

ENHANCED DECISION SUPPORT SYSTEM FOR PORTFOLIO MANAGEMENT USING FINANCIAL INDICATORS

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ABSTRACT

In many cases, financial indicators are used for market analysis and to forecast the future of stock prices. Due to the high complexity of the stock market, determining which indicators should be used and the reliability of their outcomes have always been a challenge. In this article, a hybrid approach in the form of a decision support system is being introduced that offers the best suggestions in buying and selling stocks. This system will help an investor to identify the best portfolio of stocks using a series of financial indicators. These indices act as a model that forecast the future price of a stock by examining its activities and status in the past. Therefore, using a combination of the indices enables us to make decisions with more certainty. Proficiency of this system has been evaluated through the collection of data from the stock market in Iran from 2001 through 2011. The results show that the use of indices and their combination have led to the decision support system to produce suggestions with very high precisions.

KEYWORDS

Decision support system, oversold, overbought, portfolio selection

1. INTRODUCTION

Selection of the stock is a key problem in portfolio management. It is difficult to decide which stocks should be selected because of the existence of uncertainty on their returns [12,13]. These uncertainties are severed by stock price fluctuations. Stock price fluctuations are affected by the financial data that are gathered based on the interactions that take place on the stock. When a stock begins trading and circulating in the market, it gains many features, including opening price, closing price, highest price, lowest price and trading volume per day and others that in general or in a way shows the value of a stock. Stock performance is evaluated based on related past data and using a set of indicators. These indicators include the money flow index, stochastic oscillator, ease of movement and so on. These indicators use the features mentioned above as input and provide the future status of the stock as output. Studies show that there are many methodologies and models for portfolio selection [11], but does not exist an integrated framework

that organizes the choice and implementation of these methodologies and models to support portfolio selection logically.

Decision support systems are interactive computer systems that use models and data to identify and solve problems with low structured level, in order to support decision making in the process of decision [1]. A decision support system can effectively help investors through attention to its architecture that provides the best solutions between available options, describing the reason for choosing the solutions and offer the expected output of each alternative [14]. Matsatsinis [6] presented a survey on the most important factors of decision support systems in the field of management and stock assessment.

In this paper, we propose an approach to support decision making to select a stock for selling or buying. For this purpose, the data from Iranian stock market from 2001 to 2011 have been collected and used. Due to the nature of stocks and the ability to compare them, the stocks have been grouped initially. The information for each group of stock is available on the official website of the stock exchange market. The proposed decision support system recommends 10 ranked stocks between the existing stocks from each group based on profitability. Of these 10 stocks, 5 are for purchase and the other 5 for sale. These suggestions are based on a series of calculated financial indicators from each stock's historical data. The output of these financial indicators demonstrates two concepts: their oversold and overbought levels. An oversold stock indicates a major reduction of its price in the market while an overbought stock indicates the increased in its price. Therefore, decision making and suggestions are based on these two factors. So, after the calculation of indicators, value of each stock, if most of indices show the signal of buy/sell of a stock, that stock will be appropriate for buy/sell.

This paper is structured this way, in the second section; the related works are reviewed. In the third section, some financial indicators that are applied in this work are explained. In the fourth section, our decision support system architecture is introduced. In the fifth Section, we present our experimental results, with a detailed analysis of the proposed system and then we describe our evaluation method to determine the accuracy of our system. Finally, conclusions are drawn in Section 6.

2. LITERATURE REVIEW

This section will provide an overview of previous works where the selection of the stock is focused on decision support system.

Most of research trends on decision support systems for portfolio management are in designing intelligent systems using data mining techniques include neural networks, genetic algorithms (GAs), multi-agent systems, and support vector mechanism [10]. Chou in [2] presented an intelligent decision support system for stock selection that has two components of technical analysis and artificial intelligence. The technical analysis component is used for pre-processing of input data, filtering, and recommending a list of Stocks for buy or sell. The second component is an artificial intelligence component, has the role of an experienced businessman, works toward improving the list of recommended stocks through the component of technical analysis. In fact, the main focus of this article is on computerizing the technical analysis using the intelligent decision support system. Also, Sharma et al in [9] proposed a framework for designing a decision support system using Genetic Algorithm for constructing an efficient portfolio of equities for investors. One advantage of this system is that it simplifies the portfolio selection process.

