Identifying the financial ratios influencing the explanation of firm values using genetic algorithm and neural networks

Maryam Gavara*, Mahmoud Moeinadin, Ramin Abghari

1- M.A, Department of Accounting, Yazd science and Research Branch, Islamic Azad University, Yazd, Iran. 2- Assistant Professor, Department of accounting, Yazd Branch, Islamic Azad University, Yazd, Iran. 3- Assistant professor, Department of engineering, Yazd Branch, Islamic Azad University, Yazd, Iran.

*Corresponding author E-mail: Maryam_Gavara@yahoo.com

Abstract

Based on the theoretical foundations of financial reporting, the primary objective is to help investors make economic decisions. One of the most important decisions is to sell and buy stock, which is in turn a function of the value of investee. Company valuation and identifying the factors contributing to it in capital markets have been always a challenging issue for investors and financial analysts. They are also seeking the identification of the contributory factors in firm value so as to control the factors and carefully determine firm value. In this study, 68 financial ratios for 122 firms from 2008 to 2012 have been examined. Using genetic algorithm, contributing ratios have been identified, then using the techniques of neural network, 23 selected ratios were used to estimate the values of companies. The results of the study indicate that the financial ratios are capable of explaining the 96.9% of firm value.

Key words: firm value, financial ratio, genetic algorithm, neural networks.

Introduction

In recent years, many accounting studies attempted to look at the relationship between certain accounting variables, such as book value per share, earnings per share, stock return, return on equity, and the value of stock market. On the other hand, the theories offered as to capital markets suggest the significance of information disclosure and its role in the efficiency of capital market. The studies conducted in this respect have stressed the effect of information disclosure on the efficiency and pricing power of markets. The matter of reporting and the disclosure of financial information and their effects on the value of stock market have received many accounting and financial management researchers’ attention in developing countries. The major goal of many of these researchers is to recognize the extent to which investors use financial reports and their reliance on these types of reports in the course of making decisions about purchasing and selling companies’ shares. The importance of financial reports and letting them exposed are coming from information that such reports on the performance of companies are made available to public users; particularly the information suggesting a company’s power of profitability. Such information and a great deal of exposed information in financial statements are of special importance to the sponsors of financial resources and investors. Raffournier and Dumontier (2002) stated that accounting data are suitable measures about firm performance, when their effects on stock price are observed. In this case, they are relevant figures and making use of the data can provide relevant information on the value of company, which in turn has a close link with market prices.

Given investors, managers, and other potential users' economic decisions and the emphasis of Financial Accounting Standard Board on providing useful information about such decision makings, one of the most important of which is related to investment in stock and is a function of the value of investee. The identification of contributing financial ratios in explaining firm value is essential. To put differently, investors seek to take advantage of market inefficiencies; that is to say, they may detect a share, thereby buying it, while its value is less than its actual determined one. Companies take action to issue stocks for further financing when the value of stock market is high and they take action to redeem shares when the value is low (Baker and Vergler, 2002). On the contrary, managers are planning out steps that determine the future of company in order to maximize firm value under their leadership. The study represents the importance of information disclosure and financial reporting and accounting variables to Stock Exchange Organization. The
idea that accounting data can have a role in determining company’s value is first raised by financial analysts. In an attempt to evaluate securities, analysts utilize fundamental analysis and technical ones. The further fundamental analyses are based on determining firm value through the data derived from financial statements. Fundamental analysts endeavor to determine the intrinsic value of securities by examining the factors associated with company’s value (Javadi, 2007). Moreover, the study dealt with the recognition of the most financial ratios for explaining the market value of company so as to let potential investors of Tehran Stock Exchange rely on them in the course of making decision.

**Research literature**

At this part, theoretical foundations associated with company’s value are discussed and in what follows genetic algorithm and neural network are briefly explained.

