

## Use of Mathematics in Stock Market

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### ABSTRACT

Stock market plays a key role in economical and social organization of a country. Stock market forecasting is highly demanding and most challenging task for investors, professional analyst and researchers in the financial market due to highly noisy, nonparametric, volatile, complex, non-linear, dynamic and chaotic nature of stock price time series. Prediction of stock market is a crucial task and prominent research area in financial domain as investing in stock market involves higher risk. However with the development of computational intelligent methods it is possible to reduce most of the risk. In this survey paper, our focus is on application of computational intelligent approaches such as artificial neural network, fuzzy logic, genetic algorithms and other evolutionary techniques for stock market forecasting. This paper presents an up-to-date survey of existing literature on stock market forecasting based on computational intelligent methods. The key result is that the probability distribution function of market timing returns is asymmetric, that the highest probability outcome for market timing is a below median return. Put another way, simple math says market timing is more likely to lose than to win—even before accounting for costs. The median of the market timing return probability distribution can be directly calculated as a weighted average of the returns of the model assets with the weights given by the fraction of time each asset has a higher return than the other. For the time period of the data the median return was close to, but not identical with, the return of a static 60:40 stock: bond portfolio. The according to six main point of view: (1) the stock market analyzed and the related dataset, (2) the type of input variables investigated, (3) the pre-processing techniques used, (4) the feature selection techniques to choose effective variables, (5) the forecasting models to deal with the stock price forecasting problem and (6) performance metrics utilized to evaluate the models. The major contribution of this work is to provide the researcher and financial analyst a systematic approach for development of intelligent methodology to

forecast stock market. This paper also presents the outlines of proposed work with the aim to enhance the performance of existing techniques.

## **INTRODUCTION**

The two primary forms of analysis in the stock market are fundamental and technical. The fundamentals refer to financial statement trends, including profitability, capitalization and cash flow. Technical analysis, in following chapters, refers to all matters concerning price, volume, momentum, and moving averages.

These relate to price trends in the overall market, not only for price and its immediate trends, but also for the weighting of indexes, new high and new low statistics, advances and declines, short interest, volatility, mutual fund cash to asset ratio, and the large block ratio. Unlike fundamental analysis of individual companies and technical analysis affecting price, these indicators apply to the overall market and help investors determine whether the current mood of the market is positive or negative.

Successful stock traders give the impression that successful trading means 100 percent accuracy. But most successful traders are right only half the time at best. Simple mathematics shows that "winning" on only four or five of every 10 trades can put a trader ahead, depending on how much was won versus how much was lost. Mathematics, teamed with patience, builds stock market wealth more reliably than "big score" attempts. Power law, on the other hand, calculates how changes in the value of one quantity affect another quantity, such as how a company's value affects stock prices in its industry. This helps calculate standard deviations, which can help traders better understand potential risks and allow them to buy or sell accordingly. Computer-based quantitative analysis, which studies how, amounts, or quantities, relate to each other, is the most common mathematical model used by trading houses. The field includes algorithms, which study patterns of behavior in entities such as the financial sector. These calculations can help identify potential risks ahead, but overreliance on quantitative models and algorithms can lead to wild speculation, imprudent investing and "flash crashes." This is when the market takes an unanticipated nosedive.

An efficient market can be described as a market, where the market price represents an unbiased estimate of the actual value of the investment. It is not necessary that the market price and the actual value must be same at each point of time. The essential condition is that the errors in the market price should be unbiased i.e. the market prices can be different from the actual value but if these deviations are random, the market would be efficient. It strongly influences the investment strategy of an investor because it's extremely difficult to choose undervalued securities in an efficient market as there are no undervalued securities in an efficient market. However, in an inefficient market, an investor can make excessive returns. In this paper, five important stock indices are analyzed by using non-parametric tests. This would not only test the efficiency of the stock market but also test the random walk nature of the stock market

Although stock trades come from many different sources -- such as autonomous computer trading programs or program-trading orders set by investors -- all of them have a human being somewhere in the process, even if just to set in place the rules of the autonomous trading system. Over the course of the day, a stock's price usually fluctuates, whether in wide swings or narrow bands. Ultimately, all sources of trading and all fluctuations in the market over the short term are driven by one factor: human psychology. The linear programming model has been applied in a large number of areas including finance, transportation scheduling, production and inventory management, telecommunications. Many problems simply lend themselves to a linear programming solution but in many cases some ingenuity is required for the modelling. Linear programming also has interesting theoretical applications in combinatorial optimization and complexity theory. The classical tool for solving the linear programming problem in practice is the class of simplex algorithms proposed and developed by George Dantzig (1963). Methods of nonlinear programming methods have also become practical tools for certain classes of linear programming problems.

