# SOFT-COMPUTING IN CAPITAL MARKET

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*Edited by*

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BrownWalker Press
Boca Raton

*Soft-Computing in Capital Market*



BrownWalker Press
Boca Raton, Florida
USA • 2014

ISBN-10: 1-62734-503-5
ISBN-13: 978-1-62734-503-3

www.brownwalker.com

Cover image @Cutcaster.com/Adrian Sawvel

***"The power of God is with you at all times; through the activities of mind, senses, breathing, and emotions; and is constantly doing all the work using you as a mere instrument."***

***— Bhagavad Gita***

*……..*

***To my Father***

*But for whom nothing could have been possible.*

***My special thanks & gratitude to***

*Mr. Jeff Young*
*Publisher, Universal-Publishers,*
*Who has directly or indirectly helped and extended his support in bringing the book to the present shape.*

*……..*

***My affections to***

*My daughter Lori*
*For her inspirations and suggestions*

# Contents

# Preface

Computational Finance, an exciting new cross-disciplinary research area, depends extensively on the tools and techniques of computer science, statistics, information systems and financial economics for educating the next generation financial researchers, analysts, risk managers, and financial information technology professionals. This new discipline, sometimes also referred to as "Financial Engineering" or "Quantitative Finance" needs professionals with extensive skills both in finance and mathematics along with specialization in computer science. Therefore, to fulfill the need of applications of this offshoot of the technology, this book is in print which is an edition of plethora of collections from cross disciplinary research.

This edited book covers most of the recent and advance research and practical areas in computational finance i.e. starting from traditional fundamental analysis using algebraic and geometric tools to the logic of science to explore information from financial data without prejudice. Utilizing various methods, the researchers of computational finance aim to determine the financial risk with greater precision that certain financial instruments create.In this line of interest, twelve papers dealing with this new techniques and /or novel applications related to computational intelligence, such as statistics, econometrics, neural-network and various numerical algorithms are included in this volume.

In Chapter-1, the research study is being predicted for the stock price of activate companies in Tehran Stock Exchange (Iran) using General Regression Neural Network (GRNN) and Linear Regression (LR). At first, 10 macro economic variables and 30 financial variables are considered and then using Independent Components Analysis (ICA) results are shown that has input obtained from seven final variables which includes three macro-economic variables and four financial variables. The findings presented two models for stock price prediction. The results have shown that artificial neural network method is more efficient than linear regression method.

In recent years, many researchers have introduced various methodologies and theories to explain and analyze stock market data. However, Chapter-2 tries to explain that the stock market is a very complex system. The complexity of the stock market increases the difficulty of testing any hypothesis relating to the market. For instance, the linear time series models are used for presenting stock market data rarely produce satisfactory results. In this study, the application of wavelet transform (WT) on identifying structure break for stock market data is explored. In doing so, this study hopes to acquire a better understanding of the information adaptation process by focusing on using time scale analysis to study structure break behavior of stock market through decomposing stock market into a scale domain. Results indicate that WT manage to uncover structure breaks behavior in monthly Amman Stock Exchange (ASE) Index from 1998 until 2009. In addition, these structure breaks represent some of the economic and financial events that affect ASE.

The purpose of Chapter-3 is to define a conceptual model representing the stock market in the micro level. This model is essentially based on cognitive behavior of the investors. In order to validate this new model, an artificial stock market simulator is built based on agent-oriented methodologies. The proposed simulator includes the market supervisor agent who executes transactions via an order book and various kinds of investor agents depending to their profile. The target of this simulation is to understand the influence of psychological character of an investor and the effects of his neighborhood on his decision-making and their impact on the market in terms of price fluctuations. Interactions between investors and information exchange during a transaction reproduce the market dynamics and organize the multi-agent based pricing. The resulting simulation system is a tool able to numerically simulate financial market operations in a realistic way. Simulation experiments are being performed to observe stylized facts of the financial times series and to show that the psychological

attitudes have many consequences on the stock market dynamics. These experiments show that representing the micro level led to observe emergent socio-economic phenomena at the macro level.

