of uncertain parameters. The principal behind using monte carlo analysis is, it's simplicity and easy to grasp. The investors use a system that is made up of basic mathematical components. Thus,

these investors do not have an understanding how all the individual input vectors or elements can provide solution points to develop market insights. Second, computational systems make approximations faster than working out a complex math solution. These solutions rather require sophisticated and time-consuming computer programming to run multiple case studies [7]. Monte carlo simulations can be performed using add-ins i.e. software that can be added to a computer to give extra features or functions to Microsoft excel [9].

The following table shows a comparison between artificial neural network and monte carlo simulation based discounted cash flow calculator considering various parameters [15][16].

TABLE I. FEATURE ANALYSIS OF MONTE CARLO SIMULATION AND ANN

Parameters	Monte carlo based DCF calculator	ANN
Target Audience	System can be used by fundamental analysts, chartered accountant, CFP, CFA	Technical Analysts
Values Analyzed	The system analyses vectors that drive the change of price of stock in market.	It only analyses the past behavior of price movement.
Holding time frame	Time horizon for investing using DCF calculator is three to five years.	It is used for daily trading.
Comprehension	The system comprehends random motion of stock movement by generating random scenarios.	The system only comprehends historic price motion.
Details	This system provides detailed price analysis of every scenario that played out.	This system does not provide any detailed analysis.
Statistical Analysis	Various types of statistical analysis are possible which includes descriptive statistical analysis of all possible scenarios.	This system is built only on standard deviation.
Historicity	Only five years of historical record of financial statements is required for this system.	It requires ten to fifteen years of historical price movement to be able to predict the data.

IPO Evaluation	The system can comprehensively analyse initial public offerings	Since initial public offerings do not have historical prices it is beyond this system to analyse it.
Basis of evaluation	Fundamental indicators & cash flow forecasting based intrinsic value of stocks.	Previous price based future prediction of price.
Usage	To find multibaggers or make investment calls for three to five-year horizon.	Daily or weekly trade calls based on past price pattern.

III. PROPOSED SYSTEM

System performs statistical analysis on large data set of intrinsic values for every share. Comparing this statistically calculated value and current market price investor will be able to add a solid statistical reasoning for investment decision. This reasoning will not have human or emotional biases as there will be no human intervention involved in arriving to the final value.

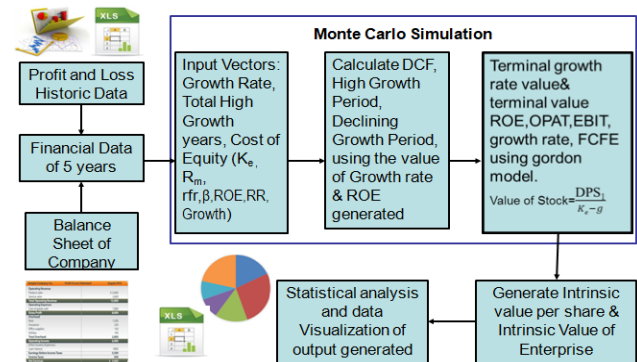


Fig. 1. Block diagram of proposed system.

In Fig.1, represents a block diagram of proposed system that briefly explains the process flow of the system. The system's primary input requirement is financial data of last five years that includes profit loss statement and balance sheet of the company to be evaluated [16]. In Monte Carlo simulation block, there is a combination of various vectors taken as input, for example growth rate, high growth years, cost of equity, beta (β) index sensitivity to nifty 50, reinvestment ratio. Then computational analysis is done on input vector using discounted cash flow (DCF), along with high growth period and declining growth period using two input vectors that are growth rate and ROE generated. Thus, intrinsic value is calculated per share and statistical analysis is performed and output is generated in form of graphs and charts.

