Feasibility of applying the theory of gray system bankruptcy syndrome diagnosed in the automotive industry companies

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Original Article

ABSTRACT

Going concern concept and its prediction has received increasingly attention from the researchers and analyzers of financial accounting and affairs during the recent times. This is because of the emergence of competitiveness in industry and quick changes in technology. In doing so, there are various models and techniques used for the prediction of firms’ bankruptcy. These functions came to different conclusions, but the gray system theory has not been considerably used in studies and specifically in Iran. Therefore, the present study is planned and designed to introduce that technique and apply it in identifying the bankruptcy syndrome in Tehran listed firms. The sample is composed of 5 companies classified in two groups of bankrupted and non-bankrupted companies. The findings confirm the application possibility of this technique in identifying bankruptcy syndrome of the analyzed company. The conclusions also indicate that the sensitivity of the utilized financial ratios is the same. However, quick ratio is the most sensitive financial ratio in determining the syndrome for this firms.

Key words: Bankruptcy, Gray Systems Theory, Firms’ Illnesses, Firm Identification.

Introduction

Bankruptcy is an almost ancient and equally common issue. Bankruptcy may occur in a small retail shop that is closed because it could not fulfill the rent obligations or it may be happened in a large manufacturing company due to the lack of appropriate liquidity and ongoing annual losses. Accountants must understand bankruptcy reasons because they can inform the management and provide prevention solutions before bankruptcy occurrence. Therefore, in this study, the researchers sought to identify a mechanism to evaluate the performance of the company’s bankruptcy syndrome. In this study, the term syndrome is the technical term used in medicine to describe pathological condition of the company. In this study, researcher investigates a dangerous phenomenon called syndrome of bankruptcy. As disease in humans is the fact of small loss is in one organ that may be treated with medication, in one company also management identifies the function of a non-specific subsystem of a company capable of creating unusual situations and improves company conditions by having all the tools and recognizing abnormalities. Therefore, bankruptcy syndrome may be considered as a complicated symptom associated with a particular situation or it can be defined as the loss of control and unpredictable behavior as a disease that can lead to bankruptcy that if left untreated [9]. Therefore, the research is focused on elements such as: symptoms and function of bankruptcy, and how to determine bankruptcy syndromes and predict future evolution of the company in order to determine the abnormal behavior of a company. This investigation helps organizations to evaluate the country’s current situation of requesting credit institutions or those institutions requested for financial cooperation and non-bank credit institutions. Despite these issues, every research project is carried out to achieve specific goals and outcomes. The present study is aimed at determining the predictive power of bankruptcy syndrome using gray model in companies accepted in Tehran Stock Exchange and evaluating the effectiveness degree of gray model in prediction of actual results.

Zhang and Hey formulated the prediction model of "GrayMarkov Chain " to predict the power requirements in the agricultural sector of Shanghai. Kay and Atok developed the gray prediction model to forecast the electricity demand in Turkey [11]. Fang in another study used gray relation analysis and TOPSIS approach to select staff to be...
deployed overseas missions. It was the best decision made by him and he selected most desirable individuals to be deployed overseas missions. The results show that the gray relation analysis approach contains higher ability to achieve these goals [13].

Ping in other research used synthetic approach of Artificial Neural and Gray approach to predict the efficiency of telecommunication companies. This study indicated that according to the complex and uncertain space of the industry, the Gray Prediction model can better predict the companies’ efficiency [15].

Deng study entitled "A gray-based decision making approach to the supplier selection problem " is an attempt to select suppliers using gray possibility degree and linguistic variables to solve multiple attribute decision making problem under uncertainty situation[12].

Koh used gray relational analysis to solve the locating problem. He indicated that gray relational analysis is largely close to the TOPSIS method and considered the results confirmations of the two methods as a measure of the given real rankings [16].

Jabbari et al, study (entitled "Evaluation and selection of the portfolios of stocks investment fund "). They rated Eight Joint Investment Fund and considered a small sample size and lack of information using gray theory system and the degree of gray relation. Therefore, they investigated actual data in 2008-2010. Obtained data after ranking showed that the national bank, Pouya shares and Ashena Funds met the highest performance during this study. Finally, the investment ratio of each Fund was determined using GrayLinear Programming model and IntegerProgramming[3].

