Analyzing financial statements of firms accepted in Tehran Stock Exchange by using if-then Fuzzy rules

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ABSTRACT

Financial statements show the summery of operational activities, financing, and the investment of companies during a financial period. The analysis of financial statements enables decision makers, lenders, investors, and managers to get an overall view of the health of the company and its competitive status. Analyzing through mathematical relations shows the relationships among the definite items of financial statements. The rules achieved in the present research showed that there exists a certain relationship between financial indexes and the decisions which will be made by the company in the future to resolve the problems. Due to the existence of ambiguities and lack of precision in accounting field and lack of paying attention to it in analyses methods carried out up to now, the present research is going to pose fuzzy logic model to remove the ambiguities and lack of precisions. Three criteria under investigation in this research were current ratio, the collection period of the claims, and flow of inventories which were analyzed by using if-then Fuzzy rule and 7 language variables of the effect of performances of them on each other. The results showed that the short time for the period of claims' collection means that there exists a suitable level of liquidity in the company and it has a direct relationship with current assets. The desirable amount of current assets and in time collection of claims will increase the sales of inventories and this would show that companies are in a good financial position.

Key words: financial ratios, flow of inventory, Fuzzy logic

INTRODUCTION

There is ambiguity and lack of precision in human judgments in many scientific courses. There are also ambiguities and lack of precision in many important aspects of accounting. The problem of ambiguities and lack of precision in accounting and auditing is related to the accounting rules and system (Namazi and Karimi, 2011). Byung (1982) believes that basically the concept of importance is not two dimensional such as black or white, or good or bad, but there are some degrees of importance which are ignored in accounting (AbouRizk and Sawhney, 1993). Yuan (2007) stated in analyzing the cost relationships, activity amounts, and profit that the traditional approaches of accounting are unable to present precise information due to the ignorance to the lack of precision and clarity in each of the variables utilized (Bernstein, 1978). Ambiguities and lack of precision are basically different from being random. Being random is related to lack of assurance about the occurrence or lack of occurrence of an incident and is
expressed in the form of probabilities. Meanwhile, ambiguities and lack of precision are related to lack of precision and lack of clarity in describing the words, occurrence of happenings, and judgments (Namazi and Karimi, 2011). Ignoring ambiguity and lack of precision in decision making models can limit the usefulness and capability of accounting models through the reduction of usefulness in identification characteristics of the incidents and their prediction power (Zariffard, 2008). The necessity of considering ambiguity and lack of clarity in science has been posed since 1920, but it had not grown much due to the lack of a strong logical basis until the year 1965 in which Lotfi-e-Asgharzadeh, original Iranian Professor in California University, proposed the theory of "Fuzzy Sets" or "multi-amounts" term for the first time to model the imprecise information and the approximation reasoning with mathematical equations which created a great revolution in mathematics and classic logic. The idea of Fuzzy sets was posed by Professor Lotfizadeh by the following expression: "We need another type of mathematics to be able to remove ambiguities and model lack of precision of the incidents, a model which is different from the theory of probabilities". Since the analysis of financial statements has been carried out by using different methods and different indexes but using the traditional methods results in defects and the problems of two values and lack of attention to the ambiguities and lack of clarity and absoluteness, the researchers tried to aggregate the two quantitative and qualitative values and used fuzzy logic in which the main goal was to prepare a basis in order to have approximate and exact reasoning (Shavandi, 2008). The present research tries to use fuzzy logic to analyze the financial statements of companies. The study of the performance of fuzzy logic in analyzing the financial statements of companies presents sensitive and valuable information and functional results to control the financial status of the companies to have a dynamic management and to perform the duty of financial reporting and to inform the investors, creditors, and stockholders. This research is going to answer the question that: Is using if-then fuzzy rules of the current ratio and the concurrent receipt period of claims effective on the flow of the inventories of firms accepted in Stock Exchange?

Research literature

Foreign Researches

Panahian (2011) used fuzzy if-then rules to analyze the ratio of liquidity of financial statements of 48 firms accepted in Tehran Stock Exchange. He used three indexes, three language variables of "low", "average", and "high" to investigate about the financial status of companies and categorize them based on the best profitability status. This model studied the status of financial statements of the companies in lack of assurance status and presented valuable results for decision makings by managers and stockholders. Dean Ting et al (1999) used fuzzy logic to form a model to study and assess the cost of new technologies in the most primitive stages of product designing. The results showed that this model needs a less amount of data compared to the traditional models. This model can consider the characteristics of elements in lack of assurance and ambiguous conditions and can reduce the amount of capabilities thought in assessing the cost of product and the process. Also the presented model can be utilized to determine the cost of any product such as the current products of the company and through the use of historical data. Seceme et al (2009) used the hierarchical fuzzy and TOPSIS analysis to assess the fuzzy performance of banking in Turkey. In this study where the goal was to suggest a multi-indexed decision making model in the form of financial and non-financial indexes in 5 big business banks of Turkey the fuzzy approach in the form of hierarchy was used to rank the priorities of financial and non-financial criteria. The results of this research showed that not only financial performance but also non-financial performance should be applied in competition and comparison among banks.

