APPLICATION OF ANTS COLONY SYSTEM FOR BANKRUPTCY PREDICTION OF COMPANIES LISTED IN TEHRAN STOCK EXCHANGE

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Abstract

One of the most recent researches in financial field is using an Ant Colony System (ACS) in the corporate bankruptcy prediction.

In this paper, the Ant Colony System is used to predict the bankruptcy of listed companies in Tehran Stock Exchange. The research findings shows that model’s prediction power is about 59% with taking into account the rations proposed by Altman (1968). After examining the causes of significant errors in model, a proposed model is introduced. This model which is based on four financial ratios fits the economical infrastructure of Iran. The results obtained from testing of the suggested model indicate that this model is able to predict the corporate bankruptcy one year prior to bankruptcy with an accuracy of 93% for large-sized firms and about 90% for small-sized ones, respectively.
Introduction

Human foraging behavior always seeks to approach an integrated set of information and to discover relationships between phenomena for the explanation of these phenomena and the prediction of their behaviors. These attempts extended to financial field and have induced researchers to discover relationships between financial information in order to provide the financial information users with more powerful control tools.

A highly valuable effort made by financial researches has been the application of financial ratios in bankruptcy prediction. The research conducted in this field resulted in proposing numerous models for the prediction of corporate bankruptcy. The continuity of these researches led to introduction of using artificial intelligence (AI) and computer science techniques in the field of finance.

One of the techniques introduced is the application of Ant Colony System in bankruptcy prediction (Milea, 2005). This model was initially proposed by Dorigo (1992) to solve the Traveling Salesman Problem (TSP) (Dorigo and Stutzle, 2004). Thereafter, researches tended to benchmark this model to solve similar optimization problems in their field of study. The researchers of financial field were also to test this model in order to find out a solution for financial problems.

In this research, the applicability of this model in the prediction of corporate bankruptcy will be explained and the coefficient of success of this model will be tested. For this reason, the financial ratios of corporate have filed in Tehran Stock Exchange in the period 2001-2007 were used.

Ants’ behavior

In real world ants run more or less at random around their colony to search for food. Ants deposit a chemical substance called pheromone along the travelled paths (Dorigo and Caro, 1999). After rainfall, these paths get white and become visible. Other ants upon finding these paths would follow the trail. Then, if they discover food source they will return to the nest and deposit another path along with the previous one, and will be strengthened the preceding path.

When it turns to select a path, ants will prefer one containing high density of pheromone, i.e. paths on which more ants have travelled. Pheromone is gradually evaporated. This evaporation is useful for three reasons:

It makes the next trail less attractive for following ants. Ants mostly take shorter paths; hence, the shorter path between nest and food source is highly strengthened and any farther path is less strengthened.

Unless pheromone did not evaporate at all, the paths having been passed many times would become so attractive that the random searching for food would be highly limited.

When food finished at the end of path, evaporation of the remaining paths would not mislead ants in their searching for that track leading to food source.

Therefore, when an ant finds a shorter (optimal) path from nest to food source, other ants will more likely follow the same path and, over time, the continuous strengthening of the path and the evaporation of other trails will make all ants become unidirectional (Dorigo and Colorni, 1996).

This behavior in ants has a kind of swarm intelligence having been recently considered by scientists. But it should be reassured that there is a major difference between swarm intelligence and social intelligence. In social
intelligence the agents have a degree of intelligence. But, in swarm intelligence the agents have random behavior and there is no direct relationship between them and they are in indirect contact with each other by signals. This behavior was first studied by Grassé, a French scientist. It was referred to as Stigmergy which is a particular form of indirect communication used by social insects to coordinate their activities via changes made in the local environment (Dorigo et.al, 2000).