Kazemi et al study entitled "Prediction of energy demand in the transport sector by Gray Markov ChainModel" evaluated the energy demand. The obtained results of the mentioned prediction were compared with results obtained by the predictiveregression model. This comparison showed that gray Markov chain model prediction accuracy is higher than that of regression model. Moreover, the energy demand in the transport sector was predicted using this model in 2008-2010 [6].

2.1. Bankruptcy :

Bankruptcy has different definitions. In this study, was a number of business and legal definitions of bankruptcy are provided.

"Bankruptcy is defined as company costs higher than that of income, in other words, internal rate of return (IRR ) is less than the company cost of capital" [17].

"Bankruptcy occurs when liabilities of a company exceeds the market value of assets." [13].

"Bankruptcy process is the behavioral process for payment of debts to creditors when companies have a problem to pay for debts." [11].

"A company is called bankrupt when it cannot pay for debts and internal rate of return ( IRR ) is low or negative" [5].

"Bankruptcy in the legal terms means spending the total assets of the debtor in favor of the creditor. But it can start working again after bankruptcy removal" [5].

"The word bankruptcy means failure in business." [1].

Article 141 of the Commercial Code of Iran is bankrupt companies states:

"If at least half of the company capital to be lost due to incurred losses on the company, management is obliged to go immediately to call extraordinary general meeting of shareholders to issue liquidation or survival of the company. If mentioned assembly does not vote to liquidate the company, the capital of company should be reduced to the amount of available capital based on the provisions of Article 6 of this law. If the board, contrary to this article, invite the extraordinary General Assembly or the board fails to act in accordance with legal regulations, then any beneficiary can request the competent court in the liquidation of the company ." [4].

In this study, the same article is accepted as the basis for bankruptcy.

2.2. Bankruptcy procedures:

Newton classified the company adverse financial conditions as follows: incubation period, the cash deficit, fiscal solvency or commercial power failure, lack of full solvency and finally bankruptcy (Fig. 1). Although most bankruptcies follow these steps, some companies may experience full bankruptcy without following all mentioned steps.

Condition of business unit does not suddenly and unexpectedly cause bankruptcy. The incubation period may involve one or more hidden adverse situation in the business units that cannot be identified immediately. For example, changes in product demand include factors such as continued increase in overhead costs, obsolescence of production methods, etc. Economic losses and falling of asset returns usually occurs in incubation period. The best situation for companies occurs when the problem is solved in the discovery phase. The second issue is that the easy solutions effective at this stage will not be responsive in the next step. The third issue is that if a problem is discovered and fixed in the same stage , the public trust will not be subject to uncertainty. In the next step, the problem solving reduces public confidence to the company and therefore it will be more difficult to access funds and profitable projects may be rejected by the company.
Cash deficits stage begins when the first business unit has no access to caches to fulfill current obligation or immediate needs access, even though it access physical assets several times more than what it may need with enough profit records. The problem is that the assets are not enough cashable and investments are held.

In the stage of absence of commercial power or financial solvency, the company will still be able to obtain sufficient funds obtained from consumption channels. Management has the proper tools such as using financial or commercial professionals, the credential committee and restructuring of financing techniques. Through these methods, it will be possible to identify and resolve problem at this stage.

In the stage of "fiscal solvency or commercial power failure ", companies are in decline. Total liabilities exceed the value of the assets of the company and the company cannot completely avoid bankruptcy [2].

2.3. Gray System Theory:

There are many different various systems in the real world, each of which have their specific components and subsystems for the understanding of which their components, structures and relationship between should be identified.

If the system obvious or unknown information to be represented by white and black colors respectively, then information on the nature of most information systems are not white (completely known) or black (completely unknown), rather a mixture of the two is shown in gray color. Such systems are called gray systems. The main character of this system is incomplete information about the system [8].Figure 2 illustrates the concept of gray system.

So a gray system is something absolute while its black and white color is something relative. Gray systems are such systems. Since the main characteristic of a gray system is its incomplete information about the system, so it is the beginning point of such systems investigation and its main goal is focused to discover the true features of the system under the lack of information [8].Moreover, gray theory follows some assumptions and principles including the principle of different non-unique answers, least information, central recognition,
priority of new information, gray information developed Deng. [14].

