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Article

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Provided in Cooperation with:
Danubius University of Galati

Reference: Sarikhani, Mehdi (2017). Investigating determinants of disclosure quality using artificial neural network.

This Version is available at:
<http://hdl.handle.net/11159/1435>

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Investigating Determinants of Disclosure Quality Using Artificial Neural Network

Mehdi Sarikhani¹, Seyed Mojtaba Saif²

Abstract: The purpose of this research is to propose a model for predicting disclosure quality using artificial neural network. Toward this end, this research has used the variables related to liquidity, profitability, leverage, company size, corporate governance and other effective variables by using the artificial neural network. Minimal-Redundancy-Maximal-Relevance criterion and sequential feature selection as two Feature selection methods are used to preprocess the data that could improve the accuracy of model. Results show that in the model where all variables are applied, the linear regression correlation between network output and scope data is %87. 8 while in the model where the seven variables of Ownership concentration, Assets-in-place, Age, Profit margin, Percentage of non-executive board members, Institutional ownership ratio, and Number of employees are used, this correlation stands at %92. 26. Also, these results show the significant effect of the corporate governance variables on disclosure quality.

Keywords: Disclosure Quality; Artificial Neural Network; feature selection

1. Introduction

Quality financial information disclosure, leads to decrease the degree of information asymmetry between managers and investors and plays a significant role in reducing agency costs. Also, quality information disclosure results in reducing capital cost, increasing volume of exchanges and reducing the share output fluctuation. In return, as witnessed in the recent wave of financial scandals, disclosure of weak financial information normally results in misleading shareholders and has a negative effect on their capital (Karamanou & Vafeas, 2005). Levitt (1998), Chairman of the United States Securities and Exchange Commission, believes that the success of the capital market is directly linked to the disclosure quality and accounting system. He believes that the disclosure quality of financial information results in the reliance and trust of investors on financial reporting and without this trust, market growth is impossible.

Considering the significant role played by the disclosure of quality information in the growth of the capital market, it is not clear why some companies choose to use weak disclosure procedures and some use suitable procedures. Accordingly, there have been many studies done on analyzing the determinants of the disclosure quality (Singhavi & Desai, 1971; Riahi-Belkaoui, 2001; Gao & Kling, 2012). The common trait of all these studies is the use of statistical methods like regression. In these methods, assumptions such as the linearity, normality, and also the independence among independent variables exists which makes it difficult to deduct the results (Tsai & Chiou, 2009). Therefore, the Artificial Neural Network will be used in order to resolve disclosure quality based on determinants. The viewpoint that using data mining methods like the artificial neural network which are free from many statistical assumptions, may improve the deductions and analysis (Tsai & Chiou, 2009). Also in

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this study, it is analyzed that whether use of features selection methods like minimal redundancy – maximum relevancy (mRMR) and sequential feature selection leads to better performance of the disclosure quality prediction model using the artificial neural network.

The organization of the study is as follows: first the literature review of this subject are presented in section 2. Then, the data and Research methodology are explained in section 3. Sections 4 is devoted to the discussion and conclusions.

2. Literature Review

Singhavi and Desai (1971) did a research on the effect of the number of shareholders, listing status, accounting firm size, return on equity and profit margin in disclosure quality. This study demonstrated that the corporations which disclose inadequate information are likely to be: (a) small in size as measured by total assets and number of stockholders, (b) free from listing requirements, (c) audited by a small CPA firm, (d) less profitable as measured by rate of return and earnings margin.

Riahi-Belkaoui (2001), investigated the determinants of voluntary disclosure by companies. The results showed that the disclosure scores increased in firm size, growth opportunities (investment opportunity set) and multinationality (foreign profits/total profits).

Lu and Chen (2009) in a study, used data mining methods to analyze the effective factors of the quality of information disclosure in Taiwanese companies. They employed decision tree-based mining techniques to explore the classification rules of information transparency levels of the listed firms in Taiwan's stock market.