**Ant Behavior System**

Ant Colony System was initially proposed by Dorigo and Caro to solve the Traveling Salesman Problem (TSP) and with benchmarking of ants behavior he designed a powerful algorithm for solving optimization problems. In TSP the aim is to find a closed tour of optimal path connecting n cities (Dorigo and Stutzle, 2004). Therefore, the path in TSP is a directional graph, also referred to as Hamilton cycle. An optimal tour in weighted directional graph means a path with minimal length. Thus, the TSP is, in fact, finding an optimal tour for a weighted directional graph. Also, the length of optimal tour does not depend on the selection of Start vertex.

**Pheromone in Ant Colony System**

In Ant Colony System, the quantity of pheromone $\Delta \tau_{ij}^k(t)$ deposited by ant $k$ on each edge $(i,j)$ of the tour $T_k(t)$ is as follows:

$$\Delta \tau_{ij}^k(t) = \begin{cases} Q & \text{if edge } (i,j) \in T_k(t) \\ 0 & \text{if edge } (i,j) \not\in T_k(t) \end{cases}$$

Where $Q$ is an adjustable parameter and $L_k$ is the length of the tour (Dorigo and Stutzle, 2004).

**Probabilistic Transition Rule**

A probabilistic transition rule $p_{ij}^k(t)$, the probability that ant $k$ will go from $i$ to $j$ at iteration $t$, is used by the ants in building their tours. This probability depends on 2 parameters: a heuristic measure of the desirability of adding edge $(i,j)$ to the current tour, $\eta_{ij}$, and the amount of pheromone currently on edge $(i,j)$, $\tau_{ij}$. Probabilistic transition rule is given as (2) below:

$$p_{ij}^k(t) = \begin{cases} \frac{[\tau_{ij}^k(t)]^\alpha [\eta_{ij}]^\beta}{\sum_{i,j \in J_k(t)} [\tau_{ij}^k(t)]^\alpha [\eta_{ij}]^\beta} & \text{if } j \in J_k(t) \\ 0 & \text{if } j \notin J_k(t) \end{cases}$$

Where $\alpha$ and $\beta$ are adjustable parameters and $J_k(t)$ is the set of cities that remain to be visited by ant $k$.

Because in the beginning of the simulation the paths generated by the ants are mostly random, pheromone evaporation should take place, thus avoiding convergence to a local optimum.

$$\tau_{ij}(t+1) = (1-\rho)\tau_{ij}(t) + \Delta \tau_{ij}(t)$$

Where $\rho$ is the coefficient of evaporation ($0 \leq \rho \leq 1$) and $\Delta \tau_{ij}$ is given by:

$$\Delta \tau_{ij}(t+1) = \sum_{k=1}^{m} \Delta \tau_{ij}^k(t)$$

Where $m$ being the number of ants (Dorigo and Stutzle, 2004). In Ant Colony System, the parameters should take the values: $\alpha=1$, $\beta=5$ and $\rho=0.5$ (Aziz et.al, 1998).

**Ant Colony System Algorithm**

The algorithm for Ant Colony System is as follows:
1. The initialization step:

In this step ants are placed in the initial position and an amount of $\tau_0$ is taken for initial pheromone.

2. Tour calculation:

Distance between parameters is calculated.

3. Model estimation:

If the system output is not satisfactory, then ants will move to the next location based on the probabilistic transition function and pheromone is converged.

4. Repeating Criterion:

Procedure continues until the system output reaches a satisfactory position (Dorigo and Stutzle, 2004).

Literature Review

1. Classic Methods of Bankruptcy Prediction

A primary study was made on bankruptcy prediction by Whitaker and Smith in 1935. They involved investigation about the sufficiency of financial ratios as predictors of financial failures. The two aforementioned researches had been analyzing the average procedure of 21 rations for 10 years since then and concluded that “Working Capital/Assets” has more stability and accuracy and it is significant as an index to identify failure. Merwin (1942) also examined several ratios within first 6 years of the lifespan of corporate with continuous activity and those whose activity had been stopped. He concluded that three ratios of Working Capital/Total Assets; Net Equity/Debt and Current Ratio are more effective than others (Balcaen and Ooghe, 2006).