Chapter-4 proposes a fuzzy approach for evaluation of composite financial stability index and fuzzy Markov model for analysis and forecast of financial situation. The methods are demonstrated through application of factual and estimated financial and macroeconomic information of the Azerbaijan Republic.

In Chapter-5, the authors try to evaluate the performance of DEoptim on a high-dimensional portfolio problem. The setup is the same as in the R Journal article Ardia et al. (2010); namely minimizing the portfolio CVaR under an upper bound constraint on the percentage CVaR contributions. Because the resulting optimization model is a non-convex programming problem with multiple local optima, DEoptim is more apt in solving this problem than gradient-based methods such as optim and nlminb.

Chapter-6 aims to develop a forecasting methodology on sector success evaluation (SSE) relating to job creation potential which is denoted with the difference of company establishment and liquidation quantities in this study. Artificial neural network system (ANN) is used for identifying expected job creation potential of different sectors with respect to financial ratios such as liquidity, leverage, activity, profitability and growth ratios. The proposed system is carried out in three main sectors of Turkey (agriculture, construction and manufacturing). The relevant data concerning financial ratios is collected from Istanbul Stock Exchange data set and data concerning job creation potential is gathered from the Union of Chambers and Commodity Exchanges of Turkey. The results reveal that ANN is a successful decision making tool that can help managers on expected success of sectors, compare expected and real job creations and make their strategic planning more effectively. Furthermore, it is identified that "fixed assets turnover" as an activity ratio that has the highest impact on sectorial success and the changes should be frequently followed. In contrast, "current assets/total assets (%)" and "net profit margin growth rate (%)" have the lowest effectiveness on sectorial success.

In Chapter-7, the author compares nicely the performance of Black (1976), Vasicek (1977) and CIR (1985) models as benchmarks with feed forward and recurrent artificial neural networks (ANNs) in pricing Brazilian IDI calls options using daily data for the period from January 2003 to September 2008. It is the first study that evaluates the performance of ANNs in pricing Brazilian interest rate options which is one of the major emerging markets. The author measures forecast performance for all the estimated models based on summary measures of forecast accuracy. Nevertheless, he performed parametric and nonparametric statistical tests as AGS, MGN and SIGN for competing forecast models. According to the statistical tests and summary forecast measurements, ANN is superior to Black, Vasicek and CIR models in IDI calls option pricing and there are no differences between feed forward and recurrent architectures in terms of accuracy when pricing these options. The founding results suggest that ANNs may have an important role to play in pricing interest rate options for which there is either no closed-form model or the closed-form model is less successful as in Brazilian case.

In Chapter-8, an attempt is made in predicting the Shanghai Composite Index returns and price volatility on a daily and weekly basis. Here two different types of prediction models namely the Regression and Neural Network models are used for prediction of task where multiple technical indicators are included in the models as inputs. The performances of the two models are compared and evaluated in terms of directional accuracy. Their performances are also rigorously compared in terms of economic criteria like Annualized Return Rate (ARR) from simulated trading. Here, both trading with and without short selling has been considered and the results show in most cases, trading with short selling leads to higher profits. Also, both the cases with and without commission costs are discussed to show the effects of commission costs when the trading systems are in actual use.

Chapter-9 explores the use of variants of Self Organizing Maps to simulate agent's interaction in social systems. The efforts were mainly concentrated to model agents learning and psychological relationships as well as the way latter can affect the system general behavior. Lastly, the authors have developed a suitable environment to simulate economic systems dynamics, totally based on models inspired on the approach of self-organization in cortical brain models.

In Chapter-10, a GMDH-type neural network and genetic algorithm is developed for stock price prediction of cement sector in Iran. For stocks price prediction by GMDH type-neural network, the authors are have used Earnings Per Share (EPS), Prediction Earnings Per Share (PEPS), Dividend Per Share (DPS), Price-Earnings ratio (P/E) and Earnings-Price ratio (E/P) as input data and stock price as output data. For this work, data of ten cement companies is gathered from Tehran Stock Exchange (TSE) in decennial range (1999-2008). GMDH type neural network is designed with 80% of the experimental data. For testing the appropriateness of the modeling, reminder of primary data are entered into the GMDH network. The last results are very encouraging and congruent with the experimental results.