- **Firm value**

  It represents the wealth of shareholders and it is conceived as one of the measuring measures of performance with respect to balanced evaluation approach (Hashemi et al, 2011). Firm value is achieved when the company creates interest for its main beneficiaries. By beneficiaries, we mean those who receive benefit from company, which include shareholders, creditors, suppliers of raw materials, employees, clients, tax authorities. Classics view firm value as the beliefs that help company choose objectives and available course of actions or as a weight decision makers give to their alternative goals (Asgarzadeh, 2011).

- **Genetic algorithm**

  It is based on Darwin’s theory of evolution and its application rests upon natural genetics. The basic principles of genetic algorithm were offered by Holland et al in 1962. According to this, beings endowed with greater compatibility with environment can greatly survive and reproduce, consequently the odds of their presence in coming generations go up (Mosa-Zadegan and Zekri, 2008). Genetic algorithm is a set of computational methods which are employed for optimization and searching issues (Goldberg, 1989). Generally speaking, genetic algorithms are utilized for issues for which there is no rigorous algorithm, though there is the possibility of investigating how true a candid answer is for that matter (Montana et al, 1989). The application of genetic algorithm requires the explanation of each response to a special problem in the form of a string of figures. Each of the string that actually represents one of the answers to the problem is called chromosome and the numbers incorporating into it is called gene. Genetic algorithm begins with a number of different answers which form the primary generation. The number of these responses are fixed as in reiterations and coming generations, but their quality will gradually get better. For each generation, the responses are measured with the help of a target function, based on which the next generation is formed. Thus for creating the next generation, a series of responses are directly transferred to it as some other turn into new responses by causing a mutation in their chromosomes, they are also transferred to their next generation. Indeed, genetic algorithm is a quest for desired solution and relevant issues in computer science (Dastgir et al, 2011).

- **Neural networks**

  The neural networks are of dynamic systems which transfer the hidden knowledge or rule to the structure of network by processing the experimental data and based on the calculations of numerical data or samples, they acquire the general rule (Russell, 1995).

  The artificial neural networks can extract the relations between the data by analyzing them and estimate their amount by applying it in exchange of any new data. So the artificial neural networks in applied to estimate the non-linear functions (Rostamitabar, 2007). Each artificial neural network consists of the processing elements which are called the artificial neurons. These neurons can be organized to form the structure of the network by means of different methods. Each artificial neuron obtains the data, processes them and delivers an output signal. The input can be either the raw data or the output of the other processing elements. The output can be either the final product or the input for other neuron [Coates,1991, Demuth,2004].

**The research background**

Ohelson (1995) has reached a new way of stock market which is different from former methods. In his research, the relationship between the variables of book value per share, profit per share, dividends per share, fixed assets, revenues, operational assets, operating cash flows, and capital costs, and the value of stock market has been examined. Tom and Ohelson’s study constitutes the relationship between the value of stock market and accounting information, particularly the one about financial activities. It was served to measure information and accounting indicators through the variables of book value per share, profit per share, the dividends distributed, fixed assets, expenses, net income from ongoing activities. In this study, a
linear regression method was employed, which follows a significant relationship between market value per share and the variables related to financial activities.

Bernard (1995) was among the first persons who measured the relevance value of accounting information by a numerical scale. He compared the explanatory ability of a model for which share price was a function of book value and profit with that of another model for which share price was only a function of dividend. The results of the study showed that accounting variables take priority over dividend and have high explanatory ability. This was interpreted as the benefit of the relationship between accounting information and company’s value. Likewise, another researches examined many of these relationships, such researches as that of Fama (1995, 1998) and that of Fair who studied the relationship between accounting variables such as size, economic unit, book value per share, profit per share and market value per share, which followed there is a significant relationship between the variables, such as future business profit, business size, and book value per share and market value per share.

Rafik and Ezolddin (2006) studied the relevancy of accounting profit and its components to evaluate company on the Stock Exchange of Tunisia. They obtained evidence that suggest the relevance of operating profit, profit before tax, exceptional items and tax revenue so as to evaluate the company.