Samaras in [7] presented a multi-criteria decision support system to evaluate three approaches of fundamental analysis, technical analysis and assessment of stock market analysis. In this system,

methodologies of multi-criteria analysis for ranking the stocks are used. The final output of the system is the rank of four stocks that responds to four groups of different criteria. These outputs are related to the accounting program of each company listed. Also Ghasemzadeh in [4] used a decision support system to select project stock that makes decision based on project analysis and system selection.

Dong in [3] proposed an integrated framework for stock selection that chooses an effective stock for the investors. This framework focuses on the implementation of a decision support system based on the web where technology with features such as an online analytical processing, through an extension tool for analytical purposes and the parallel virtual machine is used to improve system performance. Ince et al in [8] used Multilayer perceptron networks and support vector regression for stock price prediction. They showed that these two techniques produce better results than other data mining techniques in stock price predictions.

3. THE FINANCIAL INDICATORS

This section will introduce the indicators that are used in the proposed system. Each of these indicators is a financial model that focuses on a stock's past operation and forecasts its situation in the future. All of these indicators are available in [15].

3.1 Chaikin Money Flow

This indicator measures and evaluates the volume of money in a specified period of time. This indicator fluctuates between values above and below the zero line. Analysts, weighing the balance of buying or selling pressure equilibrium by an absolute level. Positive value for this indicates a purchasing pressure while a negative value indicates buying pressure. This index is calculated using the following equation:

$$MFM = [(Close - Low) - (High - Close)] / (High - Low) \quad (1)$$

$$MFV = MFM \times VolumeForThePeriod \quad (2)$$

$$n - CMF = n - SumOfMFV / n - SumOfVolume \quad (3)$$

where MFM is the multiplier of the money flow, MFV is the volume of the flow of money, and n-CMF shows chaikin money flow for n period.

3.2 Relative Strength Index

Relative Strength Index (RSI) is an oscillator indicator that measures the rate of changes in price. RSI fluctuates between 0 and 100. Generally, the value of over 70 for this index indicates an overbought and value while below 30 indicates oversold in the market. This index is calculated using the following equation:

$$RSI = 100 - \frac{100}{1 + \frac{AverageGain}{AverageLoss}} \quad (4)$$

where Average Gain and Average Loss are the ratio of the total profits and losses to the time period, respectively. Difference between opening and closing stock price shows the profits or

losses of that stock on a daily basis; the positive value indicates profit and the negative value indicates loss.

3.3 Random Fluctuations

Random Fluctuation is an indicator that demonstrates the highest and lowest value of the stock at a specific time. According to previous researches, this price index does not follow the volume of purchases, sales or similar actions, but it follows the speed or acceleration of the stock price. This index is expressed as a percentage and swings between 0% and 100%. Values over 80% for this index indicate that the price is close to the highest price in the period and the amount less than 20% indicate that price is lowest in the period. This index is calculated as follows:

$$K = (Close - Low) / (High - Low) \times 100 \quad (5)$$

where *Close* indicates the current closing price, *Low* indicates the lowest price for the period, and *High* indicate highest price for that period.

3.4 Commodity Channel Index

Commodity Channel Index (CCI) is a versatile index that can be used to identify a new trend. Generally, CCI measures the current price by comparing it to an average price in a specified period of time. When CCI is more than its mean value, its value will be relatively high and vice versa. In these situations, CCI can be used to determine the overbought and oversold levels. The value of this indicator fluctuates between 100 and -100. Values over 100 indicate that the stock has been overbought and values below -100 indicate that the stock has been oversold in the market. This index is calculated as follows:

$$CCI = \frac{TP - \overline{TP}}{0.15 \times MeanDeviation} \quad (6)$$

$$TP = \frac{High + Low + Close}{3} \quad (7)$$

where TP indicates the average price and MeanDeviation is the standard deviation of the closing stock price on different days in a specified time period [5].