In Chapter-11, the authors emphasize on the problem of estimation of volatility of Indian Stock market. It begins with volatility calculation by Auto Regressive Conditional Heteroscedasticity (ARCH) & Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models for financial computation. At last the accuracy of using Artificial Neural Network for this is examined and concluded that ANN can be used as a better choice for measuring the volatility of stock market.

The last Chapter-12, aims at applying different methods i.e GARCH, EGARCH, GJR-GARCH, IGARCH and ANN models for calculating the volatilities of Indian Stock markets. Fourteen years of data of BSE Sensex and NSE Nifty are used to calculate the volatilities. The performance of data exhibits that there is no difference in the volatilities of Sensex and Nifty estimated under the GARCH, EGARCH, GJR-GARCH, IGARCH and ANN.

I hope the disseminated and collected information will be handy and useful to the financial researchers, analysts, risk managers, practitioners and mostly to the students' community delving in this area.

Dr. Jibendu. K. Mantri

CHAPTER 1

# A Comparison Analysis for Prediction Stock Price: GRNN and LR Models

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# A Comparison Analysis of Modeling Stock Price Prediction: GRNN and LR Models

**Abstract**

This study predicted the stock price of activate companies in Tehran Stock Exchange (Iran). For reaching this purpose, General Regression Neural Network (GRNN) and Linear Regression (LR) have implemented. At first, 10 macro economic variables and 30 financial variables selected and then using Independent components Analysis (ICA) obtained seven final variables, which including three macro economic variables and four financial variables. The findings presented two models for stock price prediction. The results have shown that artificial neural network method is more efficient than linear regression method.

**Key Words:** Prediction, Financial Market, Artificial Neural Network, Stock Price

## 1- Introduction

The important characteristic of developed countries is that their money and capital market is active and dynamic. On the other hand, in any economic system, a group with more activity and proper saving earn more for the future (Ritanjali & Panda, 2007). How to use the savings can have positive or negative effects for the community. If these savings direct with a proper mechanism to production line, besides the efficiency it can bring to the owners of capital as the main supply also it will be useful to establish investment projects in economy (Widrow et al, 1994). If this money enters to unhealthy economic flow, it will have some inappropriate effects for the community. It has seen in most countries where the volume of liquidity in the hands of the people is a lot , the most important task for the country's economic officials is guiding, absorbing and creating conditions to increase the efficiency of these monetary resources for the whole community (Chen & Dua, 2008). One of the most important tools, which have the ability to absorb this liquidity, is "Stock Exchange". In this issue, stock exchange and buying and selling mechanism play an important role, because the owners can operate their capital with expected return by purchasing stock, and on the other hand ,they can have participation in supplying finance resources for the country's industry (Manne, 1966). Owners of small capitals are not able to get good returns from their investment and not the size of today's economy will allow them to have the power to produce alone or to move the wheel of community's economy. But if an appropriate mechanism collects these small assets, high efficiency can bring to the community; therefore, stock exchange is the economic institutions of society in developed countries and its operations is one of the important indicators that reflects economic- social conditions of these countries. Any insecurity in the stock market could lead to huge economic crisis.

The financial forecasting or stock market prediction is one of the hottest fields of research lately due to its commercial applications owing to the high stakes and the kinds of attractive benefits that it has to offer (Ritanjali & Panda, 2007). Unfortunately, stock market is essentially dynamic, non-linear, complicated, nonparametric, and chaotic in nature (Tan et al., 2005). The time series are multi-stationary, noisy, random, and have frequent structural breaks (Oh & Kim, 2002; Wang, 2003) . In addition, stock market's movements are affected by many macro-economical factors such as political events, firms' policies, general economic conditions, commodity price index, bank rate, bank exchange rate, investors' expectations, institutional investors' choices, movements of other stock market, psychology of investors, etc (Miao et al., 2007; Wang, 2003). The ability to accurately predict

the future is fundamental to many decision processes in planning, scheduling, purchasing, strategy formulation, policy making, and supply chain operations and stock price. As such, forecasting is an area where a lot of efforts have been invested in the past (Armstrong, 1988). Yet, it is still an important and active field of human activity at the present time and will continue to be in the future