IV. IMPLEMENTATION

To provide a guidance mechanism towards long term investment in selected company, the system requires basic input of data for evaluation of stock and arriving at its intrinsic value [1]. Hence, it must import a five-year historical record of profit and loss statement and balance sheet. The other parameters considered by system as an input vector are expected high growth rate which will be used as base, expected high growth period, current return on equity, current total equity, beginning and ending year of valuation, expected terminal return on equity & terminal growth rate, current total liabilities, excess cash that company may have, total value of non-cash investments made by the company.

a) Compilation of list of stocks:

The stock list is compiled through collection of freely available recommendation of stocks for multibaggers by various brokerage houses like motilal oswal, edelweiss, kotak securities, share khan, CLSA, karvy etc. These firms come up with their prediction of stocks which can be in total more than sixty to seventy stocks. This List of sixty to seventy stocks is used for preliminary investigation and elimination.

b) Selection of stocks for evaluation:

For discounted cash flow generation, system utilizes the logic of free cash flow to equity, but this does not hold water for companies that are holding high proportion of debts or that are highly leveraged. Generally, as a thumb rule for Indian equity markets companies which have more than twenty five percent of debt is considered highly leveraged. Free cash flow to equity is not a viable model for such companies. As free cash flow to equity is the base for discounted cash flow model of the system such companies that cannot be evaluated using free cash flow to equity i.e. having debt of more than twenty five percent of total asset are eliminated.

c) Mathematical terms and definition:

TABLE II. FINANCIAL TERMS USED FOR MATHEMATICAL CALCULATION

Abbreviation	Terminology
ROE	Return on Equity
DPS	Dividend per share
DCF	Discounted Cash flow
Rm	Return by benchmark index
Rfr	Risk free rate
OPAT	Operating profit after Tax
T	Tax rate
Ke	Cost of Equity
g	Growth rate
rr	Reinvestment ratio

FCFE	Free cash flow for equity shareholders
EPS	Earnings per share
PAT	Profit after tax

d) Monte Carlo Simulation and Evaluation:

In Fig.2, the process flow of system for stock market evaluation using monte carlo simulation is illustrated. The primary requisite of the system is uploading the excel file that consist list of companies to be evaluated by investor. It contains various input financial parameters that are uploaded automatically. It includes the steps of various input parameters that are considered for arriving at intrinsic value of stock and mathematical formulas used to calculate significant paramters used by fundamental analysts. Cost of equity (K_e) is the return or also reffered as rate of return that company must pay to its equity investors i.e. shareholders to compensate for the risk taken by investing their capital. rfr is risk free rate for ten years government bond yiled. Return on market (R_m) i.e. Nifty 50 is benchmark of India stock price.

Beta (β) is a measure of the volatility, or systematic risk, of a security or a portfolio in comparison to the market. Beta is used in the capital asset pricing model (CAPM), which calculates the expected return of an asset based on its beta and expected market returns. Beta is also known as the beta coefficient. Profit after tax (PAT) is calculated by adding depreciation and subtracting capital expenditure. (+) refers to adding of depreciation i.e. non-cash expenses and (-) refers to subtraction of capital expenditure from company income statement. Earnings per share (EPS) are calculated by dividing amount after tax i.e. cash profit after tax divided by total number of shares of a company. Return on equity (ROE) is net income returned as a percentage of shareholders equity.

Free cash flow to equity (FCFE) is a measure of cash amount available to the equity shareholders of a company after all expenses, reinvestment, and debt are paid. It is a measure of equity capital utilization. Intrinsic value is the true value of a company considering both the tangible and intangible factors. It may or not be same as the current market price. Operating profit after tax (OPAT) is the net profitless taxes and finance cost that the business generates due to its normal operations.

Present value of all the future estimates of cash flows for the shareholder the stock is expected to generate over the time for which the shareholder wishes to remain invested is calculated. Further, free cash flow to equity shareholder and intrinsic value by summation of free cash flow to equity shareholders. The cash reinvestment ratio (rr) is a measure of percentage of investment in assets representing operating cash retained and reinvested in the company for both replacing assets and growth in operations.