3.5 Ease of Movement

Ease of movement determines if the price of a stock index easily moves or has been stable. For example, if trends of market be buying stock over a day, then stocks will have high ease of movement. However, if the stock has buying and selling trends with global changes in the price, then the stock will have an easy of movement close to zero. Generally, this indicator shows the relationship between trading volume and price changes. If the value of this index is positive, it means the value of this index is increasing and if it is negative, it means that prices are falling and if the value is zero, it means that there will be no price changes. This index is calculated as follows:

$$EMV = \frac{\left[\frac{High(T) + Low(T)}{2} - \frac{High(Y) + Low(Y)}{2} \right]}{\frac{Volume}{High(T) - Low(T)}} \quad (8)$$

Where High(T) is today's maximum price, Low(T) is today's lowest price, High(Y) is yesterday's highest price, and Low(Y) represents yesterday's lowest price.

3.6 Money Flow Index

Money Flow Index is an oscillator that uses price and volume of trades to determine the pressure of selling and buying. The calculation for this index is very similar to RSI. The only difference is that this indicator should be calculated as the ratio of positive and negative cash flow. The value of over 80 in this index indicates an overbought and the value below 20 indicates oversold. This index is calculated as follows:

$$RMF = \frac{High + Low + Close}{3} \times Volume \quad (9)$$

$$MFI = 100 - \frac{100}{1 + \frac{PMF}{NMF}} \quad (10)$$

where RMF is the raw cash flow, PMF is the positive cash flow, NMF is the negative cash flow, and MFI is the flow of money.

3.7 Performance Indicators

This indicator compares the current closing price with the initial closing price (from the first period) and shows the rate of change in price. Performance indicators show how much a closing price changes from the price in initial period. This index demonstrates the difference as a percentage, for example, if the performance index reaches -20, it means the closing price of the stock falls by -20%. So, one can conclude that a positive value of this stock indicates buying opportunity and a negative value indicates selling opportunity. This index is calculated as follows:

$$PI = \frac{Close(today) - Close(First)}{Close(First)} \times 100 \quad (11)$$

where the Close (today) is today's closing price and Close (First) represents the first closing price.

3.8 Rate of Change Index

Rate of change index is an oscillator that calculates the percentage changes in prices from one period to another period. In fact, this index compares the current price with the past prices in n periods. The chart of this index creates an oscillator that shows fluctuations above and below the zero line. The positive value for this index indicates that the price is increasing and the negative value indicates that the price is falling. This index is calculated as follows:

$$ROC = \frac{Close - Close(past)}{Close(past)} \times 100 \quad (12)$$

where *Close* is the current closing price and *Close (past)* is the closing price in *n* periods that occurred in the past.

4. ARCHITECTURE OF DECISION SUPPORT SYSTEM

In the proposed system, the intention is assisting in decisions making about buying or selling a stock through a specific group. Figure 1 shows different a module of our DSS Architecture. It has three blocks: input block, processing block and output block. The black and white boxes represent various metrics and data repository, respectively. Input block is consisting of Target group and a time selected by investors. This time is supposed to be used for decision-making about the stock after it. So, based on this time, the earlier data is considered as test data and the later data is considered to analysis and evaluation of the system. Therefore, the input time is considered for systems dynamism.