Local Researches
Haghshenas et al (2007) used the balanced assessment system in assessing the performance of information technology unit of production industries. In this research fuzzy hierarchical analysis process was used to measure the priorities of measuring criteria identified by the scholars in information technology due to the existence of ambiguity in structures of this system. The results of this research showed that fuzzy system can result in presenting performance enhancement strategies in information technology units of manufacturing companies. Momeni et al (2009) used the aggregate model of balanced assessment and fuzzy data envelopment analysis to analyze the performance of Insurance Company. In this research which was administered in Tehran province level of insurance company branches first the balanced performance of the branches was identified. Then, regarding the un-absolute data regarding performance assessment criteria, efficiency, and the real performance of the branches was measured by using fuzzy data envelopment analysis. The researchers used this aggregate model to pose appropriate strategies in order to improve and move inefficient branches into efficient ones in insurance company.

Danesh shakib and Fazli (2009) used the aggregate approach of hierarchical fuzzy and TOPSIS analysis to differentiate the successful companies from unsuccessful ones in Tehran Stock Exchange. This study which was administered in the level of the cement companies accepted in Tehran Stock Exchange through the years between 2001 and 2007 showed the superiority and high ability of the aggregate approach by separate administration of each of the techniques mentioned in assessing the performance of cement companies.

The theoretical foundations of this research

The recognition and assessment of the effect of a financial incident on the elements of accounting equation is called analysis. Analyzing is a method of trial and error. The selection of financial information, comparison, and determining the relationship between financial information, interpretation and assessment of the comparisons and the relationships identified is called financial statement analysis. Financial statement analysis entails the assessment of three features of a business unit: liquidity, profitability, and the power to repay the liabilities. A short-term creditor such as a bank first tries to make sure about the capability of the business unit to repay for the commitments. The liquidity of a business unit is a very important criterion in assessing the safety of credit payment. On the other hand, a long-term credit such as the stockholders and the owners of bonds consider the profitability and the ability to repay the liabilities of a business unit (Alinejhad-e-Sarokolaee, 2010).

Current ratio

The current ratio is extensively utilized in assessing the liquidity of a business unit and its ability in repaying the liabilities in short-term. To calculate it we divide total assets of a business unit by the total current liabilities of it.

Claims' collection period

By calculating this ratio we can determine the time or the number of the days it rakes to collect the claims of the company. Claims' collection period is a criterion to measure the time needed to collect the claims in cash resulted from the sales to the customers and it shows the efficiency of the profit entity in receipt of cashes related to the on account sales.

Inventory flow

Good is used to show materials interchangeably and includes the raw materials, goods in production phase, and the goods produced and it also entails the requirements of production. This ratio calculates the
The flow period of inventory of the company (the number of times a company sells its inventory during a year).

The flow of inventory is calculated by dividing cost of goods sold on inventory.

In denominator and instead of inventory it is better to put average goods. Average of goods is calculated by total inventory of the start of the year and inventory of the end of the year divided by 2.

Inventory flow = \frac{\text{cost of goods sold}}{\text{average inventory}}

By using this ratio we can calculate inventory flow or the number of times a company has sold its inventory during the year. Usually the higher amount of this ratio shows that the efficiency of the company in inventory management has been better. Inventory flow is compared by the average of industry. Low inventory flow means that the sales have been weak and inventory has increased and high flow of inventory means that the company has had a high sales ability.

**Fuzzy Logic**

Our real world is much more complicated than the one we can prepare a precise definition and description for. Therefore, there should be an approximate or a fuzzy description which is acceptable and analyzable to present a model. The term "Fuzzy" is described as "ambiguous, inexact, embarrassed, defect, chaotic and unspecific" in Oxford Dictionary. Fuzzy thought is trying to criticize Aristotle logic based on the distance between logic and reality. Aristotle logic which forms the basis of classic mathematics presupposes that the world is black and white or two valued. The main goal of fuzzy logic is to prepare a basis to do reasoning for approximation and exactness. This is done through considering an amount of merit and requirement in the range between 0 and 1 for the elements of fuzzy set. Fuzzy set includes all items through which every group or element or the subordinate elements having range characteristics follow membership function (Khosravi, 2007). This means that there is a relative acceptability of the approximate amounts and limited amounts of members of a group considering the complete lack of belonging and complete dependency to a certain set and this characteristic is in the form of a continuum. That means there is not an absolute bank.