In a study, Hadi (2006) examined the relevancy of accounting levels and profit components. The levels and profit components of accounting include: sales, gross profit, operating profit, profit before tax, and net profit as independent variables and the ratio of market value to book value as dependent variable. The results of the research showed that the components of accounting profit has a relation to the ratio of market value to book value. Investors use various profit levels to forecast the ability to produce future cash flows (Valipour, 2010).

By investigating and explaining the relationship between cash and accrual components of accounting earnings, and firm value, Roudneshin (2005) concluded that the components of cash profit have more relevance to firm value than that of accrual one and investors and management can rely on them with a view to making desired decisions.

Pourheidari et al (2005) examined the content of the low net income and the book value of company through the level of the relationship between the profit per share and the book value per share and the price per share of listed companies in Tehran Stock exchange since 1996 through 2004. The results of the study indicated that a great deal of firm value is explained through profit and the major part of explanatory ability of the total income and the book value is because of profit and the book value of company has proper explanatory power as against profit per share.

Anvar Khtibi (2006), in his study, showed that there is a stronger relation and correlation between income variables than cash flow variables and stock return. In this study, profit metrics include: earnings before interest and tax, profit after interest and tax, cash flow metrics, which include cash flow from operating activities, cash flow from investing activities, and cash flow from financing activities.

Khajavi and Elahyari (2006) examined the information content of dividend, book value and net profit on the stock price of the listed companies in Stock Exchange, concluding that the variables of book value and dividend have explanatory power almost similar to the variables of book value and reported profit. The book value has less explanatory power than other two variables.

In a study, Baraton et al (2008) dealt with the investigation of the information content of a set of financial performance parameters, which are often extracted from profit and loss statement. 46 different countries have made up the statistical population of the research throughout 1996 to 2005. They indicated that the relevancy of evaluating parameters to firm value is different from a variable to another and from a country to another. However, as a whole, operating profit bears the highest relation to firm value, as opposed to items such as sales income, comprehensive income, which have the lowest ability to explain firm value.

Kim et al (2008) examined the relevancy of reported earnings and the stock value of companies. Focusing on the changes in profits, they first specified the reasons and categorized companies in this respect, coming to the conclusion that the change in profit can be relevant information for investors if it is as a result of a change in the extent of sales, and if through other causes the profit of company changes, this has no effect on investors’ judgment about firm value.

Abba-Ibrahim et al (2009) demonstrated that accounting earnings and book value constitute a lot of information, which is relevant to company evaluation. As a whole, accounting estimates have a slight deviation from firm value with respect to market estimates. Therefore, accounting figures play a significant role in the evaluation of Malaysian companies.

Valipour et al (2010) dealt with the investigation of relevancy of the levels and components of reported earning in order to forecast firm value. The statistical population of the research was the listed companies in Tehran Stock Exchange. Based on the intended conditions for selecting sample, 49 companies were chosen throughout 1999 to 2008. The findings of the research indicate that the levels and components of loss and profit statement are considered as relevant information in relation to determining firm value. Moreover, the
relationship between the levels and components of loss and profit statement and the market value ratio to book values is more than that of Q-Tobin.

Habib (2010), in a research, attempted to examine profit and its components as well as cash flows and their relationship to firm value. His statistical population was comprised of the member companies of the Stock Exchange of Australia. He divided the sample companies into two classes in terms of size. In the first class, large enterprises were included as were medium and small companies the second class. He found out the performance evaluation parameters of the first group were much more important than that of the second group. The data of the research throughout 1992 to 2005 indicated a decrease in the explanatory ability of firm value by total income variable during the years of study.

Mir-Fakhredin (2011) examined the relationship between financial variables and the value of stock market using fuzzy regression. In this study, the investigation of the variables of the profit per share, P/E ratio and the dividend per share. The results of the research suggested that there is a positive significant relationship between the profit per share and the value of stock market as there is a negative significant relationship between the dividend per share and P/E ratio.