2.4. An introduction to the theory of gray system:

Gray system theory in recent years has been introduced as a highly effective technique for solving problems by discrete and incomplete data [20]. "Deng" in late 1960 conducted various studies on economic and fuzzy systems control and prediction and was faced with the system high uncertainty. The system characteristics were not easily described by fuzzy mathematics, probability and statistics. In general, fuzzy mathematics deals with problems in which the uncertainty can be expressed by experts using discrete / continuous functions. We need understanding of the relevant distribution functions or large samples required to achieve the required reliability. In such a case what can be done if there is no low number of experts in problem and experience level without possibility of obtaining membership or having a few samples? Professor Deng published an article entitled "problems gray systems control" in International Journal of Systems & Control Letters in 1982 for optimal solution of gray systems in such a situation. He introduced the gray system theory and its applications that are today classified in five areas of evaluation, modeling, prediction, control and decision[19].

2.5. Gray numbers:

Each gray system is described by gray numbers, gray equations and gray matrices meanwhile gray numbers are considered as atoms and cells in this system. Gray number is defined as a number of uncertain information. For example, rating of criteria for decisions is described as linguistic variables that can be included a range of uncertain numerical data.

It can also be said that gray number refers to a number that its exact value is unknown but encompasses a range of known value. Gray numbers can be shown only by lower bound of
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It can also be said that gray number refers to a number that its exact value is unknown but encompasses a range of known value. Gray numbers can be shown only by lower bound of \( \Theta \in [\alpha, \omega] \), upper bound of \( \Theta \in [-\omega, \alpha] \) or it may encompass both lower bound of \( \alpha \) and lower bound of \( \omega \). In this case, gray number is called an interval displayed as \( \Theta \in [\omega, \alpha] \). For example, a package that weighs 20 to 25 kg and the average height for a man between 8/1 to 9/1 m, respectively, are examples of interval gray numbers written as:

\[
\Theta_1 \in [20, 25], \Theta_2 \in [1/8, 1/9]
\]

Although it seems that gray numbers are similar to fuzzy numbers, but the fundamental difference between the gray numbers and fuzzy number is that the exact number is not known in gray number but its interval is known. In other words, the exact value of left and right wings of the number is unknown. While the value of a fuzzy number is defined as an interval, but the exact number is known. However, in fuzzy number, while the numbers defined are an interval, its exact number is not known and follows the left and right wings of membership function. This subtle difference between gray and fuzzy number causes calculations with gray numbers to be simpler than calculations with fuzzy numbers because determination of membership function for the left and right wings of a fuzzy number has its own complexity and computational operations [12].

3. Materials and Methods:

Different researches in terms of purpose can be classified as fundamental, applied, practical and research action types. Applied research is a goal-based research that uses cognitive and knowledge context provided by fundamental research to meet human needs. Fundamental research generates a new knowledge that has not been already available [7]. The present study is a practical research because it's expected results can be used to enhance the potential investors' insight. The statistical population of this study included a case of listed companies on the stock exchange in the automotive and parts industry. Time duration of this study was from early 2006 to late 2010.

3.1. Research variables:

Each study has a number of independent and dependent variables. Independent variables in this study include: liquidity ratios, leverage ratios, profitability ratios, debt or leverage ratios, and profit ratios calculated using data in loss and profit statements and balance sheets of listed companies Iran Stock Exchange. Dependent variable of the present study includes the bankruptcy syndrome condition of the companies.

\[
\begin{align*}
S_1 & = \text{(Performance indicator) = lack of bankruptcies ratio (Total assets divided by total liabilities)} \\
S_2 & = \text{(Current Assets) - (inventory) divided by current liabilities} \\
S_3 & = \text{Total current assets divided by current liabilities} \\
S_4 & = \text{Earnings before interest and tax deduction divided by the value of the company} \\
S_5 & = \text{Market value = number of issued shares* current value per share} \\
S_6 & = \text{Net income divided by net sales} \\
S_7 & = \text{Net income divided by shareholders' equity}
\end{align*}
\]
S8 = Net income divided by total assets  
S9 = Total debt divided by shareholders’ equity

3.2. Data analysis method

3.2.1. Gray system theory used for bankruptcy detection:

In the following section, items related to the degree of gray incidence and its calculation to determine the combination of decision matrix (Q) are presented.

Basically matrix created using gray system theory (Q) can be occurred in the analysis of company real stage that can occur in a company and to provide related results. Knowing symptoms revealed by the company (financial ratios) and having a matrix (Q) leads to determination of company efficient function or the bankruptcy.