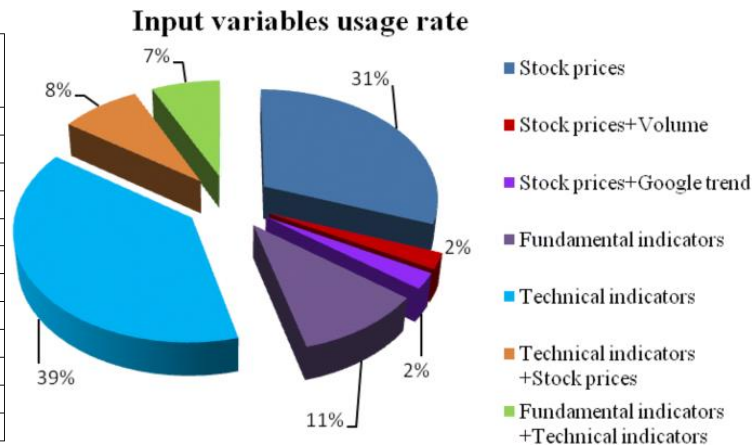
Within the modern economic reality, stock portfolio management is a problem faced, on the one hand, by many financial analysts and researchers and, on the other hand, by practitioners who are called upon to make investment decisions for substantial investment funds. Obviously, stock portfolio selection is quite sensitive given the future commitment involved. The construction of a model for effective management in the sense of maximizing potential returns will be an interesting and quite useful issue.

### **Problem Formulation**

In Table 1, we present the projections for the performance of two stocks and the Stock Index of a stock market. These are data which arose from the implementation of simulation techniques, whose variability though does not differ much from the equivalent performance of such indexes in a real stock market. The projections in Table 1 refer to the year 2019 and are on a monthly basis. Our task is to utilize these projections and to manage stock portfolios with two stocks having as our major competitor the Stock Index of the Stock Exchange for the year 2009. In essence we are tackling the portfolio problem from a game theory point of view [9], [13].

**Table 1: Projections for the Performance of Stocks of a stock market**

MONTHS	STOCK INDEX %	STOCK 1 %	STOCK 2 %
JANUARY	1.027	1.479	1.875
FEBRUARY	2.034	1.222	2.621
MARCH	2.703	2.058	4.492
APRIL	0.380	1.325	0.943
MAY	1.824	2.103	3.267
JUNE	-1.800	0.299	-1.728
JULY	0.953	0.789	1.988
AUGUST	-2.071	0.106	-2.096
SEPTEMBER	-1.981	0.184	-1.494
OCTOBER	-2.092	-0.157	-0.943
NOVEMBER	2.965	1.337	4.071
DECEMBER	3.597	3.523	4.821



We could briefly suppose that the management of a stock portfolio includes the following phases:

**Phase 1** Stock portfolio selection. From the data of the exercise, stock portfolio selection is a given fact. There are two stocks and the major competitor is the Stock Index of the Stock Exchange.

**Phase 2** optimum Stock portfolios Structure. The stock portfolio structure refers mainly to the percentages of each stock' s participation in the stock portfolio. The optimum stock portfolio structure will arise from the selection of the percentage of each stock' s participation in the stock portfolio.

### How to Predict the Stock Market

#### 1. CALCULUS

The first and foremost mathematical technique that helps an investor determines the movement of the price in the stock market is **Calculus**.

Calculus is the study of continuous change and is therefore essential for a stock market investor. An investor can predict short-term movements in theory with the help of calculus and statistics. This is where probability comes in. Financial analysts work day and night to try and find a trend using the past few months' data. They use the past data to predict the future data, and after they manage to find a pattern, they project it on a graph for better visualization.

#### 2. MARTINGALES

Martingale is the mathematical method of predicting the future price of a stock based on the stock' s current price. According to this theory, past returns or results do not matter in present scenarios and predict future prices. This concept is part of probability theory. This concept of martingales suggests that the best bet on tomorrow' s stock price is today' s price of the stock. A martingale where the next price value is predicted to be higher is known as a sub-martingale. In this theory, the current stock price and volatility rate are the only inputs for future predictions. This trend has been consistent for over 8 decades of stock market pricing.

This theory assumes that the stock market movements are purely random. Let me explain with an example: If you had 100Rs, and a dice roll of 6 would give you 500Rs, but any other number means you

lose the 100Rs too. So, in this case, there are two possibilities, i.e., you end up with 600Rs after getting 6 (1/6<sup>th</sup> chance), or you end up with nothing (5/6<sup>th</sup> chance). The prediction of the results after the dice roll is the martingale in this case.

### 3. RATIOS

This technically does come under math since calculations are required. However, there are many ratios used in the world of finance, out of which there are 2 that stand out when it comes to investing decisions – Price to Earnings ratio and Return on Assets.

What is the Price to Earnings Ratio? It is the ratio used to calculate the cost incurred by the business to earn one unit of the particular currency. So, in general, it is the cost incurred to make one dollar.