If the membership function of \( \mu_s(X) \) is considered to be variable in the range of \([0, 1]\), the membership function will be fuzzy and it would be in the following format:

\[ \mu_s(X_i) = 0 \quad \text{X}_i \text{ is not a member of S} \]

The value of \( \mu_s(X_i) \) is close to 0 \( \quad \text{X}_i \text{ is a member of S} \)

\[ \mu_s(X_i) \text{ is not much closer to 0 nor is it much closer to 1} \quad \text{X}_i \text{ is to some extent a member of S} \]

The value of \( \mu_s(X_i) \) is close to 1 \( \quad \text{X}_i \text{ is certainly a member of S} \)

\[ \mu_s(X_i) = 1 \quad \text{X}_i \text{ is a member of S} \]

In applied cases and due to the problems and great complicatedness of fuzzy calculations, we use certain fuzzy numbers. The triangle fuzzy numbers are shown:

D = \{A, B, C\}

Where, A, B, and C represent low bank, medium bank, and high bank respectively, regarding the least
possible value, the most expected possible value, and the highest possible value. In this case the membership function of $\mu_D(X)$ will be described as follows:

$$
\begin{align*}
0 &; x \leq A \\
(x-A) / (B-A) &; A < x \leq B \\
(C-x) / (B-C) &; B < x \leq C \\
0 &; x > C
\end{align*}
$$

Research Hypotheses:

Main Hypothesis: regarding fuzzy if-then rules there is a relationship between current ratio, claims' collection period, and inventory flow.

Minor Hypotheses

Regarding fuzzy if-then rules there is a relationship between current ratio and inventory flow.

Regarding fuzzy if-then rules there is a relationship between claims' collection period and inventory flow.

The status of research criteria

Regarding the 7 fuzzy language variables of "very low", "low", "average to low", "average", "average to high", "high", and "very high" and the definitions above, the best status for the current ratio is the variable "average" and the best status for the variable of claims' collection period is "very low" and the best status for inventory flow is "very high". The best alternative for current ratio is its desirable amount, not so high that it means the lack of using current assets and not so low that the liquidity of the company is endangered and since the claims' collection period is a criterion to measure the time required to collect the claims in cash resulting from the sales to customers and the efficiency of a profit unit is shown regarding the collection of the cashes related to an account sales, the effectiveness of these two criteria on inventory flow will show the financial status of companies. Inventory flow calculates the number of times a company sells its inventory during a year and usually the higher amount of this ratio shows that the efficiency of the company in inventory management is high. Thus, the best condition for the companies is determined in the rule below:

If the current ratio is "average" and the claims' collection period is "very low", then inventory flow will be "very high".

MATERIALS AND METHODS

This research is quasi-experimental and post incidental regarding positive accounting researches field and is based on real information. The main goal of the present research is to study and analyze the financial statements of companies in lack of assurance status and to study the three criteria of current ratio, claims' collection period, and inventory flow by using fuzzy logic. The present research is applied regarding the goal and it uses systematic deletion method to select those companies which are qualified. Rahavard-e-Novin 3 software and Tehran Stock Exchange website are utilized to extract the qualified companies.
Statistical population

The statistical population of the present research entails 300 companies accepted in Tehran Stock Exchange which have not had transaction stops or fiscal year changes during the years between 2006 and 2011 and their fiscal years ended at the end of Esfand (21st March). Also the firms under investigation were not among investing, holding, leasing, banks and insurance institutions. To determine the sample amount needed we have utilized Kokran's. According to this formula, the amount of sample gained was 100 companies. In this research, the sampling method was random.

Data analysis method and hypotheses testing

The present research was carried out in a 6 years period from 2006 to 2011. We have used Excel software to categorize the data and MATALB software to analyze the data. By using 7 fuzzy language variables of "very low", "low", "average to low", "average", "average to high", "high", and "very high" and 49 fuzzy if-then rules the research criteria are divided into three parts. Regarding the fact that different elements affect the financial status of companies, the present research tries to study and investigate the theoretical foundations of the three criteria above to answer this question: "Do using fuzzy if-then rules, current ratio, and claims' collection period have a concurrent effect on inventory flow of firms accepted in Stock Exchange?" In this research, 6 if-then rules can be written regarding the 6 years period investigated for each of the companies.