3.2.1.1. Steps for formation of Q decision matrix:

Suppose that there are two behavioral sequences as follows:

\[ X_i = (x_i(1), x_i(2), ..., x_i(n)) \text{and} X_j = (x_j(1), x_j(2), ..., x_j(n)) \]

Operator of zero point in the sequences is given in the following order.

\[ X_i^0 = (x_i^0(1), x_i^0(2), ..., x_i^0(n)) \text{and} X_j^0 = (x_j^0(1), x_j^0(2), ..., x_j^0(n)) \]

First step: calculation of absolute degree of gray incidence:

Absolute degree of gray incidence only measures the correlation between \( X_i, X_j \) sequences without the involvement of other factors.

(Equation 1)

\[ E_{ij} = \frac{1 + |s_i| + |s_j|}{1 + |s_i| + |s_j| + |s_i - s_j|} \]

\[ |s_i| = \left| \sum_{k=2}^{n-1} X_i^0(k) + \frac{1}{2} X_i^0(n) \right| \]

Absolute degree of gray incidence of \( E_{ij} \) encompasses following main features:

1. \( 0 < E_{ij} \leq 1 \)
2. When one of the data values changes in \( X_i, X_j \), then \( E_{ij} \) varies accordingly.
3. When the length of \( X_i, X_j \) changes, then \( E_{ij} \) varies accordingly [17].

Second step: Calculation of the relative degree of gray incidence:

Suppose that \( X_i, X_j \) are two sequences of the same length and the initial values are zero while \( X'_i, X'_j \) are initial representations of \( X_i, X_j \), respectively. Therefore, the absolute degree of gray incidence of \( X'_i, X'_j \) is called the relative degree of gray incidence. Absolute degree of gray incidence of \( X'_i, X'_j \) is shown in abbreviation form \( r_{ij} \).

The concept of relative degree of gray incidence of \( X_i, X_j \) sequences is a general representation of relative changes of \( X_i, X_j \) in proportion to the starting point. The more the rate of \( X_i, X_j \) changes is close to each other, the larger \( r_{ij} \) will be and vice versa.

(Equation 2)

\[ r_{ij} = \frac{1 + |s_i'| + |s_j'|}{1 + |s_i'| + |s_j'| + |s_i' - s_j'|} \]

The initial values of \( X'_i, X'_j \)

\[ X'_i = (x'_i1, x'_i2, x'_i3, \ldots, x'_i2, x'_i3) \]

\[ X'_j = (x'_j1, x'_j2, x'_j3) \]

Main features of the relative degree of gray incidence of \( r_{ij} \) are:

1. \( 0 < r_{ij} \leq 1 \)
2. When the length of sequences changes, then \( r_{ij} \) also varies [17].

Third step: Calculation of the synthetic degree of gray incidence:

The synthetic gray incidence degree of \( p_{ij} \) is a numeric index which describes general relationship of the closeness between the sequences [8].

Suppose that \( X_i, X_j \) are two sequences of the same length and non zero initial values while \( E_{ij} \) and \( r_{ij} \) are absolute degree of gray incidence and relative degree of gray incidence of \( X_i, X_j \), respectively. We have \( \theta \in [0, 1] \). Therefore, \( p_{ij} \) is called the synthetic degree of gray incidence between \( X_i, X_j \) [8].

(Equation 3)

\[ p_{ij} = \theta E_{ij} + (1 - \theta) r_{ij} \]

Absolute degree of gray incidence of \( p_{ij} \) has the following properties [17]:

1. \( 0 < p_{ij} \leq 1 \)
2. \( p_{ij} \) never equals zero.
3. \( p_{ij} \) also changes in direction of the \( \theta \) value changes.
4. When \( \theta = 1 \), so \( p_{ij} = E_{ij} \) and when \( \theta = 0 \) so \( p_{ij} = r_{ij} \)

Fourth step: Combining gray matrix:

Formation of this matrix occurs after calculation of synthetic degree of gray incidence (\( p_{ij} \) for each company).
• **Method of formation of mixed gray matrix:**

\[
[p_{ij}]_{x \times m} = \begin{bmatrix}
P_{11}P_{12} \cdots P_{1m} \\
P_{21}P_{22} \cdots P_{2m} \\
\vdots \\
P_{x1}P_{x2} \cdots P_{xm}
\end{bmatrix}
\]