Why is it so important? Investors will buy the shares of that company, which has a lower P/E ratio, which will mean that they are paying a lower amount to gain one dollar. A high P/E ratio would suggest that the company is paying a higher cost for earning one dollar. However, a high P/E ratio doesn't necessarily mean a bad thing. A high P/E ratio means that the investors see considerable growth potential in the company for the future. P/E = Price/Earnings or in the stock market **price of the share/Earning per share.**

**Its example time:** A company's earnings for 2020 were 1 lakh Rs, whereas the fixed costs incurred were 5 lakh Rs. The P/E ratio, in this case, will be 5 Lakhs/1 Lakh = 5 times. So, for every 1 dollar made, 5 dollars were spent. Also, it'll take the company 5 years to reach the break-even point on the current trend.

What is Return on Assets? It is the ratio used to check the profitability of any business based on its assets. So, essentially it is the report of how efficient a business' management is in utilizing the assets acquired. The higher the ROA, the better the company's management system, the better performance of the business.

Why is ROA important? It gives the true profitability of a company, as it considers even the company's debt, unlike ROE, i.e., Return on Equity. Second, it shows how good the company is at making the most out of limited resources. Third, investors will invest in a business that knows how to handle its assets well. The formula for ROA is **Net Income/Total Assets.**

**An example must be taken:** Suppose firm A just acquired a new machine for 5 lakh Rs, and the earnings for the year 2020 were 1 Lakh Rs. The ROA, in this case, will be 1 Lakh/5 lakhs = 0.2, i.e., 20%. So, in short, every dollar invested in the business by firm a generated 20% of net income.

But why only P/E and ROA? Collectively, these two ratios give a brief idea of how the company conducts its business. How well can it manage its resources, and how much growth to expect from the business. Thus, a low P/E ratio matched with a high ROA ratio is ideal. They both have their shortcomings, but these are generally used to predict whether the stock is undervalued or overvalued. This method is used

worldwide by fundamentalists. While these ratios provide a short answer to how to predict stock market trends, the following method is the broader version of this one.

#### 4. FUNDAMENTALS OF THE COMPANY

This method is a rather long one. Let me start by first explaining what fundamental investors are. These investors evaluate the fundamentals or the company's actual value using the company's data. This data can include various financial statements like balance sheets and cash flow statements, etc. The ratios we saw in the previous point are calculated using the financial statements of the company. So first, we saw the easy way of calculating those ratios; a fundamental investor has to calculate every aspect of the ratios from the giving statements. So now let's see the detailed version of it.

First off, let me tell you the company's actual value is known as its intrinsic value, and it is the same value that helps determine whether a stock is overvalued or undervalued. The most important thing in this theory understands the correlation between the financial statements. Correlation is always important when it comes to investment decisions. Firstly, an investor must know how to read the financial statements and understand them as well, as it helps in understanding the fundamentals of the business. Next comes understanding the business fundamentals, including the growth potential, profitability, management efficiency, and other factors.

Next comes evaluating the fair price of the stock or the intrinsic value of the stock using math. This will answer the question of how to predict the stock market using math. There are various ways by which one can determine the fair price of a stock. The most common method is discounting of future cash flows and the future PE-EPS method.

Anyhow these methods help an investor find the intrinsic value of any share; although these methods might not be 100% accurate, these provide a sound and logic-backed approach. Moreover, once you get the hang of it, you can start predicting the prices of the shares in short-term periods almost accurately. There are very few people in the world that can accurately judge the intrinsic value of the company. So remember, the most important step is to find the correct correlation between the financial statements and the fair price of the company's share.

The last step is to compare the share's intrinsic value with the current market price of the share. If the intrinsic value is greater than the market price of the share, the share's price will increase in the near future. But, if the share's intrinsic value is smaller than the market price, then it is likely that the market price of the share will decrease in the near future.

For example – A share's CMP is ₹100, and the investors found that the intrinsic value is estimated to be ₹110. So, naturally, they bought more of that share because the intrinsic value suggested that the share may increase in the near future.

### 5. MEAN REVERSION

Mean reversion is not a mathematical method, and for that matter, it is not even a technique where you have to do something. Mean reversion is defined as the process in which the price and returns of any stock revert to their long-term mean value. By long-term, I mean an extended period. It can be decades of stock pricing and returns. This theory assumes that the volatility of the price of the share is mean-reverting. So, over the long term, the share price will keep on reverting to its mean value. This theory may not be that feasible because of its long waiting period. However, many investors use this theory to calculate the volatility ranges of the stocks and combine them with various forecasting techniques. This way, they can make smarter decisions while investing.