Followed by these studies, a great number of researchers involved in examining the prediction of corporate bankruptcy based on financial ratios which resulted in the presentation of four univariate analysis methods, risk index model, multiple discriminant analysis models and conditional probability models for bankruptcy prediction. In 1967, Beaver was pioneer to examine the corporate bankruptcy using univariate analysis method (Balcaen and Ooghe, 2006).


Beginning in the 1980s, the application of Multiple Discriminant Analysis (MDA) method was declined but it still remained
as a standard accepted method and was continuously applied for comparative studies. Then, MDA technique was substituted by other statistical techniques such as Logit and Probit analysis and linear probability modeling. These methods resulted in the presentation of conditional probability models including a combination of variables which highly discriminated bankrupted firms from non-bankrupted ones (Balcaen and Ooghe, 2006). Ohelson (1980); Zavgren (1983); Zmijewski (1984); Gentry et al. (1985); Zavgren (1985); Keasey and Vatson (1987); Peel and Peel (1987); Swanson and Tybout (1988); Aziz et al. (1988); Keasey and McGuinness (1990); Platt and Platt (1990); Ooghe et al. (1993); Sheppard (1994); Lussier (1995); Mossman et al. (1998); Chritou and Trigeorgis (2000); Becchetti and Sierra (2002) as well as Chritou et al. (2000) are among those researchers involved in bankruptcy prediction based on conditional probability models.

2. New Methods to predict Corporate Bankruptcy

As science and technology advances, the financial information users need to utilize new and stronger models and methods for decision making is raised. As described above, an issue on which a proper and accurate decision should be made is the corporate bankruptcy prediction for the purpose of right logical investment.

Artificial neural networks have been considered as a proposed model for corporate bankruptcy prediction and its application in bankruptcy prediction proved that this method is able to predict corporate financial status with a very high accuracy. Odom and Sharda (1990); Koster, Sandak and Bourbia (1990); Cadden (1991); Coatsand Fant (1993); Lee, Han and Kwon (1996) were among those researchers who compared Discriminant Analysis Models (ADM) with artificial neural networks in terms of bankruptcy prediction (Cybinski, 2001).

One of the most recent studies in the field of bankruptcy prediction is the application of Ant Colony System introduced by Dorigo to solve the travelling salesman problem. With application of this model to predict the financial status of corporate for the first time, Wang, Zhao and Kang, 2004, took a new step to introduce artificial intelligence to the field of financial researches. Then, in 2005, Viorel Milea made some small changes in Ant Colony System model to predict firms’ bankruptcy and, then, he compared this model with Altman’s classic model. The choice for the financial ratios used in this work is based on the study by Altman. Results obtained in Milea research showed that Ant Colony System is able to predict firms’ bankruptcy with a coefficient of success of 80% and it, as compared with Altman model, provides a better prediction in some of the studies. Thus, users are able to predict firms’ financial status with having very limited statistical data at hand and in the shortest time possible (Milea, 2005).

Research Design

In this research we have decided to predict the bankruptcy of listed companies in Tehran Stock Exchange. This is done by first running test data for measuring the accuracy of the algorithm in separating the known bankrupt firms from the non-bankrupt firms. To reach our goal we fund that the current algorithm does not fit our situation and should be modified to have reasonable answer. In our modified algorithm there is one point corresponding to each firm. Therefore, in this research the number of ants is as the same as the number of the firm under the study.
Studied Variables

Independent variables used in this model and included in financial ratios applied by Altman (1968) in his ZETA model are as follows:

\[ X_1 = \frac{\text{Working Capital}}{\text{Total Assets}} \]
\[ X_2 = \frac{\text{Retained Earnings}}{\text{Total Assets}} \]
\[ X_3 = \frac{\text{EBIT}}{\text{Total Assets}} \]
\[ X_4 = \frac{\text{Market Value of Equity}}{\text{Book Value of Total Debt}} \]
\[ X_5 = \frac{\text{Sales}}{\text{Total Assets}} \]