\( p_{11}P_{12} \cdots P_{1m} \) represents the degree of synthetic gray incidence of \( S \) company’s operators [19].

| Table 1: Calculation of financial ratios |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                  | Saipa Diesel    |
| Year             | S1              | S2              | S3              | S4              | S5              | S6              | S7              | S8              | S9              |
| 2006             | 1.0663141      | 0.5656644      | 0.7199644      | 0.0456895      | 0.4958266      | 0.0176938      | 0.1355435      | 0.0084327      | 15.073575      |
| 2007             | 1.0440228      | 0.6549988      | 0.7856086      | 0.0191449      | 0.1245712      | -0.060394      | -0.314016      | -0.013241      | 22.715479      |
| 2008             | 1.0561096      | 0.4882279      | 0.7752357      | 0.0643764      | 0.4362074      | 0.0096122      | 0.0879313      | 0.0046717      | 17.822263      |
| 2009             | 1.0515498      | 0.7115353      | 0.8472154      | 0.095298       | 0.6479199      | 0.0005667      | 0.0070499      | 0.0003452      | 19.39872       |
| 2010             | 0.9688971      | 0.6978446      | 0.9622549      | 0.0062953      | 0.050558       | -0.180456      | 2.4387049      | -0.078286      | -32.15138      |

**Fifth step: Formation of Q decision matrix (intensity levels):**

First, some weights are assigned to a synthetic degree of gray incidence matrix to analyze the levels of intensity (weak or strong) in each company along with bankruptcy [19].

**Formation of Q matrix:**

After imposing all weights proportional to numbers forming synthetic gray matrix, strong levels matrix for each for each symptom obtained as follows [19].

\[
Q_{fj} = \begin{bmatrix}
q_{11} & \cdots & q_{1N} \\
\vdots & \ddots & \vdots \\
q_{F1} & \cdots & q_{FN}
\end{bmatrix}
\]

\( j = 1, \ldots, N \)

\( f = 1, \ldots, F \)

**Table 2: X^2 calculation**

<table>
<thead>
<tr>
<th>X1 (0)</th>
<th>X2 (0)</th>
<th>X3 (0)</th>
<th>X4 (0)</th>
<th>X5 (0)</th>
<th>X6 (0)</th>
<th>X7 (0)</th>
<th>X8 (0)</th>
<th>X9 (0)</th>
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<tbody>
<tr>
<td>x1 (0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>x2 (0)</td>
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<td>0.0888255</td>
<td>0.0656441</td>
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<td>x3 (0)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>x4 (0)</td>
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<td>0</td>
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<td>x8 (0)</td>
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**Table 3: Sj calculation using Equation 1**

<table>
<thead>
<tr>
<th>s1</th>
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<th>s3</th>
<th>s4</th>
<th>s5</th>
<th>s6</th>
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<td>0.022054</td>
<td>0.501415</td>
<td>0.203719</td>
<td>0.525906</td>
<td>0.076881</td>
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</tbody>
</table>

**Table 4: calculation of |s_i - s_j| using equation 1**

<table>
<thead>
<tr>
<th></th>
<th>s1</th>
<th>s2</th>
<th>s3</th>
<th>s4</th>
<th>s5</th>
<th>s6</th>
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<th>s8</th>
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<td>0.4053518</td>
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<td>0.465375</td>
<td>0.118117</td>
<td>0.405352</td>
<td>0.106307</td>
<td>0.62197</td>
<td>0.019182</td>
<td>8.800677</td>
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**Table 5: calculation of E_i using equation 1**

<table>
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<th>e12</th>
<th>e13</th>
<th>e14</th>
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<td>0.797611</td>
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<td>0.722822</td>
<td>0.983909</td>
<td>0.531717</td>
</tr>
</tbody>
</table>

**Second step- Saipa Diesel Company: calculation of the relative degree of gray incidence:**

Using the formulas described in third step, relative degree of gray incidence was calculated as described below.
Table 6: Calculation of $x_i^r$ using equation 2