### 6. MOMENTUM

This theory is rather simplistic and basic. In this method, an investor predicts the future movement of the stock prices based on the past few months' movements, i.e., the momentum of the stock. If it has been increasing for the last 3-4 months, the chances are that it will keep on increasing. Since more people will invest in a stock that keeps on increasing, it will result in a growth spiral and grow even more, but since the market forces exist, the price will eventually come down. So, as you saw that this method is nothing but predicting a vague movement of the stock based on its past movement, it has nothing to do with any analysis. Instead, you pray that the momentum is not broken. So, these were some methods and techniques which answer your questions of "How to predict the stock market using math" and "How to predict the stock market trends."

### Forecasting methods and stock market analysis

	Technical analysis	Fundamental Analysis	Efficient market theory
1. Objectives	The short-term prediction of the share price, based on their historical evolution.	The determination of the "intrinsic value" of the shares, based on economical and non-economical factors.	The explanation of the formation of the share price, based on a general behavior model, named the "efficient market".
2. Suppositions	The prices' series and the transaction volume describe some trajectories and trends that will repeat in the future, and the shares' price is determined by demand and supply.	The market value of a share has to oscillate around its intrinsic value. Otherwise the share is over or under estimated.	The markets do not have memory; any information regarding the share is instantly adjusted in price; that is why the past is of no help in predicting the future.
3. What it recommends To the users?	Tells the users which and how many shares they have to buy or sell in order to gain profits.	Tells them what they have to buy in order to obtain benefits.	The <i>weak hypothesis</i> tells them that the historical prices of shares are random and do not contain useful information that should lead to over-the average earnings. The <i>intermediate hypothesis</i> indicates the time delay of the price adjustment to new information. The <i>strong hypothesis</i> shows that

			nobody will earn more, regardless of the strategy that is used, because all the information is inside the price.
4. Which are the target users?	Mainly speculators and short-term investors.	Mainly people who want to save and long-term investors not interested in the short-term fluctuations.	Both speculators and long-term investors.
5. Methods that are used	Study of graphs, time series and a certain dose of common sense.	Economical financial studies, macro-economical analysis, multivariate statistical analysis, behavior theory (psychology, sociology, politics).	Statistical methods (regression and correlation analysis), the test of the signs, the rule of the filters, econometric analysis.

**Formula: component weight, market capitalization**

$$S * P = C$$

S = shares issued and outstanding

P = price per share

C = component weight

**Excel program**

A<sub>1</sub> shares issued and outstanding

B<sub>1</sub> price per share

$$C_1 = \text{SUM} (A_1 * B_1)$$

$$C_1 = \text{SUM} (A_1 * B_1)$$

The formula for calculating the percentage of each component, to the entire index is:

**Formula: component percentage, market capitalization**

$$C \div SC = W$$

C = component weight

SC = sum of component weights

W = weight percentage

**Excel program**

A<sub>1</sub> shares issued and outstanding

B<sub>1</sub> price per share

$$C_1 = \text{SUM} (A_1 * B_1)$$

The value of cap rated indexing has been questioned, however. Reliance on cap rating would have to assume that investors track the full index precisely, in order to achieve the assumed efficiency it provides. The term “ efficiency” refers here to an accurate and reliable overall market. While it does not exist except in theory, “ efficiency” provides a form of benchmark all on its own, by which investors can quantify their ability to generate informational efficiency. However, this is a problem because: no investor invests in the cap-weighted index; rather all manage risk in the context of their own expectations and take



an optimal position on their own perceived efficient frontier. Some might suggest that those who invest in cap-weighted portfolios believe the market to be informational efficient. Because of this they are willing to accept the mean variance efficiency of the cap-weighted index based on consensus market expectations. In an informational efficient market, however, security prices reflect the views of fully informed investors as opposed to the consensus views of all investors.

Since both capitalization and price weighting create a similar favoritism toward some issues over others, investors may choose to follow one index or another, recognizing that both types weight components unequally

**Formula: component percentage, price capitalization**

$$P \div SC = W$$

P = price of each component

SC = sum of components

W = weight percentage

**Excel program**

A<sub>1</sub> price of each component

B<sub>1</sub> sum of components

$$C_1 = \text{SUM} (A_1/B_1)$$

The advantage to generating index benchmarks is that it represents a segment of the market making it easier for investors to draw conclusions about market wide trends. Tracking more than one index ensures that distortions will be taken in context.

**Breadth of the Market**

Among the many market wide indicators, breadth of the market compares the total number of advancing and declining stocks. This is viewed as a very broad signal of whether market sentiment is positive or negative at the moment. It becomes most significant when one direction (dominance of advances or declining securities) dominates during most sessions over a period of time.