Classification Rules

In Ant Colony System applied in present research, ants, after running at random, would find the shortest route among the paths (financial parameters) to identify bankruptcy. The resulting path will be presented as a criterion to classify firms into bankrupt and non-bankrupt as follows:

\[ R = \{CX_1, CX_2, CX_3, CX_4, CX_5\} \]

\[ X_{ki} \leq CX_i, i \in \{1, 2, 3, 4, 5\} \]

Where \( CX_n \) represents the cut-point value of financial ratio \( X_n \) for which the fitness function is maximized. So, a firm with values smaller or equal to \( R \) for each financial ratio is predicted to go bankrupt otherwise not; and \( k \) is the given firm (Milea, 2005).

Explanation of Bankruptcy Concept in Iran

According to article 141 of commercial law of Iran corporate are classified in two groups of bankrupt and non-bankrupt firms as follows:

“Where, due to incurred losses, the half of corporate capital is lost the board of directors shall be obliged to call the shareholder’s extraordinary general meeting to decide for the survival or winding up of the company.

If the said meeting does not decide for winding up of the company, it will be required to decrease the company’s capital by the current amount at the same meeting in virtue of the regulations as stipulated in article 6 of the Commercial Law of Iran.”

Otherwise firm considered as Bankrupt.

Studied Sample Firms

In this research three sample firms consisted of 36 large-size firms, 36 small-size firms and a control sample composed of 42 firms (21 bankrupt and 21 non-bankrupt firms) are tested. The goal has been not only to test the prediction power of the algorithm, but to test its effectiveness on both small and large size firms.

Research Findings

Application of Ant Colony System model in the studied sample of large and small size firms based on the five financial ratios of sample firms led to the following results as shown in Tables 1 and 2.

Table 1. Model’s Results in Large- sized firms

<table>
<thead>
<tr>
<th>Description (No.)</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Situation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankrupt</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Non-Bankrupt</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>35</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Model Prediction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankrupt</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Non-Bankrupt</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>34</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Model's Results in Small-sized firms

<table>
<thead>
<tr>
<th>Description (No.)</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Situation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankrupt</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Non-Bankrupt</td>
<td>31</td>
<td>30</td>
<td>28</td>
<td>27</td>
<td>28</td>
<td>31</td>
</tr>
<tr>
<td>Model Prediction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankrupt</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Non-Bankrupt</td>
<td>36</td>
<td>36</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>36</td>
</tr>
</tbody>
</table>

The tables show that this model nearly is not able to predict bankrupt firms, but it can only predict non-bankrupt firms.

To be confident of the accuracy of the obtained results and to examine whether these results are affected by unequal number of bankrupt and non-bankrupt firms or not, we take a sample consisting of 42 bankrupt and non-bankrupt firms (21 bankrupt and 21 non-bankrupt firms) as control sample and the results are as shown in Table 3.

Table 3. Model’s Results in Control sample firms

<table>
<thead>
<tr>
<th>Description (No.)</th>
<th>Bankrupt</th>
<th>Non-Bankrupt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Situation</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Model Prediction</td>
<td>4</td>
<td>38</td>
</tr>
<tr>
<td>Correct prediction</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>Percentage of correct prediction</td>
<td>59.52%</td>
<td></td>
</tr>
</tbody>
</table>

The results of the tested sample show that for even for equal number of bankrupt and non-bankrupt samples the coefficient of success of the model has reduced to 59.52%. This result shows that the prediction power concerning bankrupt firms is as low as 19%. Therefore, it is concluded that the original Ant Colony System model, based on the five original financial rations cannot discriminate bankrupt firms registered in Tehran stock exchange above 59.52%.