Liu and Sun (2010) in a study analyzed the relationship between ownership structure and disclosure quality in Chinese companies. It was found that corporate disclosure quality is lower for firms ultimately controlled by individuals than for firms ultimately controlled by the state. Also, the negative effect of private ultimate ownership on corporate disclosure quality is stronger for firms with high deviation of cash-flow rights and control rights.

Omar and Simon (2011) studied the determining factors in disclosure quality. The results of the study revealed that firm size, profitability, number of shareholders, listing status, industry type, audit firm size and company age are significant variables in explaining the variation in the level of aggregate disclosure among Jordanian companies.

Gao and Kling (2012) in a investigated the effect of corporate governance and external audit on following mandatory disclosure requirements in China. Their findings showed that auditor opinions increase the compliance to mandatory disclosure requirements. Based on factor analysis, they also found that improved internal governance led to higher compliance to disclosure requirements.

Samaha et al. (2012) assessed the extent of corporate governance voluntary disclosure and the impact of a comprehensive set of corporate governance (CG) attributes (board composition, board size, CEO duality, director ownership, blockholder ownership and the existence of audit committee) on the extent of corporate governance voluntary disclosure in Egypt. The findings indicated that that—*ceteris paribus*—the extent of CG disclosure is (1) lower for companies with duality in position and higher ownership concentration as measure by blockholder ownership; and (2) increases with the proportion of independent directors on the board and firm size.

Chiu and Wang (2015) adopted a stakeholder theory framework to examine determinants of social reporting quality and empirically test the ability of the theory to explain disclosure quality in an emerging economy. The results support the application and demonstrate that measures of stakeholder power, strategic posture, economic resources, firm size, and media visibility are related to social disclosure quality.

3. Data and Research Methodology

3.1. Data

The data required for analysis was extracted from financial statements of companies which were acquired from the database of Tehran Stock Exchange.

Therefore with attention to the performed analysis, from the total of 430 companies listed on Tehran Stock Exchange, a number of 59 companies were chosen as samples to be analyzed between the period of 2003 and 2010.

Research Variables

In this study, disclosure quality was chosen as the dependent variable. The disclosure quality index is the score given to each company which is published by the Tehran Stock Exchange.

Independent Variables

Independent variables in this research are related to the important corporate governance mechanisms which are described below:

Firm Size

Some deduce that large companies prefer to disclose quality information for the following reasons:

1. They are exposed to more public scrutiny than their smaller counterparts;
2. Disclosing more information helps them to access new financial resources at lower costs;
3. They have enough resources for collecting, analyzing and presenting large sums of data with the least cost;
4. Their agency costs are high, because of their higher attraction of external financial resources, and these costs can be reduced by high quality disclosures (Alsaed, 2005).

On the other hand, some believe that large companies might abstain from presenting relevant information due to avoiding political costs -including stringent regulations, increase of taxes and social liabilities (Wallace et al., 1994). Therefore, this study has used the size of the company as an independent variable and will be measured using natural logarithm of sales and number of employees.

Leverage

Many studies show that there is a positive relationship between leverage and disclosure quality (for example: Botosan, 1997; Karamanou & Vafeas, 2005). These results can be related to the negative relationship between disclosure quality and capital cost. An increase in debt ratio increases the monitoring level of creditors. Since this monitoring comes at a cost, improving disclosure quality reduces monitoring costs which lead to a reduction of capital costs. Therefore based on the agency theory, more agency costs are burdened by companies with a higher debt ratio. Transparency of

financial statements and the disclosure quality can be used as a solution for reducing agency costs (Adelopo, 2011). On the other hand, Zarzeski (1996) concluded that there is a significant relationship between financial leverage and disclosure. He believes that companies with a high debt ratio prefer to present private information to creditors which are not disclosed in their annual financial statements. Therefore, this study uses financial leverage as an independent variable and will be measured using total debts to total assets ratio.

Profitability

Previous researches present different viewpoints on the effect of profitability on the disclosure quality. For example, Singhavi and Desai (1971) believe that high profitability creates the motivation in management to disclose more information and show their ability to increase the company's wealth and improve their bonuses. But Wallace and Naser (1995) concluded that there is a negative and significant relationship between profitability and disclosure quality. They believe that low profit companies might accept accurate disclosure as part of their responsibility towards the users of their financial reports. Therefore, profitability is used as an independent variable in this study and will be measured using return on assets and profit margin ratio.