Forecasting has been dominated by linear methods for many decades. Linear methods are easy to develop and implement, and they are also relatively simple to understand and interpret. However, linear models have serious limitation in that they are not able to capture any nonlinear relationships in the data. The approximation of linear models to complicated nonlinear relationships is not always satisfactory. In the early 1980s, Makridakis et al (1982), organized a large-scale forecasting competition (often called M-competition) where a majority of commonly used linear methods were tested with more than 1,000 real time series. The mixed results show that no single linear model is globally the best, which may be interpreted as the failure of linear modeling in accounting for a varying degree of nonlinearity that is common in real world problems. Artificial neural networks are one of the technologies that have made great progress in the study of the stock markets. The most important feature of neural networks is to analyze the mass of information about issues that they are not known, the economic issues are just such situation. Usually stock prices can be seen as a random time sequence with noise, artificial neural networks, as large-scale parallel processing nonlinear systems that depend on their own intrinsic link data, provide methods and techniques that can approximate any nonlinear continuous function, without a priori assumptions about the nature of the generating process (Pino et al., 2008). It is obvious that several factors are effective on future stock price and the main weak point in this surrey is that all of them considered a few limit factors in future stock price and using linear methods, Regarding that fact, although previous studies highlighted the problem to some extent, none of them provide a comprehensive model to estimate the stock price. If one estimates the prince and provides a model for it to eliminate uncertainties to a large extent, it can help to increase the investments in stock exchange. Conducting the scientific surveys to obtain a suitable and desirable model to estimate the stock price is the best task. The aim of this study is to predict stock price using classical prediction methods (linear regression) and neural networks to identify the most effective method in predicting stock prices.

## 2- Literature Review

In this section, we consider other studies in relation to classical and neural network issues. Refenes et al., (1994) compared neural networks performance with regression models by modeling the behavior of stocks via neural networks. In this study, neural networks are considered as an alternative to classical statistical techniques and these networks have been used to predict the stocks of large companies. It is shown that neural networks have better performance than the statistical techniques, and forecast more accurately and provide a better model. Statistical models based on ARIMA (p, d, and q) model are as time series methods. It is shown that neural networks explain and describe better in predicting the behavior of stock prices and it can model the environmental conditions better than regression model. Kimand & Han (2000) in their study proposes genetic algorithms (GAs) approach to feature the discrimination and the determination of connection weights for artificial neural networks (ANNs) to predict the stock price index. Olson & Mossman (2003) have used accounting ratios by neural networks and linear regression to predict stock output in Canada. The results of this study showed that the neural network back propagation method is superior to linear regression, both in classifying outputs and also in terms of predictive power. Hamid & Iqbal (2004) presented a primer for using neural networks for financial forecasting. They compare volatility forecasts from neural networks with implied volatility from S&P 500 Index futures options using the Barone-Adesi and Whaley (BAW) American futures options pricing model. Abbaspour (2004) has performed a study to predict the stock price of Iran Khodro in