<table>
<thead>
<tr>
<th>$x_i^r$</th>
<th>$X_1^r$</th>
<th>$X_2^r$</th>
<th>$X_3^r$</th>
<th>$X_4^r$</th>
<th>$X_5^r$</th>
<th>$X_6^r$</th>
<th>$X_7^r$</th>
<th>$X_8^r$</th>
<th>$X_9^r$</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.9790701</td>
<td>1.1570285</td>
<td>1.0911769</td>
<td>0.4190215</td>
<td>0.2512395</td>
<td>-3.413267</td>
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<td>-1.570196</td>
<td>1.5069736</td>
</tr>
<tr>
<td>$x_2^r$</td>
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<td>0.8631052</td>
<td>1.0767695</td>
<td>1.0899777</td>
<td>0.8797581</td>
<td>0.5432525</td>
<td>0.6487314</td>
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<td>1.1823514</td>
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<tr>
<td>$x_3^r$</td>
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Table 7: Calculation of $x_i^p$ using equation 2

<table>
<thead>
<tr>
<th>$x_i^p$</th>
<th>$X_1^p$</th>
<th>$X_2^p$</th>
<th>$X_3^p$</th>
<th>$X_4^p$</th>
<th>$X_5^p$</th>
<th>$X_6^p$</th>
<th>$X_7^p$</th>
<th>$X_8^p$</th>
<th>$X_9^p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1^p$</td>
<td>0.0090087</td>
<td>0.3948454</td>
<td>0.5129581</td>
<td>0.4826874</td>
<td>-1.011272</td>
<td>-11.43738</td>
<td>11.347293</td>
<td>-3.907096</td>
<td>9.0269745</td>
</tr>
<tr>
<td>$x_2^p$</td>
<td>0.0090087</td>
<td>0.3948454</td>
<td>0.5129581</td>
<td>0.4826874</td>
<td>-1.011272</td>
<td>-11.43738</td>
<td>11.347293</td>
<td>-3.907096</td>
<td>9.0269745</td>
</tr>
<tr>
<td>$x_3^p$</td>
<td>0.0090087</td>
<td>0.3948454</td>
<td>0.5129581</td>
<td>0.4826874</td>
<td>-1.011272</td>
<td>-11.43738</td>
<td>11.347293</td>
<td>-3.907096</td>
<td>9.0269745</td>
</tr>
</tbody>
</table>

Table 8: Calculation of $|s_i|$ using equation 2

<table>
<thead>
<tr>
<th>$s_i$</th>
<th>$s_1'$</th>
<th>$s_2'$</th>
<th>$s_3'$</th>
<th>$s_4'$</th>
<th>$s_5'$</th>
<th>$s_6'$</th>
<th>$s_7'$</th>
<th>$s_8'$</th>
<th>$s_9'$</th>
</tr>
</thead>
<tbody>
<tr>
<td>abs($s_i$)</td>
<td>0.090087</td>
<td>0.3948454</td>
<td>0.5129581</td>
<td>0.4826874</td>
<td>-1.011272</td>
<td>-11.43738</td>
<td>11.347293</td>
<td>-3.907096</td>
<td>9.0269745</td>
</tr>
</tbody>
</table>

Table 9: $|s_i| - s_j$ calculation

<table>
<thead>
<tr>
<th>$s_i - s_j$</th>
<th>$s_1' - s_2'$</th>
<th>$s_1' - s_3'$</th>
<th>$s_1' - s_4'$</th>
<th>$s_1' - s_5'$</th>
<th>$s_1' - s_6'$</th>
<th>$s_1' - s_7'$</th>
<th>$s_1' - s_8'$</th>
<th>$s_1' - s_9'$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.484933</td>
<td>0.603045</td>
<td>0.572774</td>
<td>0.921184</td>
<td>11.347293</td>
<td>-3.970696</td>
<td>9.0269745</td>
<td>0.5001339</td>
<td>0.5001339</td>
</tr>
</tbody>
</table>

Table 10: Calculation of $r_{ij}$ using equation 2

<table>
<thead>
<tr>
<th>$r_{ij}$</th>
<th>$r_{12}$</th>
<th>$r_{13}$</th>
<th>$r_{14}$</th>
<th>$r_{15}$</th>
<th>$r_{16}$</th>
<th>$r_{17}$</th>
<th>$r_{18}$</th>
<th>$r_{19}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.753824</td>
<td>0.726645</td>
<td>0.733041</td>
<td>0.695229</td>
<td>0.524716</td>
<td>0.555928</td>
<td>0.530679</td>
<td>0.770627</td>
<td>0.770627</td>
</tr>
</tbody>
</table>

Third step - Saipa Diesel: calculation of the synthetic degree of gray incidence:

Using the formula described in the third chapter, synthetic degree of gray incidence has been calculated as described in the table 11.