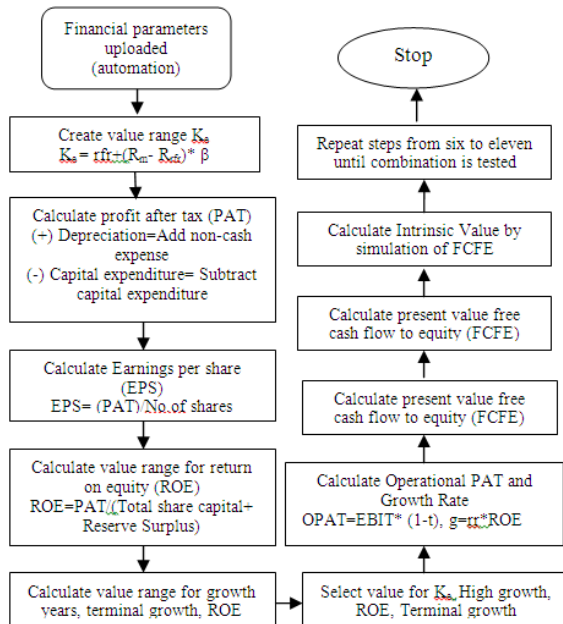


Fig. 2. Process flow of system

Terminal growth is a constant rate at which firms expected free cash flow are assumed to grow. Range for it is between two to three percent between inflation rates.

e) Reports:

Based on given scenario, a data grid of all permutations and combinations will be generated with detail of outcome of each permutation that is scenario will be presented in row format. This grid can be exported in form of excel sheets and carry out financial analysis. The software will generate report on statistical evaluators like mean, median, mode, kurtosis and standard deviation. Software will also generate a graphical report showing pareto analysis graph which will display all of the possible scenarios generated.

V. PERFORMANCE EVALUATION

The performance of the listed stocks was examined for the financial year march 2016 to march 2017. As these stocks are intended for investors who look to be in market for long term. The parameters for evaluation are selected based on widely accepted market norms. These parameters are used for analyzing the stocks fundamentally for long term investment. To benchmark the performance, stocks recommended by system are compared with the non-recommended stocks. The performance of stock is also compared with the performance of benchmark index which in this case is nifty fifty benchmark index.

TABLE III. COMPARISON OF RECOMMENDED TO NON-RECOMMENDED STOCKS BY SYSTEM

Sr. No	Parameters	Recommended Stocks	Non-Recommended Stocks
1	Average stock growth	20.52%	8.27%
2	Negative returns	23%	40.0%
3	Average negative returns	-9%	-21%
4	No. of multibagger	2	0
5	Earnings per share average growth	694%	66%
6	Negative earnings per share	0	1

TABLE IV. RECOMMENDED STOCKS COMPARED TO NIFTY 50

Parameters	Nifty 50	Recommended Stocks
Average returns	19%	20.52%
Average Earnings per share	7%	694%

For long term investors, both profit and risk reduction is equally important parameters. Average stock growth, number of multibaggers and earnings per share, average growth are three such parameters that cover profit analysis whereas, count of stocks has negative returns, count of stocks with negative earning per share and average negative earning per share covers the risk analysis.

VI. RESULT AND DISCUSSION

StatisticsWindow			
Mean Price	71580.19	Median Price	45001.41
Skewness	2.55	Std. Deviation	78644.52
Maximum	728933.91	Best Case	95029.41
Delta Mean	61380.19	Delta Best	84829.41
%	601.77	%	831.66
High Price %	0 %	Low Price %	100 %
		Worst Case	51787.92
		Delta Worst	41587.92
		%	407.72
		Kurtosis	8.99

Graphical Analysis

Fig.3. Statistical indicators used by system for stock evaluation.

In Fig.3, there are statistical indicators like mean, median and mode which are qualitative statistical indicators. Mean is average of all the intrinsic values generated by the system. Similarly median and mode values are calculated for all the intrinsic values generated by system.

If these values are significantly higher current market price and five times of current market price, then it presents a strong case for the stock being a multi bagger. Skewness and standard deviation demonstrates the spread of intrinsic value around the mean.

Delta mean represents in terms of percentage i.e. how many times more than current market price, was the mean of all intrinsic values generated. Delta Best is the difference between mean of best case scenario, where high growth years are maximum and the current market price. Delta worst is the difference of the mean of intrinsic values of worst case scenario and current market price. If both these deltas are higher than hundred percent, then it shows a very high probability that the stock would turn out to be multibagger. Thus, all the above statistical indicators help to point the user towards a stock which is statistically a strong candidate for multibagger.

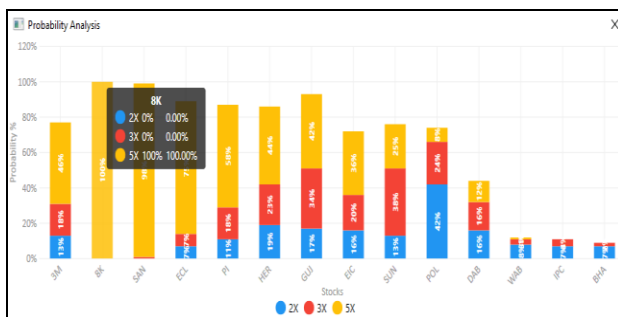


Fig. 4. Comparative analysis of stocks by system using stacked charts.

Rank	Scrip Name	Probability 2X	Probability 3X	Probability 5X
1	8K Miles Software Services	0	0	100
2	Sanofi India	0	1	98
3	Gujarat Industries Power Co#	17	34	42
4	eClerx Services	7	7	75
5	PI INDUSTRIES	11	18	58
6	Hero Motocorp	19	23	44
7	3M India	13	18	46
8	Sun Pharmaceutical Industries	13	38	25
9	Polyplex Corporation	42	24	8
10	Eicher Motors	16	20	36
11	Dabur India	16	16	12
12	WABCO India	8	3	1
13	Ipca Laboratories	7	4	0
14	Bharat Electronics	7	2	0

Fig. 5. Comparative analysis of stocks by system illustrated in tabular format.

In Fig.4 and Fig.5, a comparative analysis of all the stocks analysed are illustrated through stacked chart. The stocks are sorted by five times scenario count which is percentage count of scenarios that have produced intrinsic value greater than five times of current market price. This tabular and graphical display of results clearly shows which companies to pick out and which not to. The ranking also shows the best and worst stock pick from the list of stocks analysed. The percentage is just a probabilistic estimate that a stock would become a multibagger over an investment horizon of three to five years. For example, in Fig.3, simulated 8K Miles

Software Services shows that it has 100% probability of being a multibagger. On the contrary in Fig.4, the Bharat Electronics ranked at position seventeen, shows that it has potential to be multibagger for two times by 7% and also three times by 2%. The tabular result also shows zero percent for all the non recommended stocks, thereby giving the investor a clear direction of investment.

VII.COMPARITIVE ANALYSIS

As discussed in section II and VI, stock market prediction has been a dominant arena for investor and plays significant role in nation's economy. Artificial neural network was traditionally used to predict short term price movement. The discounted cash flow model helps the investor as guiding mechanism for long term investment in company that has the potential to become multibagger. It also predicts probability of growth of price by two, three or five times from the current investment into the company stock.

VIII.CONCLUSION

The results available after observing the stocks over a period of one financial year clearly suggest that the technique of generating intrinsic values using discounted cash flow model and monte carlo simulation provides a very strong analysis to give a long-term recommendation for a stock. This technique shows that with easily understood and accepted financial parameters and randomization of those parameters provides comprehensive investment guiding software. This technique can also be scaled to be implemented on enterprise computing systems. Such systems can produce many times more scenarios which can lead to development of more accurate and enriched system for valuation of highly levered stocks that has potential to become a multi bagger.

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