Dominance by advancing stocks is bullish, and dominance by declining stocks is considered bearish. Because this is market wide, it is a generalization of the market and cannot be applied directly to a portfolio or to a specific stock. In fact, breadth may distort actual trend-based outcomes based on how and why investors choose a particular company. In such cases, market wide breadth provides only limited value as an indicator. This is true in part because: ..firms that spend more on advertising, ceteris paribus [all else being equal], have a larger number of both individual and institutional investors. Further, we find that advertising has a stronger effect on individuals than institutions. This result is consistent with recent evidence of a “home bias” among investors and suggests that advertising helps to attract a

disproportionate number of investors who, at least in part, make their investment decisions based on familiarity rather than on more fundamental information.

Breadth provides specific value, however, but it should be analyzed in context. The question is one of how market wide indicators affect price behavior of individual stocks. Breadth is measured by advance/decline line. This is a confirming indicator used along with other sentiment signals, and reversal may be anticipated when the a/d line diverges from the prevailing trend.

**Formula: advance/decline price line**

$$P \pm N = C$$

P = previous a/d line

N = net advances (+) or declines (-)

C = current a/d line

**Excel program**

A<sub>1</sub> previous a/d line

B<sub>1</sub> net advances or declines

$$C_1 = \text{SUM}(A_1+B_1) \text{ or } =\text{SUM}(A_1-B_1)$$

The rapidly changing a/d line on this table reveals the potential volatility in the a/d line. However, this also reveals a shift from bullish to bearish sentiment, to the point that the a/d line turned negative by the last session reported. A variation of changes in the a/d line is calculation of the percentage change from one session to the next. In some respects, the percentage of change is easier to comprehend than the net number of advancing or declining issues and changes to the a/d line.

**Formula: advance/decline price percentage**

$$(A - D) \div (A + D) = P$$

A = advances

D = declines

P = percentage change

**Excel program**

A<sub>1</sub> advances

B<sub>1</sub> declines

$$C_1 = \text{SUM}(A_1-B_1) / (A_1+B_1)$$

This calculation reveals the often highly volatile day-to-day changes in advance/decline trends. However, the overall sentiment in these five sessions turned from previous bullish bias to bearish. Due to the volatile daily changes, analysts tend to rely more on moving averages than on the short-term and highly volatile changes in indicators such as this.

Another variation of advance/decline analysis focuses on daily volume rather than on the number of advancing and declining issues. Like the a/d line, the net advance/decline of volume is a cumulative index

in which each session's net advance is added, or decline subtracted, from the previous volume index value. This is used as a confirming indicator, used in conjunction with other market wide signals; or as a divergence signal when the prevailing sentiment is contradicted by the volume trend. In that case, the volume a/d may be used as a forecast of a change in price direction. Calculation of the a/d volume line is the same as that for the price-based a/d line, with the volume advances and declines substituted for the number of advancing and declining issues.

The double-digit changes in a/d volume support what was revealed with a/d of price. Short-term volatility in volume advances and declines makes it difficult to judge markets and their longer-term sentiment. The a/d volume indicator is useful for anticipating trend reversal or for identifying divergence from the prevailing trend itself.

### **Short Interest Ratio**

Another market wide indicator, the short interest ratio, compares the current number of short shares (short interest) to average daily trading volume. It is calculated for individual stocks, but may serve as a market wide sentiment indicator when the short interest for a large company changes dramatically. Among the popular application of short interest is one performed for all of the issued traded on the New York Stock Exchange? The NYSE short interest ratio applies the calculation for the entire market over a period of the last 30 trading days.

Short interest is a relatively minor indicator. Because short selling is not widespread in most stocks, its overall value, whether taken as a direct or contrarian signal, is limited: The typical stock has very little short interest; most stocks have less than 0.5% of their shares outstanding held short. Thus, while there is substantial cross-sectional variation in short-interest levels, based in part on the determinants discussed in this section, the reader should bear in mind that short selling represents only a small proportion of total transactions in the average stock.

The short interest ratio is calculated by dividing the number of short shares (short interest) by the average daily volume, usually based on the past 30 trading days.

### **Formula: short interest ratio**

$$S \div (D \div 30) = R$$

S = short interest

D = total monthly volume

R = short interest ratio

### **Excel program**

A<sub>1</sub> short interest

B<sub>1</sub> accumulated daily volume for 30 days

C<sub>1</sub> =SUM (A<sub>1</sub>/ (B<sub>1</sub>/30))

For example, current short interest is 4,865,000 shares. Daily volume for the past 30 days has added up to 5.66 billion shares. Short interest is:  $4,865,000 \div (5.66 \div 30) = 2.6\%$

Because short sellers expect the price of a security (or the entire market) to decline, the level of short interest is bearish when it rises. When short interest is covered, it indicates that short sellers are taking profits, or are concerned about possible losses if and when share prices rise. As a consequence, short cover in large volume appears as buying demand rather than as short cover. This is a deceptive indicator, and those not familiar with the trend of short cover may incorrectly believe that increased buy demand is a bullish signal. Although changes in short interest imply a change in sentiment, contrarians view short interest in the opposite way. To the contrarian, growth in short interest predicts a bullish trend, not a bearish trend. This approach assumes that with growing short interest, upward pressure eventually overcomes the short strategy.