Rezaee Dolat Abadi (2012) dealt with the investigation of the effect of financial variables on the value of stock market in the companies of the Tehran Stock Exchange. In this study, the financial variables including rate of return on investment, and gross profit margin and sales volume have been dealt with. The results showed that rate of return on investment and sale size bear a relation to stock price and gross.

Research Methodology

The research is that of correlational. In terms of purpose, it is applied and is post-event in terms of data status. Given the purpose of the research, the main hypothesis of the research is as follows:

- Using financial ratios and the technique of neural network, we can forecast the firm value at an acceptable level.

The statistical population of the study, due to on the one hand achieving financial statements procured based on the accounting standards of the branch (Iran) and on the other hand given the time of conducting the present research (i.e. in the latter half of the Iranian calendar year starting from March 21st, 2013), included all the listed companies of Tehran Stock Exchange. This is endowed with the following characteristics simultaneously:

- In order to observe the ability to compare, their fiscal period should be set to March;
- During 2008 to 2012, no change should be made in activity or fiscal year;
- They are not associated with banks and financial institutions (investment companies, financial brokers, holding companies, and leasing);
- Stop halting transactions in the course of study
- Let their information be available

Given the restrictions, the statistical population of the study consists of 122 companies.

Moreover, with regard to the application of the neural network model, the variables of the research are about to be explained in what follows in the form of two groups dependent and independent.

Dependent variable: it is firm value. In this study, the ratio of market value to book value was used to estimate firm value. The ratio of market value to book value is preferable to that of Q-Tobin with respect to estimating firm value. It is because the results show that the ratio of the market value to the book value has reacted further to the changes in the components and levels of profit or loss statement.

The ratio of market value to book value could indeed reflect more the changes in the components and levels of profit or loss. One of the reasons that may justify it is that the ratio of market value to book value merely reflects the updated value of company’s share as against Q-Tobin which reflects the book value of debts as well as the updated value of company’s share. Since the book value of debts is based on historical items, it is viewed as an irrelevant data on the part of users and causes a fall in the relevancy of information.

In other words, Q-Tobin ratio does not represent the definition of investors for company’s value and investors invariably pay regard to market information when it comes to determining firm value (valipour et al, 2010).

Independent variables: they are financial ratios presented in table 1.
In the first place, using MATLAB software and the genetic algorithm, we identified the contributing ratios in explaining firm value. The procedure is as follows: first n (the number of required features) was inserted in the software, then a primary population is selected in a quite randomly fashion, each part of the population is kept themselves to a minimum, and finally the subsets with least errors are delivered. These subsets and the ones not being already deleted constitute the primary population for the next repeating loop. This will continue as long as error changes keep themselves to a minimum, and finally the subsets with least errors are delivered.

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In this research, the data, i.e. 68 independent variables and 1 dependent variable, are first made available to the genetic algorithm, the algorithm is set to determine n independent variables, the combination of which has the highest effect on generating the dependent variable. Then the algorithm determines the number of variable using its internal structure; after this, the data of n independent variables already selected along with the data pertaining to the dependent variable are sent to the neural networks, so that it is being instructed by the data and determines how much it is able to set dependent variable. The analysis of the artificial neural network is conducted by MATLAB.

In the present study, each time of above features form the input base of designing the neural network. Training, testing, and validating data have been considered as 70%, 15%, and 15% respectively. In order to train the network, the perceptron network has been utilized; it is the most important component of the artificial nervous system of neurons, which are inserted into three layers—input, output, and hidden. Input neurons are responsible for receiving input data. The hidden and output layers consist of information processing units. In these units, algebraic operations are performed on input data, the result of which is sent to other units in the next layer as a new entry (Kia, 2011). Selecting the number of hidden layers and their neurons does not follow a particular rule, as achieving the best arrangement calls for the comparison of the evaluation measures obtained from different tested combinations. In this study, having examined and instructed numerous neural networks, the number of a hidden layer and 25 neurons yielded the best result. The neural network learning algorithm is here Levenberg-Marquardt back propagation and layer transfer function is Hyperbolic tangent sigmoid) and output layer transfer function is Linear. The evaluation measures of the network power, for the research, are as follows;