Liquidity

There are two viewpoints on the effect of liquidity on disclosure quality. Based on the signaling theory, companies with high liquidity prefer higher quality disclosure, opposite of the agency theory which shows that companies with low liquidity disclose more and higher quality information in order to reduce the conflict between shareholders and creditors (Omar & Simon, 2011). Therefore, this study has used liquidity as an independent variable which has been measured using the current ratio.

Audit Firm Size

There is a viewpoint amongst auditors that large audit firms are more concerned about their reputation and have a higher preference to work with companies which disclose more and higher quality information in their financial reports (Wallace et al., 1994; Alsaed, 2005). Likewise, large audit firms who have a good reputation might coerce companies to disclose more and higher quality information (Raffournier, 1995). Therefore, this study will use the audit firm size as an independent variable and will measure it using dummy variables; meaning that companies which have been audited by audit firms will be given a number one and companies which haven't will be identified by a zero.

Age

Previous Studies show different viewpoints regarding the effect of age on the disclosure quality. According to Omar and Simon (2011) older companies disclose more information than younger companies, in order to attract the confidence of investors and reduce their distrust. On the other hand, Akhtaruddin (2005) believes that companies with a longer listing period in the stock exchange, considering that they have more resources and experience for increasing their popularity in the market, disclose more information in comparison to companies with a lower listing period. In this study, the company's age shows the number of years since its name has been listed on Tehran Stock Exchange.

Ownership Concentration

According to the viewpoint of the agency theory, due to the agency costs and lack of higher information asymmetry between shareholders and the company's management, information disclosure may play an important role in reducing agency conflicts in companies with dispersed ownership.

Therefore, many researchers (including Chau & Gray, 2002; Adelopo, 2011; Samaha et al., 2012) believe that companies with higher ownership dispersion disclose more information. This study measures ownership concentration from the ownership of the major shareholders (total percentage of shares held by shareholders who hold over 5% of the total shares).

Institutional Ownership Ratio

There is a viewpoint which states that the majority of institutional shareholders, through a high share of the ownership, have one or more representations in the company's board of directors which due to their access to confidential information, may not consider financial reports as important sources of information (Omar & Simon, 2011). On the other hand, Barako *et al.* (2006) have shown that institutional shareholders who hold a high share of the ownership may monitor the disclosure procedures and it may induce management to supply more information, to fulfill their expectations. Therefore, this study has used institutional ownership as an independent variable which has been measured using the percentage of the ownership held by the institutional shareholders.

Board Composition

The board of directors is the main internal control mechanism for monitoring managers. It is considered that a board of directors with a higher percentage of non-executive managers, due to their independence from the company as an employee, improves the quality of monitoring on management and likewise protects the shareholder's interests (Samaha et al., 2012). This study uses the percentage of non-executive board members in contrast to the total board members, a dummy variable of the presence of one of the non-executive board members as chairman and the presence of at least three non-executive board members in the board of directors as the index of board composition measurement.

Assets-in-Place

There is a viewpoint that the exploitation of tangible assets by managers is more difficult in comparison with the estimated value related to unknown growth opportunities. Therefore, companies with a higher percentage of tangible assets in the assets structure generally have lower agency costs therefore the need for managers to disclose financial information in these companies, as one of the solutions to reducing agency costs, is lowered. Also, there is a viewpoint that in these companies, the transfer of wealth from creditors to shareholders is more difficult, which itself lays the groundwork for reducing agency problems and thus reducing the need for financial information disclosure (Hossain and Hammami, 2009). This study measures the assets-in-place variable from the net ratio of fixed assets to the total assets.

3.2. Research Methodology

The multi-layer perceptron (MLP) neural network topology, figure 1, is the most widely used neural network typology. It is introduced by Werbos and developed by Rumelhart and McClelland (Rumelhart et al., 1987). Approximately 70% of all neural network studies have been used MLP (De Oa & Garrido, 2014). A MLP with a single hidden layer can estimate any predictive model (Funahashi 1989; Hornik, 1989). In order to predict the disclosure quality, this study uses MLP. A supervised learning algorithm based on gradient-descent is used for determining the weight of the neural network connections. This algorithm trains neural network by iteratively updating the weights of neural network until the error function reaches a local minimum (De Oa & Garrido, 2014). The error function is the Mean Square Error (MSE) in this study. The weights were initialized with small random values

before the start of every training. The initial value of the weight and the number of neurons in hidden layer are effective on the neural network accuracy (Hagan et al., 1996).

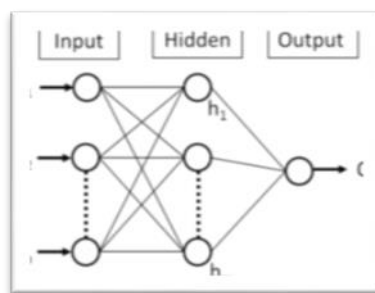


Figure 1. Architecture of a progressive neural network

(Hagan et al., 1996)

In general, the learning steps of a neural network are as follows. First, a network structure is defined with a fixed number of inputs, the number of nodes in the hidden layer and outputs. Second, an algorithm is chosen to realize the learning process. However, a fixed structure may not provide the optimal performance within a given training period. A small network may not provide good performance owing to its limited information processing power. A large network, on the other hand, may have some of its connections redundant. Moreover, the implementation cost for a large network is high. To obtain the network structure automatically, constructive and destructive algorithms can be used. The constructive algorithm starts with a small network. Hidden layers, nodes, and connections are added to expand the network dynamically. The destructive algorithm starts with a large network. Hidden layers, nodes, and connections are then deleted to contract the network dynamically (Leung et al., 2003). Therefore, a simple constructive algorithm is used for determining MLP structure in our method.

The purpose of using MLP is to find knowledge from disclosure dataset. A problem associated with neural network applications is the “Curse of dimensionality” that leads to the large number of weights in a neural network (Tabakhi et al., 2014). Therefore, the neural network performance is reduced, and the computational complexity for processing the data will be significantly increase (Theodoridis and Koutroumbas, 2008). Consequently, a method to overcome this problem is reducing dimensionality by selecting a subset of useful feature. Feature selection is the importance and frequently used technique used in preprocessing for neural networks (Tabakhi et al., 2014).

The proposed method for predicting disclosure quality consists of two stages including the determining MLP structure with a constructive algorithm and then selecting a useful subset of feature with a hybrid method.

Determining the Neural Network Structure

In order to present a predictive disclosure quality model, this study uses a MLP which includes three layers. The input layer contains 14 neurons and the output layer contains one neuron that shows the disclosure quality score. The number of hidden layers has been determined by the constructive algorithm. In this algorithm, the number of hidden layer neurons have been increased from 5 to 25 in graduation and in each case, the linear regression (R) and the model error produced from the neural network has been calculated to specify the optimum amount. A review of the results shows that if

there are 20 neurons in the hidden layer, the Correlation Coefficient will be at maximum and the error function amount will be at minimum.

Also in this model, 80 percent of the data has been used for training and 20 percent of the data has been used for test. Table 1 shows the results in the training, test and all data groups. In order to increase the productivity of the neural network and placing data in one small interval according to Kim (2003), normal data is used.

Table 1. The results without feature selection

Performance Measures	Training data	Testing data	All data
Mean Square Error (MSE)	66. 299	512. 838	144. 335
Correlation Coefficient	0. 948	0. 533	0. 878

Features (Variables) Selection Methods

Feature selection is a process of selecting a subset of most relevant features from original feature set, which leads to the increase the performance of a neural network. There are a large variety in the methods for features selection. These methods can be classified into two main categories including filter and wrapper approaches. The filter approach relies on statistical properties of the data to decide which features are relevant such as mRMR. The wrapper approach utilizes a given learning algorithm to evaluate the candidate feature subsets. Hence, the feature selection process is wrapped around the learning algorithm such as sequential forward selection (Tabakhi et al., 2014).