Fuzzy if-then rules

Regarding 7 fuzzy language variables of Fuzzy if-then rules, from among 49 fuzzy if-then rules we have the followings:

If the current ratio is "very low" and claims' collection period is "high", then inventory flow will be "very low".

If the current ratio is "low" and claims' collection period is "average to low", then inventory flow will be "average".

If the current ratio is "average to low" and claims' collection period is "low", then inventory flow will be "average to high".

If the current ratio is "average" and claims' collection period is "very low", then inventory flow will be "very high".

If the current ratio is "average to high" and claims' collection period is "very low", then inventory flow will be "high".

If the current ratio is "high" and claims' collection period is "average to high", then inventory flow will be "low".

RESULTS

%66 of the rules is realized among 24 companies and they have the best status (table 1), and among 31 companies, %50 of the rules is realized which have a suitable status (table 2). Meanwhile, %33 of the rules is realized among 23 companies which have a weak status (table 3) and the remaining 22 companies
have not a suitable status (table 4).

Table 1: realized among 24 companies

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
<th>of</th>
<th>Name of company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Absal</td>
<td>6</td>
<td>Kaveh papers</td>
<td>11</td>
<td>Pars Khazar</td>
<td>16</td>
<td>Isfahan cement</td>
</tr>
<tr>
<td>2</td>
<td>Abidi drugs</td>
<td>7</td>
<td>Hafez tile</td>
<td>12</td>
<td>Pars Metal</td>
<td>17</td>
<td>Ardekan cement</td>
</tr>
<tr>
<td>3</td>
<td>Khavar elastics</td>
<td>8</td>
<td>Combine factory</td>
<td>13</td>
<td>Pars Pamchal</td>
<td>18</td>
<td>Shahd Iran</td>
</tr>
<tr>
<td>4</td>
<td>Isfahan sugar</td>
<td>9</td>
<td>Iran leasing</td>
<td>14</td>
<td>Molding industries</td>
<td>19</td>
<td>Glass and gas</td>
</tr>
<tr>
<td>5</td>
<td>Pipe gas</td>
<td>10</td>
<td>Pars drugs</td>
<td>15</td>
<td>Barez industrial</td>
<td>20</td>
<td>Ardebil cement</td>
</tr>
<tr>
<td>21</td>
<td>Petro chemistry</td>
<td>22</td>
<td>Lorestan refrigerator</td>
<td>23</td>
<td>Darab cement</td>
<td>24</td>
<td>Weeding poisons</td>
</tr>
</tbody>
</table>

Table 2: among 31 companies

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tissues</td>
<td>12</td>
<td>Tolipers</td>
<td>23</td>
<td>Iran carburetor</td>
</tr>
<tr>
<td>2</td>
<td>Hepco</td>
<td>13</td>
<td>Gorji biscuits</td>
<td>24</td>
<td>Toka transportations</td>
</tr>
<tr>
<td>3</td>
<td>Azmayesh</td>
<td>14</td>
<td>Golgohar</td>
<td>25</td>
<td>Isfahan Mobarakeh Steel</td>
</tr>
<tr>
<td>4</td>
<td>Wool &amp; Glass of Iran</td>
<td>15</td>
<td>Mashhad carton</td>
<td>26</td>
<td>Yazd baf</td>
</tr>
<tr>
<td>5</td>
<td>Tractor Company</td>
<td>16</td>
<td>Iran merinos</td>
<td>27</td>
<td>Kerman cement</td>
</tr>
<tr>
<td>6</td>
<td>Jaam drugs</td>
<td>17</td>
<td>Iran chinaware</td>
<td>28</td>
<td>Gorgan plant and industry</td>
</tr>
<tr>
<td>7</td>
<td>Borojerd textiles</td>
<td>18</td>
<td>Automobile equipments</td>
<td>29</td>
<td>Bafgh mines</td>
</tr>
<tr>
<td>8</td>
<td>Bakhtar cables</td>
<td>19</td>
<td>Arj</td>
<td>30</td>
<td>Behseram</td>
</tr>
<tr>
<td>9</td>
<td>Iran fuse company</td>
<td>20</td>
<td>Farabi drugs</td>
<td>31</td>
<td>Iran Aluminum</td>
</tr>
<tr>
<td>10</td>
<td>Pars tile</td>
<td>21</td>
<td>Alvand tile</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Vitana</td>
<td>22</td>
<td>Alborz rubber</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>
Table 3: realized among 23 companies