For contrarians – those investments based on analysis rather than on instinct or emotion – sentiment itself is a questionable cause for making trading decisions. A contrarian view of investor behavior points to the flaws in reliance on the past to identify future performance. In other words: some investors tend to get overly excited about stocks that have done very well in the past and buy them up, so that these "glamour" stocks become overpriced. Similarly, they overreact to stocks that have done very badly, oversell them, and these out-of-favor "value" stocks become underpriced. Contrarian investors bet against such naive investors. Because contrarian strategies invest disproportionately in stocks that are underpriced and under invest in stocks that are overpriced, they outperform the market.

This opposite-leaning bias among contrarians is based on observations that crowd thinking in the market is poorly timed more often than it is well-timed. The short interest ratio is one way to measure the sentiment and to time trades by contrarians.

### **New Highs and New Lows**

New highs and new lows represent statistical ranges, thus the degree of volatility over time in the market, broadly speaking. For calculation of the broader historical volatility, the current trend can be viewed easily be application of other technical indicators with chart overlays.

Because volatility is a quantified expression of market risk, stock investors track the degree of volatility, in the form of the number of stocks reaching new high or new low prices. As one or both sides expand, volatility also grows; and if the annual number of record new high or new low prices declines, this is one version of declining volatility. The new high/low index tracks the number of records set over 52 weeks. It is referred to as a breadth indicator because it defines the range of price movement, and several different versions can be calculated. The record-high percentage is calculated by dividing the number of new highs by the sum of new highs and new lows, and the result multiplied by 100, to calculate the index value.

### **Formula: record-high percentage**

$$(H \div (H + L)) * 100 = P$$

H = new highs

L = new lows

P = record-high percentage

#### **Excel program**

A<sub>1</sub> new highs

B<sub>1</sub> new lows

C<sub>1</sub> =SUM (A<sub>1</sub>/ (A<sub>1</sub>+B<sub>1</sub>))\*100

For example, during the past month, new highs were 413 and new lows were 367. The record-high percentage was:  $(413 \div (413 + 367)) * 100 = 52.9\%$  A second calculation is the high/low index, which is a simple moving average of the latest 10 days' record-high percentage.

#### **Formula: high/low index**

$(R1... R10) \div 10 = I$

R = record-high percentage (for days 1 through 10)

I = high/low index

#### **Excel program**

A1:A10 record-high percentages

B10 =SUM (A1:A10)/10

#### **Formula: high/low percentage**

$(H - L) \div T = P$

H = 52-week highs

L = 52-week lows

T = total issues

P = high/low percentage

#### **Excel program**

A<sub>1</sub> 52-week highs

B<sub>1</sub> 52-week lows

C<sub>1</sub> total issues

D<sub>1</sub> =SUM (A<sub>1</sub>-B<sub>1</sub>)/C<sub>1</sub>

For example, the number of new high priced stocks over the last 52 weeks on the S&P 500 was 120, and low lows were 32. With a total of 500 issues, the high/low percentage is:  $(120 /32) \div 500 = 17.6\%$

The overall trend in high/low analysis is expressed as the net new 52-week high. It indicates not only a trend toward bullish or bearish sentiment, but the strength of that trend as well. The indicator could be in the negative in instances when new low issues exceed the number of new high issues.

#### **Formula: net new 52-week high**

$$H - L = N$$

H = 52-week new highs

L = 52-week new lows

N = net new highs

**Excel program**

A<sub>1</sub> 52-week new highs

B<sub>1</sub> 52-week new lows

C<sub>1</sub> =SUM (A<sub>1</sub>-B<sub>1</sub>)

**Formula: high/low line**

$$N \pm P = L$$

N = net new high, current

P = net new high, prior

L = high/low line

**Excel program**

A<sub>1</sub> net new high, current

B<sub>1</sub> net new high, prior

C<sub>1</sub> =SUM (A<sub>1</sub>+B<sub>1</sub>)

The same data are used to track the number of issues trading above a specified moving average. Various MA' s can be applied. For example, using a 50MA (50- session moving average), the calculation of the percent trading above is revealing and tracks a bullish or bearish trend over the period studied.

**Formula: percent above MA**

$$S \div T = P$$

S = number of stocks trading above MA

T = total stocks in the index

P = percent above MA

**Excel program**

A<sub>1</sub> number of stocks trading above MA

B<sub>1</sub> total stocks in the index

C<sub>1</sub> =SUM (A<sub>1</sub>/B<sub>1</sub>)

For example, applying the 50MA to the S&P 500, 42 stocks were currently trading above the 50MA line. The percent above MA is:  $42 \div 500 = 8.4\%$

**Put/Call Ratio**

An overall market indicator is also calculated using the relationship between volumes of options. A comparison between puts and calls is believed to track market trends. When the ratio is greater than 1, it

is the result of puts having greater volume than calls. A ratio less than ' 1' results from the opposite. A high ratio is interpreted as bearish, so that a rising ratio tracks a bearish trend.