This study uses a hybrid of the sequential forward selection and the mRMR method proposed by Peng *et al.* (2005) for preprocess data. Table 2 shows the achieved results by using the mRMR and online processing method.

Table 2. The results by using the mRMR

Number	Variables (Features)
1	Leverage
2	Presence of one of the non-executive board members as chairman
3	Ownership concentration
4	Natural logarithm of sales
5	Assets-in-Place
6	Audit firm size
7	Age
8	Profit margin
9	Percentage of non-executive board members
10	Current ratio
11	Institutional ownership ratio
12	Number of employees
13	Return on assets
14	Presence of at least three non-executive board members in the board of directors

The order of classification of the variables in table 2 is horizontally based on minimal redundancy and maximal relevance with the objective variable (model results). In simpler terms, this order shows that if two features (variables) are used, the financial leverage composition with the dummy variable of one of the non-executive members as the chair of the board of directors is better than the financial leverage

composition with ownership focus or the dummy variable of one of the non-executive members as chair of the board of directors with ownership focus.

After determining the order of variables, we needed to select a subset of variables. Clearly, this selected subset should include variables of high importance and moreover, the neural network created from such variables must have a good performance. To find this subset, we created a subset of variables and the number of members was increased from 1 to 14, respectively. The increasing number of variables is shown on table 2. A neural network model was created for each subset. Table 3 shows the Correlation Coefficient amounts and Mean Square Error for each neural network.

Table 3. The results associated to sequential forward selection for data preprocessing

The number of variables	Correlation Coefficient	Mean Square Error (MSE)
1	0.353	545.05
2	0.348	547.67
3	0.356	543.39
4	0.476	481.43
5	0.485	476.8
6	0.497	468.81
7	0.606	393.97
8	0.779	244.4
9	0.807	224.48
10	0.431	507.7
11	0.787	266.92
12	0.813	232.6
13	0.831	203.96
14	0.849	174.53

Seven variables were selected while the sequential forward selection method was used for preprocessing. Table 4 shows the variables are selected by sequential forward selection. The acquired results from this model are presented in table 4.

Table 4. The variables are selected by forward selection method

Order	Variables (Features)
1	Ownership concentration
2	Assets-in-place
3	Age
4	Profit margin
5	Percentage of non-executive board members
6	Institutional ownership ratio
7	Number of employees

These results show that the model constructed with sequential forward selection method for preprocess data in comparison with the model constructed with mRMR for preprocess data or the model constructed without feature selection, that the result shown in table 1 show a more suitable turnover.

Table 5. The results associated to disclosure quality model with sequential forward selection for data preprocessing

Performance Measures	Training data	Testing data	All data
Mean Square Error (MSE)	55.308	455.521	125.253
Correlation coefficient	0.968	0.603	0.923

4. Discussion and Conclusion

The existence of transparent and comparable financial information is the absolute necessity of economic development and achieving an efficient capital market. Therefore, with respect to the significance of disclosure quality in informed economic decision making, by using artificial neural network and improved feature selection models, this study has tried to present a prediction of disclosure quality.

In order to present disclosure quality prediction models from Perceptron Neural Network and in order to measure these models from the error squares average indexes, linear regression correlation between the network output and objective data has been used. The acquired results show that the prediction model is comprised of all variables, linear regression correlation between network output and data target of 87. 8%. Also, this study has shown that in order to increase the efficiency and capabilities of the model, a suitable subcategory of the features (variables) has been selected and the prediction model has been presented accordingly. Hence, first by using the mRMR method, the variables have been ordered based on Minimal Redundancy – Maximal Relevance statistical features (variables), by using the target variable; then other feature selection methods like consecutive feature selection method has been used to achieve a suitable subcategory from the features (variables) at a low cost. Finally, by using these methods, 7 methods of ownership focus variable, structure of assets, age, profit margin, composition of board of directors, institutional ownership and the number of employees has been selected. The results of this study show that the model constructed with the collection of these variables along with having a linear regression correlation between network output and the target data equivalent to 92. 26% has a more suitable turnover in comparison to the model which was built with all the features (variables).

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