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sand supply</td>
<td>7</td>
<td>Ahwaz Navard &amp; pipe</td>
<td>13</td>
<td>Power mover</td>
</tr>
<tr>
<td>2</td>
<td>Shahab</td>
<td>8</td>
<td>Khark chemistry petro</td>
<td>14</td>
<td>Navard Aluminum</td>
</tr>
<tr>
<td>3</td>
<td>Mahram</td>
<td>9</td>
<td>Tehran cement</td>
<td>15</td>
<td>Pars Khodro</td>
</tr>
<tr>
<td>4</td>
<td>Ghazvin glass</td>
<td>10</td>
<td>Mashhad ring</td>
<td>16</td>
<td>Khorasan Pegah</td>
</tr>
<tr>
<td>5</td>
<td>Toos industry</td>
<td>wool</td>
<td>Jahan oil</td>
<td>17</td>
<td>Iran tire</td>
</tr>
<tr>
<td>6</td>
<td>Appliances</td>
<td>12</td>
<td>Arya electric</td>
<td>18</td>
<td>Bahonar copper</td>
</tr>
</tbody>
</table>

Table 4: remaining 22 companies

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
<th>No.</th>
<th>Name of company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sobhan drugs</td>
<td>9</td>
<td>Brake rubber</td>
<td>17</td>
<td>Ghaemshahr textiles</td>
</tr>
<tr>
<td>2</td>
<td>Electric automobile</td>
<td>10</td>
<td>Zinc mines of Iran</td>
<td>18</td>
<td>Tabriz oil refinery</td>
</tr>
<tr>
<td>3</td>
<td>Alborz packing</td>
<td>11</td>
<td>Arak automobile</td>
<td>19</td>
<td>Pars electric</td>
</tr>
<tr>
<td>4</td>
<td>Bhutan</td>
<td>12</td>
<td>Sina chemicals</td>
<td>20</td>
<td>Pars oil</td>
</tr>
<tr>
<td>5</td>
<td>Azarab Gostaresh</td>
<td>13</td>
<td>Automobile axis</td>
<td>21</td>
<td>Pars pump</td>
</tr>
<tr>
<td>6</td>
<td>Iran plaster</td>
<td>14</td>
<td>National copper industries of Iran</td>
<td>22</td>
<td>Malayer industries</td>
</tr>
<tr>
<td>7</td>
<td>Negin coals</td>
<td>15</td>
<td>Textile industries of Iran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Sahand rubber</td>
<td>16</td>
<td>Shoko pars</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The 49 fuzzy if-then rules above show the rules investigated in the present research. Continuity, lack of increase and decrease of any of the indexes show lack of gaps and the appropriate curvature of the graph of correctness and approve of the rules.

**Conclusion**

Fuzzy logic prepares a different method for some problems which need control. This method is concentrated on what the system should perform not on how the jobs should be done. The utilization of fuzzy logic is easy and it is able to resolve some complex problems easily and fast which cannot be solved by using usual mathematical methods. This logic acts as the knowledge of a scholar. Fuzzy sets theory was designed to act in lack of assurance conditions and this is done by using daily common and language variables which could be utilized to change qualitative issues into quantitative ones and assess them. Thus, fuzzy logic is an appropriate logic for management science which mostly deals with qualitative variables. By getting helps from fuzzy logic we can avoid totality and absolute expressions and lead the trend towards more accurate answers. In today's era fuzzy logic which has accompanied difficult complexities can be considered as a suitable answer for the questions. The method presented in this research expressed the type of analysis of financial ratios in 100 bourse companies by using an expert fuzzy system. The rules gained in this research show that there exists a certain relationship between financial indexes and the decisions that will be made by the companies in the future to resolve the problems and we can find the weak points and strengths of the organizations by comparing the amounts of the ratios and therefore design a suitable strategy for the future of the organization. The results gained express that 24 companies have had the best status, 31 companies have had a suitable status, 23 companies have had weak status, and 22 companies did not have a suitable status. Thus, the future strategies of the companies would be removing the weak points and reinforcing strong points in the analysis. The model presented is based on the data of Tehran Stock Exchange and regarding the
environmental changes in industry and business which will affect the results of the present research the range changes of financial ratios and updating them from time to time during some years is suggested in the model posed. In this research we have tried to present new and valuable information for valuable managerial decision makings for the investors, stockholders, managers in industries, organizations, and companies whose financial status has been investigated.

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