Tehran stock exchange with the use of artificial neural network. The data used in this study include daily data in the period of 2001 to 2002.Variables affecting Iran Khodro's stock prices and exchange rates include oil prices, (P/E) ratio and stock trading volume. The results indicate the priority of artificial neural network to forecast prices by the box-Jenkins. Allen & Yang (2004) examined the deviation of the UK total market index from market fundamentals implied by the simple dividend discount model and identified other components that also affect price movements. Enke & Thawornwong, (2005) introduced an information gain technique used in machine learning for data mining to evaluate the predictive relationships of numerous financial and economic variables. Neural network models for level estimation and classification are then examined for their ability to provide an effective forecast of future values. Cao et al., (2005) have used artificial neural networks in order to move the stock price changes of the Chinese market. In this way the neural network compared with the linear regression method and has concluded that the neural network serves better than the regression method. Raei & FallahPour (2006) have done a research to predict stock returns in Tehran stock exchange by the artificial neural networks and multi-factor models. Daily stock price of Behshahr Industries Development Corporation was selected as the sample. Multivariate linear regression is used for processing multi-factor model and multi-layer Perceptron is used for neural networks. The results show the superiority of the artificial neural network model to multifactor model. Wang (2007) integrated new hybrid asymmetric volatility approach into artificial neural networks option pricing model to improve forecasting ability of derivative securities price. Rashid (2007) investigated the dynamic association between daily stock index returns and percentage trading volume changes. To proceed with this, linear and nonlinear Granger causality tests are applied to the Karachi Stock Exchange (KSE) data. Chang & Liu (2008) in their study used an integrated system, CBDWNN by combining dynamic time windows, case based reasoning (CBR), and neural network for stock trading prediction. Hsu & Hsieh (2008) employed a two-stage architecture for better stock price prediction. Zhang & Wu (2008) proposed an improved bacterial chemo taxis optimization (IBCO), which is then integrated into the back propagation (BP) artificial neural network to develop an efficient forecasting model for prediction of various stock indices. Chen & Du (2009) adopted the operating rules of the Taiwan stock exchange corporation (TSEC) which were violated by those companies that were subsequently stopped and suspended, as the range of the analysis of this research. De-Faria & Gonzalez (2009) in their work performed a predictive study of the principal index of the Brazilian stock market through artificial neural networks and the adaptive exponential smoothing method, respectively. Araújo (2010) presented a hybrid intelligent methodology to design increasing translation invariant morphological operators applied to Brazilian stock market prediction. Daim et al., (2011) evaluated the effectiveness of neural network models which are known to be dynamic and effective in stock-market predictions. The models analyzed are multi- layer perceptron (MLP), dynamic artificial neural network (DANN) and the hybrid neural networks. Chang (2011) in his study used the artificial neural networks (ANN), decision trees, the hybrid model of ANN and decision trees (hybrid model), the three common algorithm methods used for numerical analysis, to forecast stock prices. The author compared the stock price forecasting models derived from the three methods, and applied the models on 10 different stocks in 320 data sets in an empirical forecast. Dai et al., (2012) in their research, a time series prediction model by combining nonlinear independent component analysis (NLICA) and neural network is proposed to forecast Asian stock markets.

**3- Objectives**

The present study attempts to undertake the best method of forecasting between artificial neural network and classical linear regression methods to determine stock price for companies listed in Tehran Stock Exchange. For reaching this objective, we consider;

I) Determine the main variables to estimate future stock price of companies acting in stock exchange.

II) Price estimation using two methods of artificial neural network and linear regression and comparison of these two methods' results.

## 4- Research Methodology

### 4-1- Sample Unit

The sample of the present study includes all companies, which were activated in Tehran stock exchange during 2004-2010. Therefore, those companies whose symbol was not active during this period were omitted and finally, 100 companies were chosen. The scope of subject in this study includes the consideration of the relationship between macro economic and financial variables with stock future price.

### 4-2- Data Collection Method

In this study, we used 10 macro economic variables and 30 financial variables to study their effects on stock future price. Data related to macro economic variables were collected through Central Bank yearbook, economic reports and balance sheet of Central Bank and Monetary and financial Research Center of Iran Central Bank and data related to companies financial variables collected through companies financial statements send informational Agency of Tehran(Iran) stock exchange.

### 4-3- Methodology Steps

a) Identifying related factors and omitting additional variables (among macro economic and financial variables) through the analysis of independent components.
b) Modeling and estimating stock future price through the linear regression equation.
c) Modeling and estimating stock future efficiency using General regression neural network.
d) Comparison of result related to these methods.

#### 4-3-1- Independent Components Analysis (ICA)

To estimate financial time series, it is necessary to use a set of continuous descriptive input variables among a very huge set of primary inputs. It is difficult to choose a significant and suitable subset of input variables. In several scientific fields, it is difficult to find a reasonable transfer for a huge set of multi-data. Our purpose is to use a technique to summarize independent components of time series in a set of variables which is named independent components Analysis (ICA). This method will decrease the number of descriptive variables by decreasing a set of financial and economic information into smaller subsets of independent components and maintaining the suitable information. Removing the random elements from each data set will facilitate the identification of relationship between independent components and stock indexes. Independent components Analysis are process to summarize a new set of statistical independent components in a guide vector. These components will show some estimations of data main resource. This process supposes a matrix of time series which includes a compound process; so that, this process will analyze the independent components by creating a matrix when we enter them, and identify the related and unrelated components and provide us with the best matrix of estimative variables.

This technique will summarize as follows:

- This technique will summarize independent components of time series in a set of variables.
- This technique will find a way to change data with the minimum statistical dependency among the summarized components into a linear data.
- If two random variables are unrelated, they will not be independent.
- This technique is so special for analysis and estimation which uses two matrixes of data covariance and data changes by increasing the arrangement of linear and non-linear regression

**4-3-2- Linear Regression**

If researchers want to estimate the dependent variable by one or more independent variables, they will use a linear regression model. This model will be shown as follows;Amount of P for each set of data will result in minimum $\mu$ .When ever we use standard scores instead of raw variables in the analysis, P regression coefficients will be shown as B.

Linear regression can be a method to estimate a set of time series. Average of financial and macro economic variables of identified resources in the beginning of each year are independent variables in these estimations. Dependent variables Q are the real output of the company in estimation model, which depend on price data of all stocks in our sample. Dependent variable will be estimated using regression step method (OLS). All independent variables will enter to the regression equation. These independent variables with P-values more than 5% will be omitted in estimation period and at last, we will choose a subset of independent variables. Olson & Mossman state that variables of 3 to 7 independent variable will show the best estimations for this period. According this study if step solution method chooses more than eight independent variables, P–value will be decreased to 3% or 4%, and if step solution method chooses one or two variables, P- value will be increased to 10% to include more variables.

$$Q_{j,t} = \sum_{i=1}^{k} P_{i,t} * F_{j,i,t-1} + u_{j,t} \qquad (1)$$

K = The number of independent variables
P = Regression coefficient of independent variable I in month t
$F_{j,i,t-1}$ = Independent variable I for stock j at the end of previous period (month t-1).
$Uj,_t$ = Error terms for each regression
Qj, t = Price of (dependent variable) stock j in month t.

**4-3-3- General Regression Neural Network**

General Regression Neural Network (GRNN) can approximate any arbitrary function from historical data. The major strength of GRNN compared to other ANNs is that its internal structure is not problem dependent.

***Topology of GRNN***

- GRNN consists of four layers:
- The first layer is responsible for reception of information.
- The input neurons present the data to the second layer (pattern neurons).
- The output of the pattern neurons are forwarded to the third layer (summation neurons).
- summation neurons are sent to the fourth layer (output neuron)

***We can summarize this model as:***

- This model will consider a few non- linear aspects of the estimation problem.
- This network model will be taught immediately, and will be suitable for scattered data.
- First, data will be clustered to decrease the needed layers in hidden layer.
- This model enables to solve any problems in monotonous functions.
- This model can not ignore non-related inputs with out the main revisions in the main algorithm.

**5- Factors for Comparison of Two Methods**

In time series, conforming of estimation model to data pattern is very important. We can obtain the conformity of estimation method with data pattern by calculating estimation error during the time period. For example, when a technique of evaluation estimates the periodical and seasonal alternations in time series, then estimation error will show the disordered or random component in time series. Mean Square Error (MSE) index is obtained through dividing total error differences square by time series. Mean Absolute Percentage Error (MAPE) is an index, which will be used whenever estimation of error based on percent is more suitable. Determination coefficient ($R^2$) is the most important factor, which can explain the relationship between two variants

**6- Choosing Final Variables among Primary Variables**

40 financial and macroeconomic variables will enter independent components analysis method:

**A. Macroeconomic Variables**

Growth rates of industrial production
Interest rate
Inflation rate
Exchange rate
Rate of return on stock public
Unemployment rate
Oil price
Gross Domestic product (GDP)
Money supply 1 (M1)
Money supply 2 (M2)