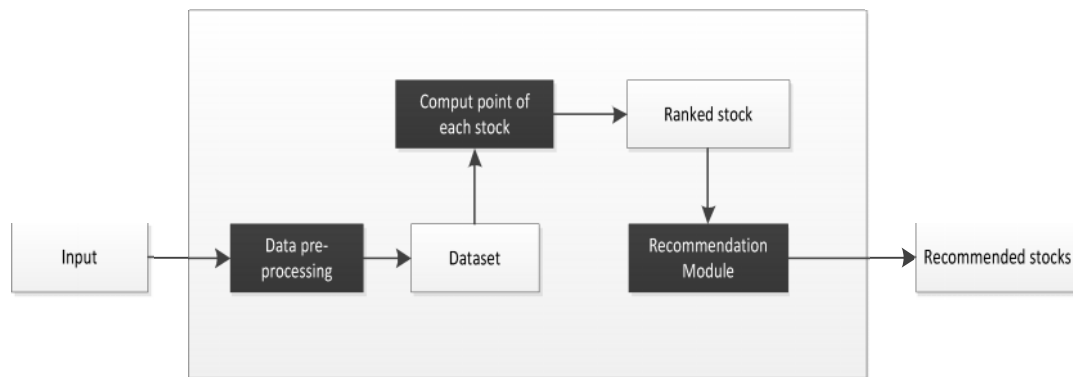


Figure 1. Architecture of our decision support system

In the stock market, there are different groups and in each group different symbols demonstrate their stocks. These groups and symbols in each group are extracted from the available information in the stock market and are defined for the system. When the user selects a group, the symbols in the group of stock and the related datasets are entered in the system. The purpose of the decision support system is choosing a limited number of suitable alternatives between all the available alternatives, and describes their output and suitability. To achieve this purpose in the proposed system, the indicators introduced in Section 3 are used. These indices are a series of financial models that indicate the status of stocks in the future. These indices are selected in a way that the output of each of which present the same concept and also leads to synergistic. In fact, the value of each index has specific meaning that is fully described in Section 3. Overall, these indices, in a way, insist on two factors: the oversold and overbought in the market. Oversold means the increasing level of purchase in the market, or more precisely, the stock price has dropped more than expected of market and it is likely that the change in the uptrend will occur and in this situation the purchase of a stock is suggested. On the other hand, overbought means that the purchase of stock has increased where the price of the stock has increased more than expected and it is possible that changes may occur in a downtrend and selling stocks is recommended in this situation. Given the concept of indices being used is in one direction, it can be concluded that if the indicators show a similar decision pattern for a stock then we can effectively apply that decision. For this purpose, it is possible to rank the stocks. For example, for making decisions about buying stocks: first, we calculate each stock through the selected indices introduced in Section 3, then for each stock that shows the signal for purchase, we give a positive score to.

Finally, we list the stocks based on acquired rating. The stock that gains the most points will be considered as the best alternative. Section 5 shows that the proposed system can operate with high accuracy and in most cases, it provided the correct solutions. In fact, using the indices that express the same concepts enable us to be able to decide with more certainty. For example, from the 8 indices being used in this system, 6 of them show that a stock is in selling position, so we can decide with more certainty that the particular stock is profitable.

5. EXPERIMENTS

In this section, we evaluate the performance of our proposed decision support system. To evaluate the performance of system, first based on user input, from the different stocks that are available, 5 stocks for purchase and 5 stocks for sell are recommended. Stocks in each of these two categories (buying or selling) are classified through the rank rating. Then a chart is plotted for each stock. This chart is based on the time and the closing price of a stock in a specified day. The time period in the chart is at intervals of user input time interval addition to 10 days. The reason for the use of 10 days is to investigate the performance of the system. It is expected that the stock price be match with the recommended items price before the generation of recommendations. (In the case of suggesting to purchase a stock, it is expected that the stock price will be rise in the future and vice versa in the case of suggesting to sell a stock, it is expected that the stock price will be decrease in the future.)

Data from the Iranian stock market from 2001 to 2011 have been collected and experimented. In order to compare the stock operation with each other, the introduced grouping in the stock market is used. In fact, the operation of each stock is compared with the stocks in the same group.

Here, the output of system is presented for a given input. Entrances are ordered to the sequence of chemical products and the date is May 2, 2001. Given these inputs, the system recommends five stocks for sale and five stocks for purchase with a priority order. In addition, we study the stocks with first ranking in two sections.