Fourth step: Formation of synthetic gray matrix:

After calculating the synthetic degree of gray incidence ($p_{ij}$ for each of the homogeneous companies), the synthetic gray matrix will be formed (3 - step 4).

Table 11: Calculation of $p_{ij}$ using equation 3

<table>
<thead>
<tr>
<th>$p_{ij}$</th>
<th>$p_{12}$</th>
<th>$p_{13}$</th>
<th>$p_{14}$</th>
<th>$p_{15}$</th>
<th>$p_{16}$</th>
<th>$p_{17}$</th>
<th>$p_{18}$</th>
<th>$p_{19}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.769206</td>
<td>0.7363417</td>
<td>0.7844464</td>
<td>0.7259432</td>
<td>0.6445979</td>
<td>0.605996</td>
<td>0.666482</td>
<td>0.6989541</td>
<td>0.6989541</td>
</tr>
</tbody>
</table>

Table 12: Calculation of $Q$

<table>
<thead>
<tr>
<th>$Q$</th>
<th>0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td></td>
</tr>
</tbody>
</table>

Fifth step: Decision matrix ($Q$ strong levels)$Q$:

First, some weights are assigned to a synthetic degree of gray incidence matrix to analyze the

<table>
<thead>
<tr>
<th>Company Name</th>
<th>0.6</th>
<th>0.8</th>
<th>0.8</th>
<th>0.6</th>
<th>0.8</th>
<th>1</th>
<th>0.8</th>
<th>0.8</th>
<th>0.8</th>
</tr>
</thead>
</table>
Analysis chart of companies’ performance and identification of the bankruptcy syndrome:

<table>
<thead>
<tr>
<th></th>
<th>Saipa Diesel</th>
<th>Iran Khodro</th>
<th>Iran Khodro Diesel</th>
<th>Pars Khodro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>0.4</td>
<td>1</td>
<td>0.2</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
<td>1</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
<td>1</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>0.8</td>
<td>1</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
<td>1</td>
<td>0.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

After imposing all weights proportional to numbers forming synthetic gray matrix, strong levels matrix for each for each symptom obtained as follows in the this page [20].

Diagram 1: Companies performance analysis and identification of bankruptcy syndrome

4. Discussion and conclusion:

Obtained results of conducted studies suggest that among the 5 companies selected from the auto industry that were homogeneous in terms of type of activity, Iran Khodro had best performance during 2006-2010 compared with Saipa, Pars levels of intensity (weak or strong) in each company along with bankruptcy [14].

Diagram 1 shows that Iran Khodro Company have had the best performance during 2006-2010 compared to other companies. Moreover, Iran Khodro Diesel Company had the worst performance compared with other companies in the industry over the years

Khodro, Saipa and Iran Khodro Diesel. Moreover, Iran Khodro Diesel and Saipa Diesel respectively had the worst performance compared to other companies in this industry during these years and had bankruptcy syndrome. Bankruptcy is predicted for these two companies in the coming years. The financial statements and financial ratios of each of the companies in the same industry, were analyzed using the gray model to test the accuracy of the results obtained in this study. Therefore, according to the gray prediction model, the actual results show that Iran Khodro Company with high profitability over the course of the study have the best performance compared to other companies in the auto industry. According to this fact that this method can predict bankruptcy syndrome in each company, it is suggested that investors consider this technique during investment. Moreover, auditors can use this model for feasibility of the company continuity.

Recently, several scientific research conducted about bankruptcy titled financial performance of a company and health problem. These studies examined successfully only the diagnosis or prediction of a particular company status in future. The present study, compared with other researches, represents bankruptcy syndrome using one of the newest theories of gray system. Therefore, it is recommended in the analysis of bankruptcy syndrome using gray model consider the non-quantitative aspects for formation of the economic and financial knowledge. Moreover, G (0.1) model can be used in the studies entitled “identification and prediction of the companies.

References

5. Farahani, Gh., 1989. insolvency and bankruptcy treatments (first volume), Iran University publications.