**B. Financial Variables**

Book value per share
Sales per share
Earning per share
Cash flow per share
Inventory turnover rate
Annual average volume of daily trading relative to annual average total market capitalization
Dividend yield
Dividend payout ratio
Dividend per share

Total of sales to total assets
Bid – ask spread
Market impact of a trade
Price per share
Trading volume
Turnover rate
Commission rate
Indicator variables for the day of the week effect
Holiday effect
January month
Amortized effective spread
Price history
Past return
Size of firm
Ratio of total debt to stockholder's equity
Pastor measure
Ratio of absolute stock return to dollar volume
Market depth
Ratio of net income to book equity
Operating income to total assets
Operating income to total sales

Independent Components Analysis (ICA) method chooses variables with minimum statistical dependency and explanation strength, and then we chose 40 variables.

**C. Financial Variables**

Earning per share
Size of firm
Ratio of total debt to stockholder's equity
Operating income to total sales

**D. Macroeconomic Variables**

Inflation rate
Money supply 1 (M1)
Growth rates of industrial production

**7- Results**

Here, we show the results of two methods and the models created by linear regression and neural network methods and comparison of the models' results using the above-mentioned factors.

**7-1- Estimation of Linear Regression Model**

**Table 1: Model Summary**

| Durbin-Watson | Std. Error of The Estimate | Adjusted R Square | R Square | R |
|---|---|---|---|---|
| 2,013 | 83,487569 | 0,211 | 0,279 | 0,368 |

A Predictors: (Constant), EXCHANGE, DEPT, EPS, SOF, INFLATION, M1,B Dependent Variable: Stock Price

**Table 2: Table of ANOVA**

| Model | Sum Squares | df | Mean Square | F | sig |
|---|---|---|---|---|---|
| 1 Regression<br>Residual<br>Total | 381258,653<br>287923,471<br>326214,368 | 7<br>1117<br>1123 | 441,257<br>382,186 | 5,0<br>09 | 0,000a |

a. Predictors: (Constant), EPS, SOF, income, inflation, M1, Dept, ratio

**Table 3: Table of Coefficients**

| Model | Un-standardized Coefficients | | Standardized Coefficients | t | sig |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| 1 (Constant) | -14,61 | 39,216 | | -2,498 | 0,459 |
| ratio | 2,009 | 0,843 | 2,138 | 3,181 | 0,001 |
| inflation | 7,162 | 3,728 | 0,179 | 2,772 | 0,005 |
| income | -0.208 | 0.096 | -0,022 | -0,532 | 0,066 |
| Dept | 0.0309 | 0,223 | 0,031 | 1,991 | 0,042 |
| SOF | -0,0001 | 0,001 | 0,027 | 2,107 | 0,047 |
| EPS | 0,189 | 0,005 | 0,184 | 2,987 | 0,001 |

a. Dependent Variable: stock price

$$\mathbf{Y=-14.61+2.009X_1+7.162X_2+0.0309X_3-0.0001X_4+0.189X_5} \quad (2)$$

Y: stock price
$X_1$: Growth rate of industrial products
$X_2$: Inflation rate
$X_3$: Ratio of total liabilities to stockholders pay
$X_4$: Company's degree
$X_5$: Earning per share

As it is observed financial variable of operational income to total selling are not mentioned in the model, because of a variable to be meaningful and mentioned in the model, "t" should be more than 1.98 and "Sig" less than 0.05, respectively. Therefore, the significance level for this variable is more than 5% and t-value is (-0.532), so this variable will not be mentioned in the model.
According to the tables, which calculated by algebra method, multi correlation factor (R) is 0.368. That is, 0.368 correlations between independent variables and dependent variables. This means that independent variables which remained in regression equation have 0.368 significant relationships with stock price.Determination coefficient ($R^2$) or (Pearson's correlation coefficient) shows a ratio of total dependent variable changes, which are calculated by dependent variables of the equation. So, in dependent variables could estimate 0.279 variance of dependent variable (price). Moreover, according the B standard coefficient one can say growth rate variable of industrial products (Beta = 2.138) in a significant level 0.001 is the most descriptive for dependent variable value or stock price.