Figure 2, demonstrates the first rank stock for purchase. The circle in the chart, indicate the time that the user initially entered the data that was related to the stock's past operation and the calculation of indices are completed based on them. As it is indicated in the figure, after the date specified by the user, the stock price is rising and in the case of the purchase of such stock, the possibility of profitability will be very high.

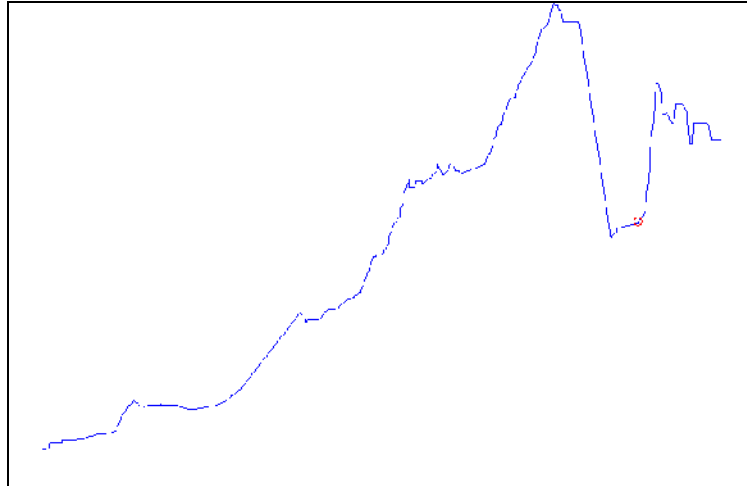


Figure 2. Diagram that suggests the purchase of a stock

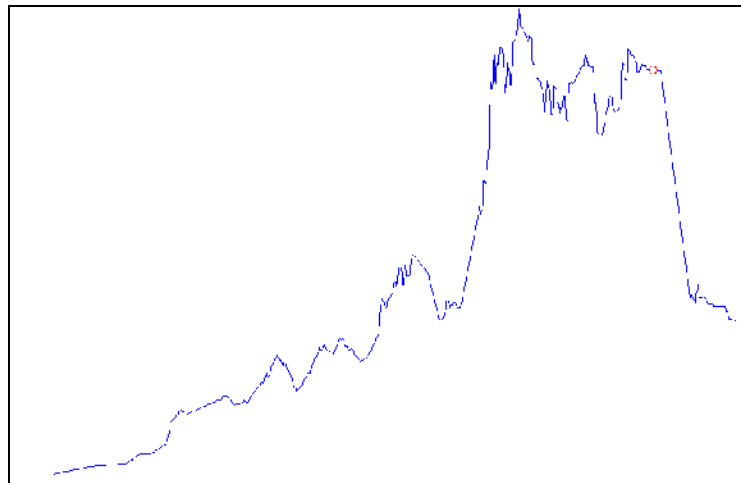


Figure 3. Diagram that suggests the sale of a stock

Figure 3 is also related to the first rank stock for selling. As is indicated in the figure, after the date specified by the user, the price of the stock is reducing and the sale of such stock will prevent excessive losses.

6. CONCLUSIONS AND FUTURE WORKS

In this paper, a hybrid approach of using financial indicators is presented to evaluate a stock in the form of a decision support system. The experiments demonstrate that this system is able to generate recommendations with high accuracy. In fact, using a combination of indices increases the certainty of the decision making. The system also recommends a stock for buy/sell that the most indicators show signals of buy/sell about it. Using divergence analysis can be considered as a future research. In this paper, the saturation of the sale / purchase has been done on the output of each indicator. The use of divergence analysis with examination of the saturation of buy / sell stocks can be very effective. Other work that can be done in this regard is the use of the proper indicators that weighs methods to select a stock in the group that relates to that stock. It means that assign high weight to the important indicators output rather than the same weight to them.

Also, to continue, more indices in this regard can be used so that the decisions can be generated with higher certainty.

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