**Formula: put/call ratio**

$$P \div C = R$$

P = put volume

C = call volume

R = put/call ratio

**Excel program**

A<sub>1</sub> put volume

B<sub>1</sub> call volume

B<sub>1</sub> call volume

C<sub>1</sub> =SUM (A<sub>1</sub>/B<sub>1</sub>)

For example, a day' s summary reveals that equity put volume was 492,606 contracts, and equity call volume was 741,190. The put/call ratio was:  $492,606 \div 741,190 = 0.66$

This result is less than 1.0, the result of greater volume in calls. Tracking this relationship over a series of trading sessions reveals the continuation or reversal of the trend. The overall market may be further judged by a series of ratios concerning trading and profitability in mutual funds. The fund-based trends are significant; as total dollars invested (approximately \$15 trillion) represent about 22% of total worldwide stock valuation of \$69 trillion.

**Mutual Fund Ratios**

With many investors choosing to invest in a variety of mutual funds and rely on the services of professional managers, the question of how to pick a fund has to be raised. Load and no-load funds are a starting point, but an array of fees is also applied. No direct management is required in an exchange-traded fund (ETF), because rather than managing a portfolio of securities, the ETF is based on a predetermined " basket of securities" with something in common (geography, sector, or type, such as equity, debt, currency, or commodity, for example).

For any mutual fund investment, either as an alternative to direct ownership of securities or as a means of diversification, specific calculation help determine the viability and potential of one fund compared to another. The first important calculation is the liquidity ratio. This is a method for quantifying whether a mutual fund management team is bullish or bearish. It compares the level of total assets invested versus the amount held in the form of liquidity (cash or cash equivalents). If fund management has a larger than average percentage of a portfolio held in cash, it implies that management has difficulty finding investments that meets its standards, or that management is cautious under current market conditions. Conversely, when a fund' s management has the minimum amount of the overall portfolio held in the form of cash, it implies a bullish position based on current market conditions.

**Formula: mutual fund liquidity ratio**

$$C \div A = R$$

C = cash and cash equivalents

A = total assets

R = liquidity ratio

**Excel program**

A<sub>1</sub> cash and cash equivalents

B<sub>1</sub> total assets

$$C_1 = \text{SUM} (A_1/B_1)$$

For example, a mutual fund reports current cash and cash equivalents of \$32,515,800 and a total portfolio value of \$107,550,034. The liquidity ratio is:  $\$32,515,800 \div \$107,550,034 = 30.2\%$

A second ratio of importance to mutual fund investors is net asset value (NAV). This is the total value of all a fund's assets, minus its liabilities. It is also termed net book value per share. If NAV rises, it points to increased profits from investments, and conversely, NAV will decline if the portfolio experiences net losses. The calculation takes into account all assets, including securities in the portfolio, plus cash and cash equivalents, accounts received, and accrued income, all calculated at market value (usually at the end of a trading day). From this, all liabilities are subtracted, including accrued expenses and debts owed by the mutual fund. NAV is then expressed per unit, which is the mutual fund's equivalent if a share.

**Formula: net asset value**

$$(A - L) \div U = N$$

A = assets

L = liabilities

U = units outstanding

N = net asset value

**Excel formula**

A<sub>1</sub> assets

B<sub>1</sub> liabilities

C<sub>1</sub> units outstanding

$$D_1 = \text{SUM} (A_1 - B_1) / C_1$$

For example, at the end of a trading day, fund reports total assets of \$107,550,034, total liabilities of \$3,007,623, and units outstanding of 4,016,660. NAV is:  $(\$107,550,034 - \$3,007,623) \div 4,016,660 = \$26.03$

Thus, an investor holding 800 units would have current value in the mutual fund of:  $800 * \$26.03 = \$20,824$



A third key ratio for mutual fund investors is the expense ratio. Funds, including both load and no-load funds, assess a variety of fees. These include load, management fees, 12b-1 (marketing and distribution fees), and administrative fees. A wide variety of different fees makes reliable comparisons elusive. For this reason, using a fund analyzer and calculator helps make valid and accurate analyses of mutual fund fees.

**Valuable Resource:**

The expense ratio calculates total operating expenses as a percentage of average net asset value for the fund, calculated for one full year. Average net asset value is the average of monthly or quarterly NAV over a year, or the average of the beginning and ending NAV reported for a year.