### 7-2- Estimation of General Regression Neural Network Model

To estimate General Regression Neural Network Model, we consider seven variables obtained from dependent components analysis as input (P) and stock price as output (T). Also, we calculated spread = 0.8326, because spread of more than one will cause in hyper fitting of network and a larger region of input to output vector, and its very small value will cause in increase of estimation error. In a way that function will have a high slope and neuron which weights are more similar to its input will have more outputs than other neurons. In this network, member of input vector (P) will be calculated for all neurons and will be calculated for transfer function (sigmoid function) and the output will be gained after multiplying in weights vector and adding to bias, and this output will be a vector. We used a three-layer general regression neural network which had seven neurons in internal layer and 14 neurons in middle layer and one neuron in external to design. After using learning algorithm and network education of 37 educational periods, network error graph is as follows.

#### 7-2-1- Model One

Is an estimated model which is not educated and has its own real error?

$$\mathbf{Y=-8.11+\ 1.83X_1-0.000011X_2+7.16X_3+2.07X_4-.00008X_5+0.957X_6+0.243X_7} \quad (3)$$

#### 7-2-2- Model Two

- Which is obtained through using learning algorithm in model One which has the minimum error.
- LM learning algorithm was chosen which has the most adaptability to all survey aspects.
- Value of SPREAD = 0.8326 was used because spread value of more than one will case in hype fitting in network and a larger region of input to output vector, and its very small value will cause in increase of estimation error.
- We used a three–layer general regression neural network, which had seven neurons in internal layer, 14 neurons in middle layer and one neuron in external layer to design.

(4)

$$\mathbf{Y=-11.07+4.11X1-0.000009X2+6.74X3+1.31X4-0.0007X5+0.39X6+0.131X7}$$

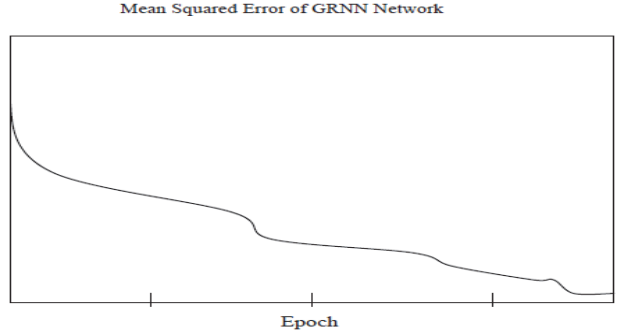


**Fig1: Mean Squared Error of GRNN Network**

## 8- Conclusion

### 8-1- Comparison of two Methods Results

As it is shown in the table below, value of Mean Square Error, Mean Absolute Percentage Error and Determination Coefficient will be decreased significantly after using training in neural network, which will be shown the increase of estimation factor in trained neural network.

**Table 4: Compare of two methods**

| Factors | $R^2$ | MAPE | MSE |
|---|---|---|---|
| **GRNN** | 0,71 | 1,42 | 76,2 |
| **LR** | 0,368 | 3,73 | 97,6 |

After using LM algorithm and network training, above statistics will be changed as follows;

**Table 5: Compare of two methods after using LM algorithm**

| Factors | R2 | MAPE | MSE |
|---|---|---|---|
| **GRNN** | 0,98 | 0,78 | 31,6 |

In this survey, we chose 100 companies of high quality in Tehran stock exchange, and according to results we understand that artificial neural network method is better than linear regression method in estimation. Models based on neural networks can appropriately simulate the behavior of stock prices and offer a model which is closer to reality than classic methods. Thus, this study shows the superiority and priority of the non-linear models on linear models. The result of this analysis indicates that investors can use scientific methods to predict stock price, and so their investment can be successful in the Stock Market. According to the results of research, stock prices can be predicted with minimal error using artificial neural network. So, the investors using the inputs listed in the pages before can be easily obtained, and being familiar with MATLAB software can predict stock price of the companies present in stock exchange.

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