Proposed model

The failure of the original model in predicting the bankruptcy status of the Tehran Stock Exchange, especially in the case of small-size firms, forced us to closely examine the model. We found out that in the original model:

1. Non-fitness of bankruptcy identification criterion in Iran with the ratio of Market Value of Equity/Book Value of Total Debt:

As described in previous sections, the bankruptcy of companies in Iran is identified in article 141 of the Commercial Law. Hence, the classification criterion to identify firms into two groups of bankrupt and non-bankrupt is the amount of firm’s capital. With glancing over the concerned independent variables in order to test Ant Colony System for bankruptcy prediction we will find out that this criterion has not been considered in any of independent variables and, instead, Market Value of Equity ratio has been expressed in terms of fluctuation which, in spite of firms’ belonging to samples with equal sizes, would be high in studied samples.

2. Inflation Impact on Sales/Book Value of Total Assets:

In the calculation of Sales/Book Value of total assets, sales at current value as well as assets value are historical costs. Under the Iran economic conditions with very high inflation rate as well as instability of economic conditions, sales are very inflated rather than book value of total assets. In order to make modifications to the influence of inflation on Sales/Book Value of Total Assets, revaluation of firms’ assets enabling this ratio to express firms’ status in a more
reasonable manner is necessary. But, due to lacking any legal obligation concerning listed companies in Tehran Stock Exchange to revaluate their assets, this ratio will remain as a problematic parameter whenever financial problems are to be solved. Also, as a result of monopoly for some products such as steel and automobile, the above ratio cannot be an appropriate scale to compare firms.

The following measures were taken to resolve the above-mentioned issues:

1. Due to using amount of Capital for classifying corporate into two groups of bankrupt and non-bankrupt firms, we have used Book Value of Equity/Book Value of Total Debts instead of Market Value of Equity/Book Value of Total Debts.

2. As a result of very highly inflated Sales/Book Value of Total Assets as well as lacking any legal obligation for Listed Companies in Tehran Stock Exchange to revaluate their assets and the monopoly for some products, we eliminate this ratio from the model.

Thus, we examine Ant Colony System model with new conditions for the samples having been previously tested. The new suggested model to predict the bankruptcy of listed companies in Tehran Stock Exchange is composed of four independent variables as follows:

\[ X_1 = \frac{\text{Working Capital}}{\text{Total Assets}} \]
\[ X_2 = \frac{\text{Retained Earnings}}{\text{Total Assets}} \]
\[ X_3 = \frac{\text{EBIT}}{\text{Total Assets}} \]
\[ X_4 = \frac{\text{Book Value of Equity}}{\text{Book Value of Total Debts}} \]

Due to unequal number of bankrupt and non-bankrupt corporate in both studied samples (large- and small-sized firms) and in order to be confident that the proposed model is not affected by unequal number of firms, we, firstly, test the model for the control sample composed of 42 corporate (21 bankrupt and 21 non-bankrupt firms). The results obtained from control testing are as shown in Table 4.

### Table 4: Results of proposed model in Control sample firms

<table>
<thead>
<tr>
<th>Description (No.)</th>
<th>Bankrupt</th>
<th>Non-Bankrupt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Situation</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Model Prediction</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Correct prediction</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Percentage of correct prediction</td>
<td>90.47%</td>
<td></td>
</tr>
</tbody>
</table>

The results displayed in Table 4 indicate that this model is able to predict up to 90% of corporate financial status.

After examining of proposed model in control sample and being confident of the model accuracy within the same sample, we tested the new suggested model for two main samples, i.e. sample of large- and small-sized firms. The results obtained from testing of proposed model are as shown in Tables 5 and 6.

### Table 5: Proposed model’s Results in Large- sized firms

<table>
<thead>
<tr>
<th>Description (No.)</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Situation</td>
<td>Bankrupt</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Non-Bankrupt</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>35</td>
<td>31</td>
</tr>
<tr>
<td>Model Prediction</td>
<td>Bankrupt</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Non-Bankrupt</td>
<td>31</td>
<td>35</td>
<td>33</td>
<td>35</td>
<td>34</td>
</tr>
<tr>
<td>Correct prediction</td>
<td>33</td>
<td>35</td>
<td>33</td>
<td>34</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Percentage of correct prediction</td>
<td>91.67%</td>
<td>97.22%</td>
<td>91.67%</td>
<td>94.44%</td>
<td>91.67%</td>
<td>91.67%</td>
</tr>
<tr>
<td>Average of correct predictions per.</td>
<td>93.06%</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
93% for the model to predict the bankruptcy of large-sized corporate.