SSE benchmark: it is calculated as follows (the less the better)

\[
\text{SSE} = \sum_{i=1}^{N} (\text{Error}_i)^2
\]

1) \(\text{Error}_i = |\text{Targets}_i - \text{Outputs}_i| \quad \text{for } i = 1 \ldots, N\)

2) \(\text{Targets}_i\): the actual values that must be anticipated, outputs: the values forecasted by the neural network, N: the number of the sample being tested

RMSE benchmark: i.e. root mean square error, it is the difference between the value forecasted by the statistical model or estimator and true value. It is a good tool for comparing prediction errors by a set of data, which is calculated as follows (the less the better)

\[
\text{RMSE} = \sqrt{\frac{\text{SSE}}{N}}
\]

R2 benchmark: the R2 value is invariably used as a base for determining the quality and usefulness of results, which is shown as follows (the higher the better): for the following expression, \(\sigma_{\text{Targets}}^2\) is the value of the target data variance.

\[
R^2 = 1 - \frac{\text{SSE}}{(N-1) \times \sigma_{\text{Targets}}^2}
\]

The results of the analysis

As explained, we first approached the identification of the contributing ratios using a genetic algorithm. The genetic algorithm was run by MATLAB. The good features (variables) are shown in table (2) by the genetic algorithm.
Table 2. The contributing financial ratios identified by the genetic algorithm

<table>
<thead>
<tr>
<th>The number of features</th>
<th>The contributing financial variables selected by the genetic algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 overriding features</td>
<td>[12, 15, 28, 32, 63]</td>
</tr>
<tr>
<td>10 overriding features</td>
<td>[12, 14, 15, 18, 28, 32, 34, 39, 63, 65]</td>
</tr>
<tr>
<td>15 overriding features</td>
<td>[12, 14, 15, 18, 28, 29, 32, 34, 39, 47, 56, 60, 61, 63, 65]</td>
</tr>
<tr>
<td>20 overriding features</td>
<td>[7, 12, 14, 15, 18, 28, 29, 32, 34, 39, 44, 46, 47, 56, 59, 60, 61, 63, 65]</td>
</tr>
<tr>
<td>22 overriding features</td>
<td>[7, 11, 12, 14, 15, 17, 18, 28, 32, 34, 39, 44, 46, 47, 56, 59, 60, 61, 63, 65]</td>
</tr>
<tr>
<td>23 overriding features</td>
<td>[7, 12, 14, 15, 18, 19, 25, 28, 29, 30, 32, 34, 38, 39, 40, 46, 47, 56, 59, 60, 61, 63, 65]</td>
</tr>
<tr>
<td>24 overriding features</td>
<td>[7, 12, 14, 15, 18, 19, 21, 25, 28, 29, 30, 32, 34, 38, 39, 46, 47, 56, 59, 60, 61, 63, 65, 68]</td>
</tr>
<tr>
<td>25 overriding features</td>
<td>[7, 11, 12, 14, 15, 18, 19, 21, 25, 28, 29, 32, 34, 38, 39, 44, 46, 47, 56, 59, 60, 61, 63, 65, 68]</td>
</tr>
<tr>
<td>30 overriding features</td>
<td>[7, 8, 11, 12, 14, 15, 16, 17, 18, 19, 21, 25, 28, 29, 30, 32, 34, 37, 38, 39, 44, 46, 47, 56, 59, 60, 61, 62, 63, 65]</td>
</tr>
</tbody>
</table>

Then each of the features obtained by the genetic algorithm is instructed by the network using MATLAB. The results obtained from the neural network are shown in table (3):

Table 3. The results obtained from the artificial neural network

<table>
<thead>
<tr>
<th>Input model</th>
<th>Regression coefficient</th>
<th>R²</th>
<th>RMSE</th>
<th>SSE</th>
<th>Efficiency percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of the features</td>
<td>0.90319</td>
<td>0.8130</td>
<td>0.0845</td>
<td>4.3508</td>
<td>90.32%</td>
</tr>
<tr>
<td>5 overriding features</td>
<td>0.82797</td>
<td>0.6822</td>
<td>0.1101</td>
<td>7.3921</td>
<td>82.78%</td>
</tr>
<tr>
<td>10 overriding features</td>
<td>0.93264</td>
<td>0.8688</td>
<td>0.0707</td>
<td>3.0522</td>
<td>93.26%</td>
</tr>
<tr>
<td>15 overriding features</td>
<td>0.93656</td>
<td>0.8773</td>
<td>0.0684</td>
<td>2.8542</td>
<td>93.66%</td>
</tr>
<tr>
<td>20 overriding features</td>
<td>0.94563</td>
<td>0.8931</td>
<td>0.0638</td>
<td>2.4866</td>
<td>94.56%</td>
</tr>
<tr>
<td>22 overriding features</td>
<td>0.96764</td>
<td>0.9290</td>
<td>0.0520</td>
<td>1.6520</td>
<td>96.76%</td>
</tr>
<tr>
<td>23 overriding features</td>
<td>0.96914</td>
<td>0.9367</td>
<td>0.0491</td>
<td>1.4718</td>
<td>96.91%</td>
</tr>
<tr>
<td>24 overriding features</td>
<td>0.95773</td>
<td>0.9140</td>
<td>0.0573</td>
<td>2.0004</td>
<td>95.77%</td>
</tr>
<tr>
<td>25 overriding features</td>
<td>0.94912</td>
<td>0.8976</td>
<td>0.0625</td>
<td>2.3823</td>
<td>94.91%</td>
</tr>
<tr>
<td>30 overriding features</td>
<td>0.87117</td>
<td>0.7585</td>
<td>0.0960</td>
<td>5.6186</td>
<td>87.12%</td>
</tr>
</tbody>
</table>
The figures of the results obtained as follows:

Figure 1. Regression coefficient

Figure 2. RMSE benchmark

Figure 3. SSE benchmark

Figure 4. R² benchmark

As in table (3), the results obtained from the neural network are seen. Once the neural network with 68 features are instructed, the network is able to explain the 90.32 percent of the dependent variable (firm value). By examining and instructing the network with different features, it was made clear that the best efficiency is related to the 23 variables identified by the genetic algorithm, which could explain the 96.91% of the firm value.

Conclusion and suggestions

The aim of accounting is to provide financial information for users in an effort to help to the improvement of making decision process. Meanwhile, the aim of conducting accounting research and studies is to evaluate how useful information is for investors and other users. Financial statements are truly important resource of information which investors need to make investment-related decisions (Hadi, 2006). In the present study, an attempt was made to examine financial information ability in explaining firm value. In this respect, 68 financial ratios were first extracted by financial statements. The statistical population of the study consisted of 122 companies listed in Stock Exchange during the years of 2008 to 2012, given the limitations. In the first place, in order to identify the contributing ratios in explaining firm value, the genetic algorithm was used by MATLAB software. The contributing features in explaining the dependent variable (firm value) have been detected and determined in accordance with the selection number. Then in an attempt to look into the ability to explain these features, the artificial neural network was used. The results of the network indicated that 23 financial variables had the best ability to explain firm value, in a sense that the 96.91% of the firm value was explained as such.

Considering the results of the study, the investors and decision makers of capital market are recommended to use the selected financial ratios and the neural network model used in this study in order to estimate the market value of companies and make decisions related to buying and selling stock. Likewise, given the confirmation of the role of financial variables in determining firm value and the special interest of capital market to financial information, the supervising organizations of capital market and the designer board of auditing organizations are recommended to make special attempt to bring as much clarity as possible in capital market and increase the quality of financial information.

Concerning the study opportunities ahead in this field, it is suggested that:

The present research be conducted separately in different industries, so that better results will be obtained by controlling the effect of industry. Moreover, we can study the financial ratios selected in this research in regression models and compare it with the results of neural networks.
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