**Formula: mutual fund expense ratio**

$$E \div (A * U) = R$$

E = total operating expenses

A = average NAV

U = outstanding units

R = expense ratio

**Excel formula**

A<sub>1</sub> total operating expenses

B<sub>1</sub> average NAV

C<sub>1</sub> outstanding units

$$D_1 = \text{SUM} (A_1 / (B_1 * C_1))$$

For example, a fund's operating expenses are \$2,660,583. Average NAV is \$28.15, and outstanding units are 5,004,551. The expense ratio is:  $\$2,660,583 \div (\$28.15 * 5,004,551) = 1.9\%$

The expense ratio will vary considerably between funds, even those appearing to contain similar levels of fees. This occurs because there are so many different types of fees as well as methods for assessing them. For example, some funds charge no sales load at the time of investment, but do assess a load when funds are withdrawn. This back-end load affects the calculation of expense ratio. Also significant in assessing funds in the calculation is the yield. This is calculated as the yield earned over a one-year period, divided by the price per share as of yearend. If this calculation is performed for a period of less than one year, the income should be annualized to ensure comparable yields between different investments.

**Formula: mutual fund yield**

$$I \div N = Y$$

I = income distribution per share

N = NAV

Y = yield

### Excel program

A<sub>1</sub> income distribution per share

B<sub>1</sub> NAV

C<sub>1</sub> =SUM (A<sub>1</sub>/B<sub>1</sub>)

For example, a mutual fund's income distribution per share is \$108.16 for the full year. NAV is \$26.03.

Yield is:  $\$108.16 \div \$26.03 = 4.2\%$

The yield is perhaps the true "bottom line" for mutual fund investors. A means for comparison is the mutual fund yield to the dividend yield on a portfolio of directly owned stocks. Without having to pay the mutual fund expenses, direct ownership may improve overall net yield. The comparison is not precise, however. Variations of market risk in both the mutual fund and a directly held portfolio of stocks makes this exercise an estimate only.

A final calculation for mutual fund investing is total return. This is the current value of the account plus cash distributions, minus the initial investment. The "return" is a dollar value and not the *rate* of return.

### Formula: mutual fund total return

$$V + C - I = R$$

V = value of the account

C = cash distributions received

I = initial investment

R = total return

### Excel formula

A<sub>1</sub> value of the account

B<sub>1</sub> cash distributions received

C<sub>1</sub> initial investment

D1 =SUM (A<sub>1</sub>+B<sub>1</sub>-C<sub>1</sub>)

For example, an investment made one year ago currently is valued at \$5,100. The original amount placed into the fund was \$5,000. At the end of one year, \$975 was received in distributions. Total return is:

$$\$5,100 + \$975 - \$5,000 = \$1,075$$

From this calculation, total *yield* can be calculated.

### Formula: mutual fund total yield

$$(V + C - I) \div I = TR$$

V = value of the account

C = cash distributions received

I = initial investment

TR = total yield

### Excel formula

$A_1$  value of the account

$B_1$  cash distributions received

$C_1$  initial investment

$D_1 = \text{SUM} (A_1+B_1-C_1)/C_1$

In the preceding example, total return was set at the dollar value of \$1.075. Total yield is:  $(\$5,100 + \$975 - \$5,000) \div \$5,000 = 21.5\%$

The most accurate expression of total yield depends on whether distributions are taken in the form of cash payments, or reinvested to purchase additional shares. Reinvestment creates a compounding effect of the total yield, so the outcome would be different, especially over a period of many years.

## CONCLUSIONS

There are major differences between the forecasting methods, in terms of their complexity, restrictions, requirements and precision. Each method is appropriate in well-defined circumstances. The selection of the optimal method, which better accommodates to a particular situation and fully values the existing data, is of extreme importance. Without pretending that we exhausted the whole range of shares forecasting issues, we think that the methods we discussed should be present in any study of efficacy concerning the decision of investing in shares. Stock portfolio selection can be performed using tools such as mathematical programming which are easily digested and understood. In this way they can not only appreciate the immediate use of mathematics to the practical but important problems, but also start to be exposed to the problems of modern finance. All three algorithms provide an accuracy of 99.9% using tick data. The accuracy over 15-min dataset drops to 96.2%, 97.0% and 98.9% for LM, SCG and Bayesian Regularization respectively which is significantly poor in comparison with that of results obtained using tick data.

Purchasing power parity sometimes cannot be confirmed in reality, and it happens that, although the magnitude of changes in inflation in the observed countries is known, the expected effect of the percentage change in the exchange rate in accordance with purchasing power parity does not occur. The main argument is that the price change drives quotas in the foreign exchange market, while everything else is of a second type. All so, multinational corporations can always hedge over risks and, thanks to their knowledge, actually prevent the risk of “ dangerous” quotas and discrepancies in the differences between national currencies. The process of forecasting the factors influencing the international exchange rate is an essential aspect of eliminating the expected effects and understanding the exchange rates further movement. All these measures can significantly contribute to the fight against uncertainty in the foreign exchange market, leading to safer and more certain operations.

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