After testing of proposed model in the sample of large-sized firm, the model was also tested for small-sized firms and the following results were obtained:

Table 6: Proposed model’s Results in Small-sized firms

<table>
<thead>
<tr>
<th>Description (No.)</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Situation</td>
<td>Bankrupt</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Non-Bankrupt</td>
<td>31</td>
<td>30</td>
<td>28</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Model Prediction</td>
<td>Bankrupt</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Non-Bankrupt</td>
<td>33</td>
<td>31</td>
<td>31</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>Correct prediction (No.)</td>
<td>34</td>
<td>35</td>
<td>33</td>
<td>29</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>Percentage of correct prediction</td>
<td>94.44</td>
<td>97.22</td>
<td>91.67</td>
<td>80.56</td>
<td>91.67</td>
<td>83.33</td>
</tr>
<tr>
<td>Average of correct predictions per.</td>
<td>89.82%</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

The results of the test made on proposed model indicate a coefficient of success of 89.82% for the model to predict the bankruptcy of small-sized firms.

Upon comparison of the results of the test made on proposed model we found out that this system is slightly affected by corporate size. So that the model’s coefficient of success in large-sized corporate group is about 93% while in small-sized corporate group is about 90%, respectively.

Consequently, as the results of investigations show, the proposed model is able to predict the bankruptcy of corporate one year prior to bankruptcy.

Conclusion and Summarization

This study aims at the application of Ant Colony System for bankruptcy prediction of corporate accepted in Tehran Stock Exchange.

The primary variables used in this model include Working Capital/Total Assets; Retained Earnings/Total Assets; EBIT/Total Assets; Market Value of Equity/Book Value of Total Debts; Sales/Total Assets.

After these variables were tested in the model we found out that this model is not likely able to predict non-bankrupt firms and its real prediction power is about 59%. The investigations showed that the system error was caused by the two ratios of Market Value of Equity/Book Value of Total Debts as well as Sales/Total Assets. In virtue of article 141 of the Commercial Law of Iran and choosing capital as a criterion for corporate bankruptcy, using Market Value of Equity is not logical. Moreover, this will still remain as a problematic ratio because of lacking any legal obligation for listed companies in Tehran Stock Exchange for assets revaluation. Also, as a result of very high inflation rate in Iran, instable economic situations as well as monopoly for some products such as steel and automobile, the ratio of Sales/Total Assets is very inflated and may not be regarded as an appropriate scale to compare firms.

In order to resolve above-mentioned matters, we consider Book Value of Equity instead of Market Value of Equity and, also, Sales/Total Assets was omitted from among variables. At last, a proposed model consisted of four variables as described below was proposed to predict the bankruptcy of listed companies in Tehran Stock Exchange based on Ant Colony System:

Working Capital/Total Assets; Retained Earnings/Total Assets; EBIT/Total Assets; Book Value of Equity/Book Value of Total Debts.

The results produced by the testing of new suggested model indicated that the prediction power of this model within the sample of large-sized firms is about 93% and in the sample of small-sized firms is about 90%, respectively. Therefore, this model is able to predict the bankruptcy of listed companies in Tehran Stock Exchange with a very high coefficient of success and it is slightly affected by corporate size.
Suggestions and Prospective of Future Researches

As the Ant Colony System is a dynamic model having a very high coefficient of accuracy to search the answer of optimization problems, this model is recommended for these types of problems. Also, in order to be confident of the percentage of influence made by the elimination of Sales/Total Assets it is suggested to reconsider this ratio within the model with considering the assets revaluation problem. Also, it has been proposed to investigate about the corporate bankruptcy with using Ant Colony System and applying phase rules in Iran.

References:


