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Original Research

Designing Prediction Model of Financial Restatements Using Neural-Genetic Simulation Algorithm

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ABSTRACT

The increased number of restatements in recent years has increased the worries about the quality of financial reporting among the beneficiary groups. The presence of prior period adjustments and, subsequently, the financial restatements have a negative impact on the relatedness and reliability of the financial statements. The present study is aimed to present an appropriate criterion for predicting the financial restatements based on the Beneish model and its indices in companies admitted to the Tehran Stock & Exchange between 2009 and 2020. For this purpose, a total of 265 companies were selected considering the limitations. Also, the model estimation was performed using Beneish's primary model, a meta-heuristic neural network model, and optimization through genetic programming. As indicated by the obtained results based on the confusion matrix, the efficiency of the proposed model derived from the enhanced Beneish model with a genetic algorithm(S – $Score$) had a total prediction accuracy of 73.21%, which was the highest prediction power compared to the Beneish Model .

1 Introduction

The increased number of restatements in recent years has increased the worries about the quality of financial reporting among beneficiary groups [5] According to the previous studies, events such as the reduced value of companies, decreasing reviews in predicting the analysts' profit, increasing dispersion in predictions of the analysts, increased capital cost, reduced profit reaction coefficient, and iceberg effect can be observed. The iceberg effect means that a partial financial restatement considerably damages the credibility of a company ad can put other accounting and corporate disclosure methods under question [17]. In theoretical concepts of financial reporting, the goal of financial statements, as the main core of financial reporting, has been defined as: providing summarized and classified information about the financial status, performance, and flexibility of the commercial units, which is useful for a wide range of users of the financial statements for making economic decisions [2]. Moreover, in the "Qualitative features of Financial information" chapter of the theoretical concepts of financial reporting, it has been mentioned that: "users of the financial statements must be able to compare the financial statements

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(financial performance and status) over time with financial statements of different commercial units. As such, it is necessary to measure and pre-sent the financial effects of transactions and other similar events in the commercial unit and over time for that commercial unit through a stable procedure and also take into account the procedure coordination for measurement and reporting." Based on the above points, it can be concluded that: "financial information of commercial units can be useful when it can be com-pared with similar information of the previous years of the same unit or with similar information of other units operating in the same industry" [20]. However, considering the continuous changes in the economic and social conditions, the changes in the accounting methods and principles resulting from the complexity and high volume of commercial transactions and also the occurrence of mistakes in financial reporting and, consequently, financial restatements seem to be inevitable. A challenge that weakens the comparability and uniformity of the financial statements is the financial restatements re-sulting from the accounting changes and correction of previous mistakes. This makes ambiguous not only the comparability but also the reliability of the financial statements, as a result of which even the primary goal of financial statements (i.e. presenting useful information for making economic decisions) won't be achieved [27]. Profit manipulation occurs when managers choose actual and accrual items within and outside the framework of accepted accounting principles and use daring accounting methods. Using accrual items within the scope of accepted accounting principles is also profit management to cover fraud [11]. Profit manipulation models include models based on accruals and combined models (financial ratios and accruals). It is useful for managers to use accruals models to identify profit manip-ulation from the type of profit management. Although accruals provide the possibility of profit manip-ulation, it also has a great impact on the measurement of the company's performance. When managers use both accrual items and actual items inside and outside the framework of accepted accounting prin-ciples for manipulation, profit manipulation of this type is recognized for better performance composite models. Therefore, accrual models are mostly used to detect profit management and combined models are also used to detect profit management and fraud. Haley [4] was the first researcher who introduced models based on accruals. After that, D'Angelo [6] and Jones [10] improved it with different methods and names [11]. Benish used a combination of financial ratios and accruals to predict profit manipula-tion methods. Since there was no suitable economic theory for financial information manipulation, he used three sources to select explanatory variables. First, the examination of the company's future signs was based on the available scientific and specialized literature. He assumed that when the company's future situation is weak, the probability of profit manipulation is also higher. The second source is the selection of variables based on cash flows and accruals based on the Jones model and Healy and finally used the contractual hypothesis based on Watts and Zimmermann proof theory. The result of his re-search based on financial statement data ended up with eight variables [6]. Benish [3] presented a model to detect profit manipulation based on eight accounting variables. He found that when there is an unu-sual increase in receivables, a decrease in gross profit margin, a decrease in the quality of assets, sales growth, and an increase in accruals, the probability of profit manipulation also increases. His findings show the usefulness of accounting in-formation to detect profit manipulation. Applying the Benish model to predict profit manipulation in Iran, considering that the coefficients of the initial model are determined in a different economic environment, may be accompanied by a large error. The main goal of this research is to test the ability of the original and modified Benish model for Bini is the profit manipulation of Iranian companies. Also, the current research is trying to provide a model that has a lot of power to identify profit-manipulating companies [20]. Impink examined the power of different mod-els to predict profit manipulation in Worldcom. He used Benish's model, Altman's bankruptcy model and Olson's model for this prediction. His findings showed that the accuracy of Benish, Altman and

Olson's model in pre-dicting profit manipulation was 72, 68 and 54% respectively [3]. According to the research of Kurdestani and Tutli, the adjusted model of Benish and the models developed with the discriminant analysis and logit approach are able to identify the profit manipulating and non-manipulating companies with overall accuracy of 72, 75 and 81%, respectively. Also, in the research of Anaqiz et al, the adjusted model of Benish has an overall accuracy of 66.2% compared to the original model of Benish, whose overall accuracy is 61%, which indicates the amount of fraud in the financial statements of companies, all of which lead to renewal. Financial statements are presented.

Based on the research of Papik and Papikova users can evaluate the financial status and performance of the company based on the Benish model. The variables used in this model are not only related to the transactions manipulated inside the company, but also related to the transactions that may be manipulated by the company in the future, which leads to the renewal of financial statements. Also, these variables can work better to detect profit manage-ment and profit fraud [24]. Benish's main assumption is that during the pre-manipulation period, manipulative companies report significantly higher growth than non-manipulative companies. For this reason, the ratios in Benish's model are ratios of two consecutive periods [30]. With the development of Benish's study, Dechow, Gay, Larson and Sloan classified companies based on financial statement restatement and without financial statement restatement and using models Logit developed the Banish model and concluded that the Banish model has a predictive power of 82%. [29]. The study conducted on Enron's accounting fraud by McCarthy shows that Benish's model, compared to Altman's bankruptcy prediction model, could successfully predict Enron's fraudulent behavior between 1997 and 2000. Research also shows that manipulations have been detected in most of the input variables that feed Benish's model. Therefore, to achieve the objective of the present study, the existing accounting fraud prediction model (Beneish Model) was tested to find out whether this model can be used for predicting financial restatements or not.In the following sections, an enhanced Beneish model will be presented using the neural-genetic optimization algorithm and the abovementioned prediction models with attributes such as accu-racy, sensitivity, feature based on the confusion matrix. Similar to other countries, in our country, the issue of fraudulent financial reporting, distortion of financial statements and so on Restatement of Financial Statements It has been discussed in the auditing profession and it is not a strange issue; But despite its economic consequences on the country's companies and economy, in the country's capital market and research authorities; Less attention has been paid.Considering the increase in the number of companies admitted to the stock exchange and the process of privatization and capital growth and the necessity of public release of financial statements; Probability prediction index measurement Restatement of Financial Statements in methods other than routine audits due to audit limitations; It is essential to expose and prevent fraudulent reporting methods. The inherent limitations of internal controls as well as the limitations of auditing, the possibility of discovering and predicting distortions that lead to Restatement of Financial Statements limit the Therefore, the use of other methods, such as statistical methods based on financial statement data contracts [such as financial ratios], can help to meet this need. The role of the effectiveness of this research in the ability and capacity of auditing standards in discovering and exposing possible fraud in financial statements and possible forecasting Restatement of Financial Statements and the potential exploratory capacity in these standards can be of great help to investors, certified accountants and internal auditors, tax authorities, government institutions and the banking system. This research examines the effects of applying Benish's model and its modifications in Fore-cast Possibility Restatement of Financial Statements Paid. In this way, investors can invest with a clearer perspective based on the results of this research. Currently, a suitable model in Iran to discover potential frauds in financial

statements, Restatement of Financial Statements And beyond the usual audit methods, there is no such thing, and this research seeks to design a suitable Iranian model for discovery and prediction Restatement of Financial Statements including audited financial statements.

2 Theoretical Fundamentals and a Review of Literature

The restatement of the profit and other financial information of the companies in previous years is necessary due to the mistakes resulting from mathematical computations, mistakes in the utilization of accounting procedures, as well as misinterpretation or ignorance of the existing realities at the time of preparing the financial statements [16]. Gratsen et al. classified the financial restatements based on the management intention and alteration degree of information relatedness. On this basis, if the alteration degree is insignificant and doesn't comply with the managers' mal-intention, this type of restatement is assumed as a low-harm lie. If the alteration degree is significant but doesn't comply with the manager's mal-intention, then this type of restatement will cause, probably due to the reduced performance of the company, changes in the expectations about future predictions however it won't damage the credibility of the financial reports [14]. Motivations for purposeful financial restatements are classified into three groups: the first group includes the motivation of the companies with profitability and liquidity problem. These companies tend to improve their financial results by doing fraudulent actions and committing intentional mistakes. The second group includes the motivation of the companies that tend to meet the market predictions and expectations through fraud and intentional mistakes. And the third group includes the motivations resulting from some contracts. The award contracts depending on the stock value and performance of the company is an example of such contracts [23]. Donald Cressey's fraud plan, known as fraud triangle, describes three major situational factors of fraud behaviors. In the presence of these factors, probably the most common model for discovering fraud in accounting is the Beneish model, which is called M-score [26]. Since financial restatements can be used as a guide for fraud behaviors of the management, according to about, a poor financial status is likely to cause the management to restate the financial statements in the upcoming year(s) [1].

2-1. Beneish Model (M-score)

In Iran, there is no authority or independent body to declare profit-manipulating companies, so that samples can be easily selected like Benish. In previous researches, accrual models including Jones model, modified Jones model, Kotari, etc. have been used, and these models are used in identifying companies that manipulate or manage profit from variables that are inconsistent with general principles (GAAP) and They use variables in accordance with generally accepted accounting principles. On the other hand, in the current research, if these models were used to select sample profit-manipulating companies, accurate results would not be obtained, for the reason that the purpose of this research is to test the Benish model for profit-manipulating companies and Because accruals models use variables that exist in Benish's model to identify companies that manipulate or manage profit, so the results of the research were flawed.This model consists of 8 factors presented by Beneish. In this mathematical model, Beneish uses eight indices for identifying whether the company is manipulating its revenue or not [3]. To construct this model, Beneish studies a total of 74 companies that had manipulated their revenues and a total of 2332 companies that had not manipulated their revenues between 1987 and 1993. To recognize the revenue and manipulate the revenues, the Beneish model uses the following equation:

M-SCORE= -4.84+0.92 DSRI+0.528 GMI+0.404 AQI+0.892 SGI+0.115 DEPI-0.172 SGAI + 4.679 TATA -0.327LVGI

If the M-score value is above 1.78, it can be assumed that the values given in the financial statement have been manipulated. But if the M-score value is below 1.78, then it is not expected that the financial statements have undergone fraud actions in terms of the manipulation of revenues. Beneish's main assumption is that before the manipulation period, the manipulating companies report a significantly higher growth compared to the non-manipulating companies. Therefore, the indices in the Beneish model are ratios of two consecutive periods [15].

2.2 Optimization Algorithm (Neural-Genetic Simulation)

The application of mathematical modeling also started from the study of Freed and Glover [9] In this study, mathematical models with different parameters and limitations are considered for profit manipulation and non-manipulation groups. Dikmen and et al [8] introduced a new algorithm for mathematical planning in the diagnosis of profit manipulation methods and compared it with statistical model. Using the variables of the Benish model, they presented three stages of a new algorithm based on mathematical planning. The results of this study indicate Mathematical planning method was superior to statistical method. [8] In the present study, the genetic algorithm was used, in which the number of the participants (i.e. the initial population) was assumed equal to 100 that could be changed. Also, the number of variables (n) was considered n+1.

Having the inputs and variables of the genetic algorithm with regard to the aforementioned equations, the algorithm finds the optimal values for the coefficients and will return them to the network as outputs to calculate the values of the outputs. In the proposed algorithm, since the objective is to combine the neural network and the genetic algorithm, these two algorithms must be put together properly. The optimization algorithm solely is unable to predict and also the neural network solely is unable to improve the results. Therefore, in this study, it is attempted to put these two algorithms together in order to overcome their weakness and, ultimately, achieve an appropriate algorithm with the capability of optimization and prediction. Fig (1) show the process of investigation and optimization to achieve a more accurate diagnosis. In the existing cases, once the neural network is diagnosed, the diagnosis process is finished. But, in the present work, first, the data are provided for the neural network. Then, the neural network makes its primary guess and presents the weights assumed for the diagnostic regression equation. Next, these weights are imported into the genetic algorithm. In this algorithm, the weights are changed based on the nature and procedure of finding the optimal solution in the aforementioned optimization algorithm and then are imported into the artificial neural network in order to investigate closeness to reality. But, this time, no prediction will be made and only the new regression equation and closeness of the solution to reality will be examined. The solutions are imported into the optimization algorithm in order to direct the re-optimization procedure. This procedure is continued until the diagnosis error reaches a specific iteration (exit condition) and the accuracy reaches a desirable level.

The selection, combination, and mutation in the proposed algorithm are described in the following sections**.** In this study, the length of the designed chromosome depends on the number of variables. The designed chromosome contains the coefficients of the regression equations. First, an initial population is produced randomly, which includes the equation coefficients randomly and non-optimally. The designed chromosome is shown in figure (2).

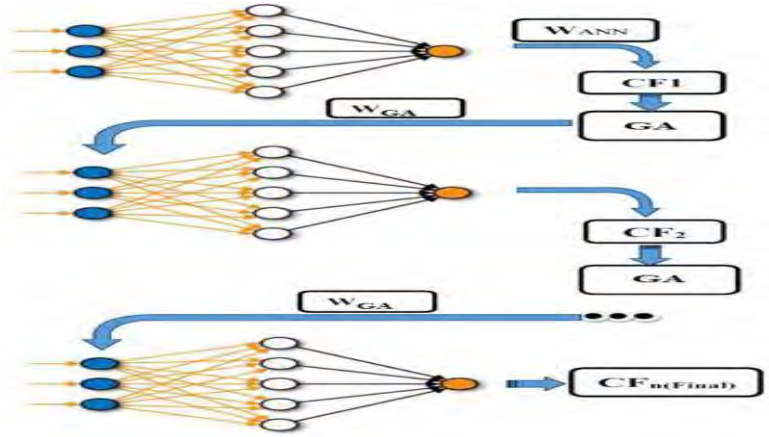

Fig-1: Diagram of the neural-genetic optimization algorithm

Fig.2: A schema of the chromosome

The above chromosome has a single-line entry so that its first column is the y-intercept of the regression equation and the number of other genes of this chromosome is equal to the number of variables imported into the study. The chromosome in the present study was a 3-gene chromosome.

To combine the populations, the percentage method was used. For this purpose, from two parents, two siblings were produced so that the first sibling was 75% from the first parent and 25% from the second parent and the second sibling was 25% from the first parent and 75% from the second parent. Fig (3) shows the produced siblings.

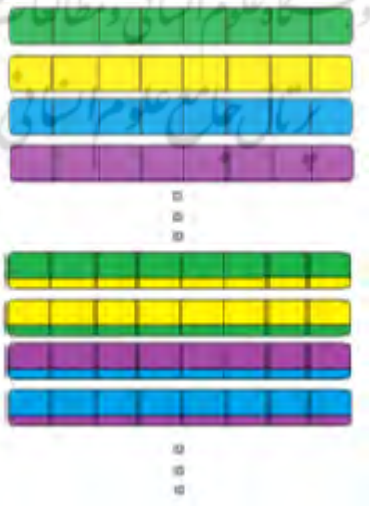

Fig.3: Siblings produced from combination

As can be seen in Fig (3), each sibling is divided into two parts. This division has been done from three-fourths of each gene. The color of the parents shows the division of the siblings by 75% and 25%.

In order for mutation in this study, 10% of the population and 2% of the genes are mutated. The number of mutations can be obtained from the following equation. Mutation in this study means that regarding the number of obtained mutations, the same number of variables in the regression equation that need mutation will be weighed randomly in order to prevent the algorithm from being entrapped in local optimal points.

Random selection from population× 10/100 = number of population

Number of mutations = length of chromosome × [2/100]

Uhan et al., in a research entitled "the relationship of the size of board-of-directors, auditing company, and debt with financial restatement", investigated the determinant factors of post-auditing financial re-statements in public companies in Vietnam. This study focused on the size of the board-of-directors, auditing company, the ratio of total debt to total asset, and effectiveness or ineffectiveness of financial restatements. According to the obtained results, the ratio of total debt to total asset had a significant relationship with the occurrence of financial restatements while the size of the board-of-directors and iiii tigg mmyyyy ii ’’’ t eemmtv vvvv vffcctt tt t tt tt ttt rccce of the financial restatements [29].

Khaksari and et al. in a research titled "Designing a native model to discover the unethical behavior of managers in financial reporting" investigated unethical behaviors such as fraud and profit manipulation, which lead to ethical failure in companies. Therefore, the introduction of an early detection tool, to warn the enforcement agencies for further investigation or legal action is necessary. The development of a model through which it is possible to predict profit manipulation and discover the unethical behavior of managers, provides the possibility of a better evaluation of the company's performance. The purpose of this research is to investigate the ability of the Benish and Spatis model to detect fraudulent financial reporting. Then, the coefficients of these two models were examined using adjusted logistic regression and the ability of these two new adjusted models to detect fraudulent financial reporting. The results show the primary model of Benish and Spatis, in the discovery of reporting Fraudulent finance does not have good power, but Benish's adjusted model and Spatis' adjusted model are able to detect fraudulent financial reporting with 77% and 82% accuracy, respectively [13].

Lehenchuk and etal conducted a research with the aim of discovering the fraud of financial statements in Ukrainian companies using Benish model. They also evaluated the ability of Rexas model to detect financial statement fraud and concluded that two models have the ability to detect financial statement fraud in Ukrainian companies [15].

Svabova and et al. conducted a study in Slovakia with the aim of detecting profit manipulation and fraudulent financial reporting that lead to restatement of financial statements. In this research, the ability of Benish model to detect fraudulent financial reporting was investigated. Also, the researchers developed a model including sixteen variables that included the variables of Benish model and came to the conclusion that both models have the ability to identify fraudulent companies, but the ability of the new model to identify fraudulent companies is higher than the original Benish model. The reason for this difference is probably due to the fact that the methods of reporting financial indicators may have significant differences in different countries [28]. Papik and Papikoa, in a study entitled " Detection Models for Unintentional Financial Restatements ", attempted to identify and analyze the determinant factors of the truthful accounting mistakes leading to financial restatements based on the database of the Securities & Exchange Commission (SEC) and annual reports. This study, initially, tested the accounting

fraud detection model proposed by Beneish on a 40-subject sample from companies with financial restatements over 10 years. Then, the authors developed two new prediction models of linear discriminant analysis (LDA) and based on the logit (logistic) regression. While testing the datasets, the LDA model achieved an accuracy of 70.96%, a feature of 25%, and a sensitivity of 79.83%. Also, the logit regression model achieved an accuracy of 62.22%, a feature of 41.66%, and a sensitivity of 66.67%, indicating that the efficiency of both models was better than the Beneish model and those proposed in other studies [24]. Nikbakht and Rafiei, in a study entitled "compiling a pattern of factors affecting financial restatements in Iran", attempted to find the pattern of factors affecting the financial restatements in Iran. For this purpose, first, they identified the factors affecting the financial restatements through interviews with 50 elites. Then, they estimated the intended pattern using the logistic regression method. To estimate the pattern, these authors used the data of 202 companies in the stock market during 2005 to 2009. As indicated by the findings of this study, profitability, financial leverage, tenure duration, management change, changing the auditor, and size of the auditing institute affected the occurrence of the financial restatements [21].

3 Research Method

Data collection was performed using the library method. The present work is applied in terms of the research objective and event-based in terms of methodology. Also, the present work has been conducted in the field of positive accounting studies and based on the real data provided in the financial statements of companies. The required data were extracted from the codal site of Tehran Stocks & Exchange and financial statements and reports of the companies admitted to Tehran Stocks & Exchange during 2009 to 2020. Also, the SPSS, MATLAB, and PYTHON software were used for data analysis in this study. From SPSS software, to choose the best ratios for prediction Restatement of Financial Statements Stepwise regression test is used. From MATLAB software to present the model using neural network-genetic algorithm and Python software has been used to check and compare the original Benish model and its improved model based on the confusion matrix. Before making the pattern, the new prediction models were developed based on two input datasets (training and test datasets). First, the total dataset of the company was divided into two groups, namely data of the years 2009 to 2019 as the estimator (training) dataset and data of the year 2020 as the test dataset, in order to initially find the final pattern based on the training data and then examine its applicability in future using the test data .The statistical population of the present study included the companies admitted to Tehran Stocks & Exchange. The selected sample had the following conditions:

Table 1. Statistical Sample of the Research

The number of companies that are members of the statistical population in March 2009:	333
Is subtracted:	
Companies that have been admitted to the Tehran Stock & Exchange after 2008 and have been eliminated from the list of stock market companies until March 2021.	11
Companies that have changed their fiscal year during the study period.	9
Investment, financial, and intermediary companies.	44
Companies whose financial information was required for calculating the research variables for them was not available during the study period.	4
The number of companies that are members of the statistical sample:	265

The date of their admission to Tehran Stocks & Exchange should be one year before 2009 and also they should have remained on the list of the stock market companies until 2020. Considering the existence

of loss and profit data in the research models, and in order to increase the comparability of the information, they shouldn't have changed their fiscal year during the under-study period. The financial information required for calculating the research variables for those companies should be available during the research period. The investment, financial, and intermediary companies have been eliminated from the selected research sample due to having different fiscal years from other companies. Finally, a total of 265 companies were selected considering the abovementioned limitations. Table (1) shows how the study sample has been selected.

4 Research Hypotheses

Despite various external and internal researches in the field of using accrual models to detect profit management, fraud, and Restatement of Financial Statements Using composite models for such predictions to predict probability Restatement of Financial Statements It is very limited. In this regard, the current research is trying to predict by using composite models Restatement of Financial Statements in the companies accepted in the Tehran Stock Exchange to determine whether the combined models such as Benish's model, the ability to identify Restatement of Financial Statements in Iran's economic environment? Is it possible to improve the forecasting accuracy of financial statements by developing a composite model? Increased? Is it possible to discover a pattern based on accrual and combination model variables? Restatement of Financial Statements Did you design? Based on the theoretical fundamentals and background of the research, the research hypothesis was constructed as follows:

The enhanced Beneish model with genetic algorithm has a higher efficiency in identifying the restated companies compared to the primary Beneish model. In the present study, the dependent variable was the financial restatement, which had a qualitative nature. To measure this variable, a value of 1 was assigned to the companies with financial restatements (regardless of the restatements resulting from insurance and tax) and significant restatement amount (net profit above 5%), and a value of 0 was assigned to the companies without financial restatements. Also, the independent variable in this study included the financial indices of the Beneish model.

In the present work, 8 indices of the Beneish model were assumed as the predictor variables of the financial restatements considered in the research hypothesis. In this regard:

M-SCORE=-4.84 +0.92DSRI+ 0.528GMI+ 0.404AQI+ 0.115DEPI-0.172SGAI +4.679TATA-0.327LVGI

where M-SCORE is the financial restatement score, DSRI is the day's sales in receivables index, GMI is the gross margin index, AQI is the asset quality index, SGI is the sales growth index, DEPI is the depreciation index, SGAI is the sales, general, and administrative expenses index, TATA is the total accruals to total assets index, and LVGI is the leverage index.

In this model: $$\text{DSRI}+\frac{\text{SEC t}/\text{SALES t}}{\text{SEC t}-1/\text{SALES t}-1}$$

An increase in the DSRI can be due to the changes in the credit policies for increasing the sales rate however an unproportionate increase in the receivables would result in revenue overstatement [3]

- The GMI can be obtained from the following equation. If the GMI is bigger than 1, it means that the gross margin has declined significantly. The weakening of the gross margin represents a negative sign of the companies' vision and increases the probability of profit manipulation.

$$\text{GMI}=\frac{\text{SALES t}-1-\text{COG t}-1\frac{}{\text{SALES}}\text{t}-1}{\text{SALES t}-\text{COG t}/\text{SALES t}}$$

where SALES is the annual sales rate and COG is the end price of the sold commodity.

- The AQI is measured by the following equation. If the value of this index is bigger than 1, the company has potentially increased the postponed expenses and invisible assets. Thus, the probability of profit manipulation is increased as well. In this equation, CA is the total current assets, PPE indicates the gross properties, machinery, and equipment, and ASSETS represents the total assets.

$$AQI=\frac{1-(\text{CA t}+\text{PPT t})/\text{ASSETS t}}{1-(\text{CA t}+\text{PPT t})/\text{ASSETS t}}$$

- The SGI can be obtained from the following equation. The sales growth solely doesn't represent profit manipulation but the profit manipulation is likely to occur with an increase in the sales rate compared to the previous period.

$$SGI=\frac{\text{SALES t}}{\text{SALES t}-1}$$

- The DI is obtained from the following equation. If it is bigger than 1, it means that the company has increased the estimate of the properties, machinery, and equipment. Thus, the probability of profit manipulation is increased. In this equation, DEP is the depreciation cost of the visible fixed assets and PPE is the gross properties, machinery, and equipment.

$$DEPI=\frac{\text{DEP t}-1/\text{PPE t}-1}{\text{DEP t}/\text{PPE t}}$$

- The SGAI is measured by the following equation. A big value of this index is indicative of the negative sign of the company's future vision. Thus, there is a probability of profit manipulation. In this equation, SGA, EXP represents the sales, general, and administrative expenses and SALES indicates the annual sales rate.

$$SGAI=\frac{\text{SGA,EXP t}/\text{SALES t}}{\text{SGA,EXP t}-1/\text{SALES t}-1}$$

- The TATA is calculated by the following equation. The probability of profit manipulation is associated with an increase in the accruals. In this equation, ACC indicates the accruals (the difference between the operational profit and the operational cash flow) and ASSETS represents the total assets of the current year.

$$TATA=\frac{\text{ACC t}}{\text{ASSETS t}}$$

- The LVGI is measured by the following equation. If the value of this index is bigger than 1, it indicates the increased probability of profit manipulation. In this equation, LTD is the total long-term debts, CL is the total current debts, and ASSETS represents the total assets.

$$LVGI=\frac{\text{LTD t}+\text{CL t}/\text{ASSETS t}}{\text{LTD t}-1+\text{CL t}-1/\text{ASSETS t}-1}$$

5 The Process of Selecting the Indices of the Enhanced (Improved) Beneish Model for Being Imported in to the Model

In this study, 8 financial indices of the Beneish model are the predictor variables of the intended financial restatements in the enhanced model. In this regard:

In the first stage, a total of 8 financial indices of the Beneish model were extracted from the financial statements of the selected companies. In the second stage, using the independent t-test to compare the

average values of the variables in the two "restatement" and "non-restatement" groups in the SPSS software, two indices that had a significant relationship with the financial restatements were selected.

In the third stage, the stepwise regression test was used to select the best ratios for predicting financial restatements. For this purpose, the following two ratios were selected as the final financial indices:

TATA and (b) LVGI

Table 2: The Best Indices for Predicting the Financial Restatements by Stepwise Regression

Step 7a	Beta coefficient	Standard estimation error	Wald test	Degree of freedom (DOF)	Statistical significance	Occurrence probability
TATA	-0.784	0.259	9.173	1	0.002	0.457
LVGI	0.250	0.259	12.624	1	0.000	1.284
Constant value	-0.259	0.088	8.690	1	0.003	0.772

A iiii tive vll ee ff β iiii aatss tttt tee vrr illl e ll yys a mrr e imrrr tttt rll e in tee cccrr rccce ff the ficccc ill rssttt mmttt .. On tee tt rrr ,,,,, , gggtt ive vll ee ff β is iiii aative ff a rrrr rrr rll tt inn ff that variable with the occurrence probability. A negative value of the regression coefficient is not indicative of anything. Considering the obtained Wald statistic and significance level, if the significance level is smaller than 0.05, the independent variable coefficient will be significant. As such, if the absolute value of the Wald statistic calculated by the statistical software is bigger than 1.96 (i.e. the value of standard normal distribution at a confidence level of 0.95), then the hypothesis H0 will be rejected. The rejection of the H0 is indicative of the effect of the independent variable on the dependent variable. Al,,, tee cccrr rccce rr iiiii iity ff tee ficccc ill rssttt mmttt ,, tee ((((β) will irrr aaee. T,,,, , ii g positive value of the coefficient indicates a powerful dependence of the occurrence probability of the financial restatements on the independent variables. The results of the Table (2) show that the value of the Wald test statistic of the variable TATA is equal to 9.173, which according to the significance level of 0.002 is smaller than 0.05, at the 95% confidence level of the assumption H1 is confirmed. Therefore, the variable TATA has a significant relationship with restatements financial statements. Also, regarding the index variable LVGI, according to the significance level of 0.000, it is smaller than 0.05, at the confidence level of 95%, hypothesis H1 is confirmed. Therefore, the index variable debt ratio has a significant relationship with restatements financial statements.

6 Research Findings

First, the descriptive statistics of the financial restatements of 265 studied companies (for the years 2009 to 2019) are presented in Table (3).

As indicated by the results in Table (3), out of 2915 samples (year-company), 1448 samples (49.7%) haven't had financial restatements and 1467 samples (50.3%) have had financial restatements, indicating the equal number of both companies with and without financial restatements.The descriptive statistics of the financial and nonfinancial ratios used in the prediction models are presented in Table (4).

Table 3: Frequency of Financial Restatements

Financial restatement	Quantity (year-company)	Percentage
No	1448	49.7
Yes	1467	50.3
Total	2915	100

The most important central index is the "mean", which indicates the point of balance and is the center of gravity (center of mass) of the distribution. For example, in Table (4), the mean value of DSRI is equal to 5.28, indicating that most of the data related to this variable are concentrated on this point.

Table 4: Descriptive Statistics of the Indices of the Beneish Model

Factor	Mean	SD	Skewness	Kurtosis	Min	Max
DSRI	5.28	100.41	33.17	1168.04	0.00	3746.77
GMI	1.13	7.87	27.93	1296.12	-122.63	346.05
AQI	1.43	6.75	16.17	437.49	-99.42	208.33
SGI	1.53	15.14	50.67	2657.29	0.00	799.56
DEPI	1.24	4.00	30.88	1076.95	0.01	158.25
SGAI	1.33	6.04	42.54	2034.88	-14.92	598.79
TATA	0.015	0.151	46.2	43.42	-1.05	2.53
LVGI	1.14	0.618	6.56	81.32	0.051	12.34

The dispersion parameters are generally the criteria for determining the dispersion of data from each other or their dispersion from the mean. One of the most important parameters of dispersion is the standard deviation. The value of this parameter for the aforementioned variable is equal to 100.41, which indicates the dispersion of this variable around the mean. The asymmetry value of the frequency curve is called skew ness. If the value of the skewness coefficient is zero, it indicates the population is completely symmetric. But the positive and negative values of this coefficient represent skewness to the right and skewness to the left, respectively. For example, the skewness coefficient of the DSRI variable is equal to 33.17, indicating that this variable has a skewness to the right. If the value of kurtosis is about 3, the frequency curve has a normal and balanced status in terms of kurtosis. But in the case of values bigger than 3, the curve will be peaked and in the case of values smaller than 3, the curve will be wide. The kurtosis values of all variables of this study are bigger than 3.

6.1 Findings Beneish Model

To test the research hypothesis, the accuracy and error of the main Beneish model (1999) were examined in both groups of companies with and without financial restatements. As can be seen in Table (5), the correct prediction of the model in the "restatement" and "non-restatement" groups is equal to 70% and 25%, respectively. Also, the incorrect prediction of the main Beneish model is 30% in the "restatement" group and 75% in the "non-restatement" group. Moreover, the accuracy and total error of the main Beneish model have been estimated to be 29.43% and 70.57%, respectively. Therefore, the Benish model correctly predicted only 78 companies out of a total of 265 companies in the Iranian capital market.

Table 5: Identification of the Companies Using the Beneish Model

$\boldsymbol{M-Score} = -4.84 + 0.92DSRI + 0.528GMI + 0.404AQL + 0.892SGI + 0.115DEPI - 0.172SGAI + 4.679TATA - 0.327LVGI$					
The primary Beneish model (1999)					
M<-1.78					
Group	**Observation**	**Accuracy**	**Error**	**Correct prediction**	**Incorrect prediction**
Companies with restatement	27	19	8	70%	30%
Companies without restatement	238	59	179	25%	75%
Total	265	78	187		
Overall accuracy of the model	(19+59)/265=29.43				
Overall error of the model	(8+179)/265=70.57				
100*(total number of restated companies + number of non-restated companies)/(accuracy of the number of non-restated companies + accuracy of the number of restated companies)=overall accuracy of the model					
100*(total number of restated companies + number of non-restated companies)/(error of the number of non-restated companies + error of the number of restated companies)=overall error of the model					

6.2 Developing the Model Using a Genetic Programming Model

After getting familiar with this concept, the algorithm proposed in this study can be presented. First, the optimization parameters used in this algorithm should be presented. This has been done in the following section. Table (6) shows the input specifications of the algorithm.

By starting the algorithm, first, the inputs enter the network and the network performs its light training once and presents the weights. In the next stage, based on the obtained values, the value of cost function in this algorithm is calculated as error. The input is introduced to the algorithm. In the following sections, we will review the changes occurring during the optimization. In this regard, it will be attempted to shows the changes during the optimization properly

Table 6: Input Specifications of the Algorithm

Variable	Value
Name of the optimization algorithm	Genetic
Type of the neural network	Feedforward network
Number of neurons	10
Cost function	$MSE \cong \frac{\left\| +T\ 0\ Network(I), \right.^{2}}{\overline{N}}$
Network training function	Levenberg-Marquardt algorithm
Network performance function	MSE
Number of optimization cycles	Reaching convergence in the value of cost function
Number of individuals (initial population variable) entering the optimization	100

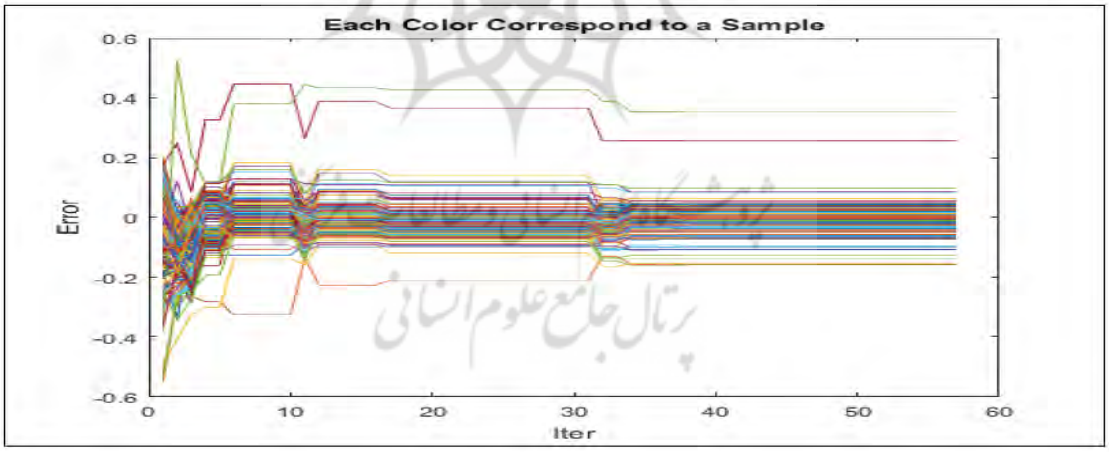

Fig.4: The changes in the network's accuracy during the optimization

Fig (4) shows the error variations during the optimization. As can be observed, the intensity of the changes has been high at the beginning but with the proceeding of the optimization cycles, the intensity of the error variations decreases so that from the middle of the optimization process, the error intensity has been as small as the percentage deciles, indicating the accuracy of the algorithm in a maximal optimization. Furthermore, the error rates calculated in the neural network and the improved neural network are compared in the following table.

Table 7: Comparison of regular neural network and GA-optimized neural network

Name of network	Regular neural network	Genetic algorithm-optimized neural network
Mean squared error	5.176e-4	2.285e-4
Improvement level	**55.8%**	

As can be seen in Table (7), after applying the optimization process has led to a nearly 56% optimization in the optimized neural network compared to the regular network and also has led to a considerable reduction in the error rate. The regression graph of the regular neural network is presented in Figure (5).

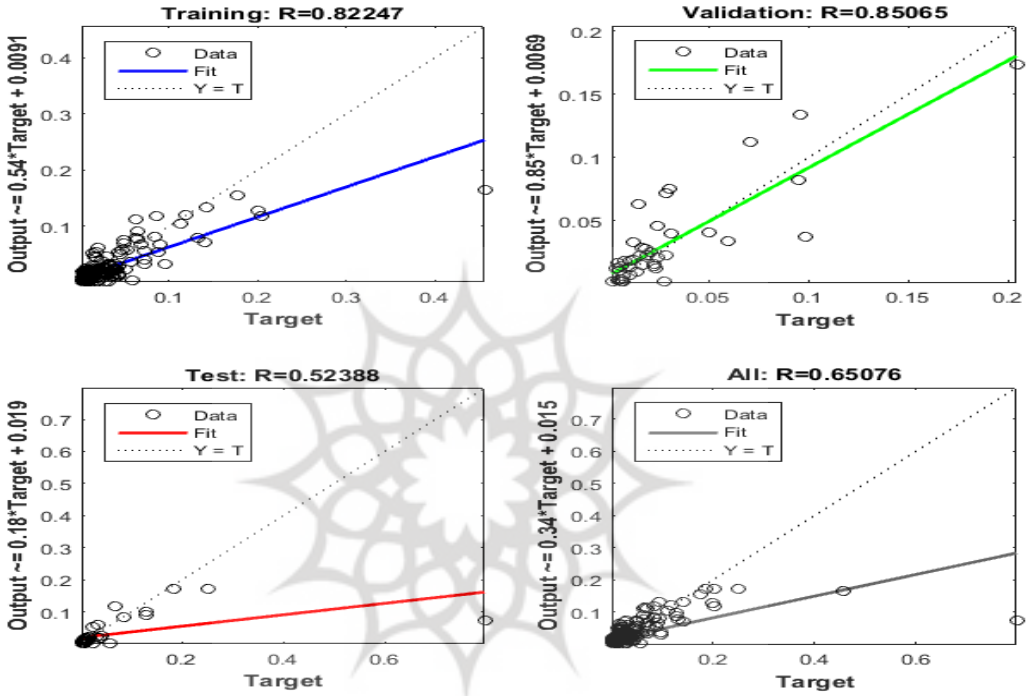

Fig. 5: Regression graph in the artificial neural network

According to the results in Figure (5), the regular neural network could predict the variable's variance up to 52% so, considering the 56% optimization in the GA-optimized neural network, this prediction will be much better in this algorithm. After optimization by genetic algorithm, the existing population (chromosomes) converged and almost all populations exhibit the same equation, which had been presented due to reaching the absolute extremum point of the regression function and all chromosomes inclined toward this optimal value. As mentioned above, after the optimization, all the existing chromosomes reached a good convergence and the first raw of this table, which is the superior chromosome in the final superior population, will constitute the main and optimal coefficients. The obtained equation between the financial restatements and the input variables based on the GA-based optimization is as follows: $--Score$ = -0.46 – 0.60 (TATA) + 0.84 (LVGI)

6.2.1 Validity of the Genetic Programming Model

To evaluate the validity of the genetic programming model, data of 265 companies underwent primary examination. Then, by using the genetic programming model and substituting the data in the obtained

model, the following results were obtained:

Table 8: Validity of the Genetic Programming Model

$S-Score$ = -0.46 – 0.60 (TATA) + 0.84 (LVGI)					
Observations			**Restated**		**Model accuracy**
			0	**1**	
Disconnection point = 0/05	**Restated (real)**	**0**	TN=186	FP=52	78/15
		1	FN=19	TP=8	26/63
	Overall accuracy percentage of the model				**73/21**

As shown in Table (8), the predictor variables could identify and classify the companies in terms of restatement or non-restatement with an overall accuracy of 73.21%.

According to table (8), the correct prediction of the model is 4% (8 companies) in the renewal group and 96% (186 companies) in the non-renewal group. Also, the incorrect prediction of Benish's main model is 27% (19 companies) in the renewal group and 73% (52 companies) in the non-renewal group. The results obtained from the confusion matrix are as follows:

TP=8: means that out of the 265 samples that we considered for the test, 8 correctly predicted the positive answer.

FP=52: indicates that out of the total number of 265 test samples, 52 items whose answer was positive were predicted with a negative error.

TN=186: means that out of the total number of 265 test samples, he correctly predicted the number of 186 samples whose answers were negative.

FN=19: indicates that out of the total number of 265 test samples, 19 samples has a negative answer It was wrongly predicted.

7 Assessment of the Efficiency of the Models

To assess the efficiency of the research models, after implementing the confusion matrix with Python software, the following results were obtained:

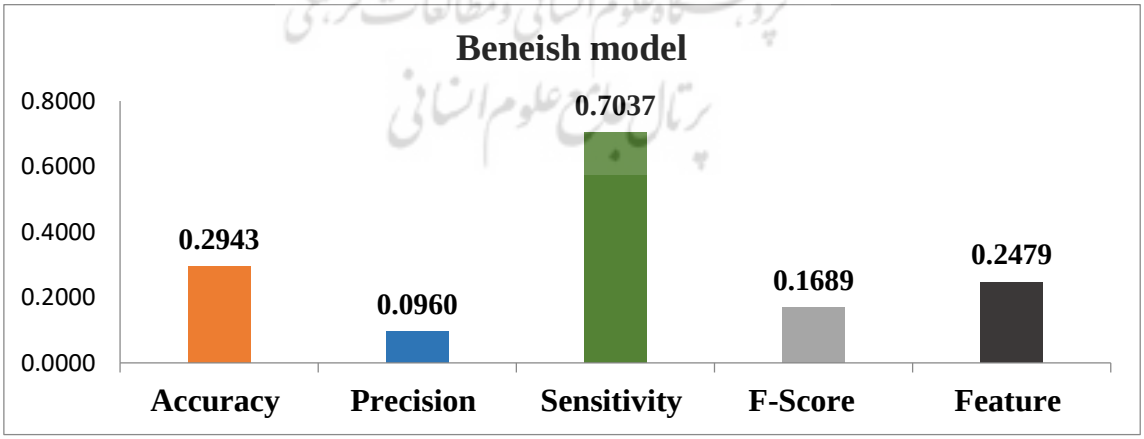

Fig.6: Output graph of the confusion matrix using the Beneish model

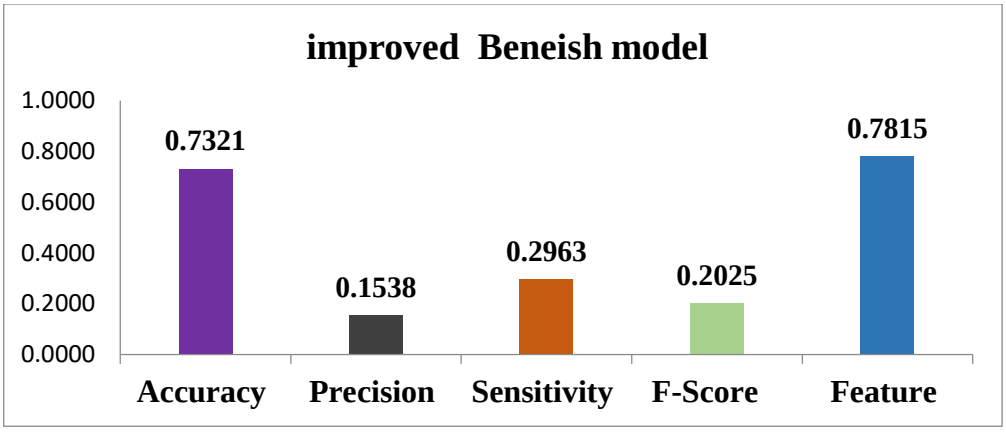

Fig.7: The output graph of the confusion matrix using the genetic programming model

As can be seen in Fig (6), the accuracy of the Beneish model for predicting the financial restatements in the capital market of Iran has been 29.3%, indicating that the Beneish model solely cannot predict the financial restatements in Iran. Also, the accuracy of the GA-enhanced Beneish model (Fig.7) for predicting the financial restatement has been 73.21%, indicating that the efficiency of the GA-enhanced Beneish model in identifying the restated companies compared to the Beneish model (1999). Thus, the main hypothesis of the stud is approved. Sensitivity represents the true positive predicted values against all true positive outputs. In other words, the indicator The proportion of companies that are correctly with Restatement of Financial Statements have been identified.The sensitivity of Benish's improved model was equal to 29/63%. The reason for its low level is the imbalance between the companies Restatement of Financial Statements and companies Absence Restatement of Financial Statements (238 companies against 27 companies).

8 Conclusion

The present study aimed to predict the probability of financial restatements based on the primary Beneish model and the genetic algorithm-based enhanced Beneish model. For this purpose, first, the primary Beneish model was tested, based on the results of which the overall accuracy and error of the primary Beneish model was estimated to be 29.43% and 70.57%, respectively. In the next stage, to construct the enhanced Beneish model, the stepwise regression test was used to select the best ratios for predicting the financial restatements. In this regard, two TATA and LVGI were selected as the final financial indices. Afterward, using the results obtained in the previous stages and using the genetic programming model as the representative of the metaheuristic methods, it was attempted to estimate the model for predicting the probability of financial restatement of the companies accepted to the Tehran Stock & Exchange. Then, by comparing the primary Beneish model and the enhanced Beneish model, the best model and method for prediction were selected. The research hypothesis states that the efficiency of the GA-enhanced Beneish model in identifying the restated companies is higher than the primary Beneish model. Results of the test data of 2020 indicate that the overall accuracy of the prediction of the primary Beneish model was 29.43% while the same value is predicted be 73.21% for the GA-enhanced Beneish model.Therefore, the research hypothesis is approved and, accordingly, the efficiency of the GA-enhanced Beneish model in identifying the restated companies is higher than the primary Beneish model. Based on the obtained results, the following suggestions are presented:

- Considering the importance of financial restatements and the need for further studies in this

field, it is suggested to researchers to use the presented models as the representative of the financial restatements for companies.

- Since, according to the statistical methods, the selected final indices have the highest potential for predicting the probability of financial restatements, it is recommended to the audits, investors, creditors, and all users of the financial reports of the companies to pay special attention to these ratios in their analyses.
- Since the metaheuristic models (e.g. neural networks, genetic algorithm) have higher prediction capability compared to the single methods (e.g. Beneish model, Altman), it is recommended to the researchers to use the metaheuristic methods and models in tier analyses.
- Since the financial restatements can result from financial insolvency, bankruptcy, fraud, it is recommended to the supervisory and regulatory institutions such as tax organization, Stocks & Exchange Market, to use the extracted model of this study in their analyses.

Results of the present work can be a basis for developing the studies on financial restatements. Thus, the following suggestions are presented for future studies:

- Since in the present study, the Beneish profit manipulation model and its indices were selected as the representative of financial restatements, it is recommended to use other models and criteria (e.g. Altman, Falmer, bankruptcy prediction models) for predicting the financial restatements.
- In this study, to predict the probability of the financial restatements in a company, the financial indices of all industries were used. Thus, it is recommended to use these factors and indices separately for each industry for predicting the probability of financial restatement in companies.
- In this study, the metaheuristic model of the genetic optimization algorithm (neural-genetic simulation) was used. Therefore, it is suggested to use multiple metaheuristic models (e.g. ant colony algorithm, artificial bee colony algorithm, PSO) in the future studies and then compared the results and, thereby, select the best model.

The current research, like other researches, has faced a series of limitations. The limitations of the research are mainly related to the factors that affect the generalizability of the results in some way. The most important limitations of this research are:

- Impossibility of using corporate governance features such as: lack of audit committee, lack of internal audit in some listed companies, etc.

- In this research, due to the fact that the effect of the industry is not taken into account and only based on the financial indicators of the Benish model and without considering the financial and non-financial ratios of the effect, we have predicted the possibility of re-presenting the financial statements of the companies, so the results should be interpreted with caution.

References

[1] Abbott, L.J., Parker, S., and Peters, G.F., Audit Committee Characteristics and Restatements, Auditing: A *Journal of Practice and Theory*, 2004; 23(1): 69-87. Doi: 10.2308/aud.2004.23.1.69

[2] Accounting Standards Committee, Principles and Criteria of Accounting and Auditing, Accounting Standards: Standards 1 to 29, *Journal 160 of Accounting Organization*, 15th Edition, 2009

[3] Beneish, M. D, Lee, C, Press, E, Whaley, B, Zmijewski, M, Cisilino, P., The detection of earnings manipulation, *Financial Analysts Journal*, 1999; 55(5):24-36.

[4] Carcello, J., Palmrose, Z., Auditor litigation and modified reporting on bankrupt clients, *Journal of Accounting Research*, 1994; 32:1-30. Doi: 10.2307/2491436

[5] Chenlung, Chin; Hsin-Yi, Chi., Reducing Restatements with Increased Industry Expertise, *Contemporary Accounting Research*, Toronto: 2009; 26(3): 4. Doi: 10.1506/car.26.3.4

[6] Coca, T. C., Marian, S., Veronica, G., Dan-Andrei, C., Fiscal and Accounting Fraud Risk Detection Using Beneish Model a Romanian Case Study, *International Journal of Business and Society*, 2021; 22(1): 296-312. Doi: 10.33736/ijbs.3176.2021

[7] Dechow, P. M., Ge, W., Larson, C. R., Sloan, R. G., Predicting material accounting misstatements: predicting material accounting misstatements, *Contemporary Accounting Research*, 2011;28:17-82. Doi:10.1111/j.1911-3846.2010. 01041.x

[8] Dikmen, B., Küçükkocaoglu, G., The Detection of Earnings Manipulation: the three phase cutting plane algorithm using mathematical programming, *Journal of Forecast*, 2010;29(5): 442–466. Doi: 10.1002/for.1138

[9] Freed, N., Glover, F., A Linear Programming Approach to the Discriminate Problem, *Decision Sciences*, 1981; 12: 68-73. Doi: 10.1111/j.1540-5915.1982.tb00139.x

[10] Gertsen. F., Van Riel C., and Berens, G., Avoiding reputation damages in financial restatements, *Long Range Planning*, 2006; 39 (3), 429-456. Doi: 10.1016/j.lrp.2006.09.002

[11] Impink, J., Earnings manipulation and bankruptcy: WorldCom, Bachelor Paper, *University of Amsterdam*, 2010

[12] Khajavi, S., Ghadirian Arani, M., Investigating Effect of Profit Quality on Financial Restatements, *Accounting Advancements*, 2015; 7(2):54-89. Doi: 10.22099/JAA.2016.3546

[13] khaksari, I., shoorvarzi M, mehr azin A, masih abadi A., Developing a local model to detect the unethical behavior of managers in financial reporting. *Mieaoi*; 2021;10(36) :325-351.

[14] Kheirollahi, F., Eyvan, F., Mohebbi, E., Consequences of Failure of Financial Reporting for Non-Obliged Managers, *Experimental Studies on Financial Accounting*, 2017; 4(54): 109-132. Doi: 10.1111/j.1475-679x.2005.00172.x

[15] Lehenchuk, S., Mostenska, T., Tarasiuk, H., Polishchuk, I., and Gorodysky, M., Financial Statement Fraud Detection of Ukrainian Corporations on the Basis of Beneish Model, *International Conference on Business and Technology2020*; 1341-1356. Doi: 10.1063/5.0079051

[16] Lev, B., Corporate earnings: Facts and fiction, *Journal of Economic Perspectives*, 2003; 17 (2): 27-50. Doi: 10.1257/089533003765888412

[17] Linn, Erik; Diehl, Kori, Financial Restatements Causes, Consequences, and Corrections, Strategic Finance, *Accounting and Tax Periodicals*, 2005; 87(3): 34.

[18] MacCarthy, J., Using Altman Z-score and Beneish M-score models to detect financial fraud and corporate failure: a case study of Enron corporation, *International Journal of Finance and Accounting*, 2017; 6:159-166. Doi: 10.5923/j.ijfa.20170606.01

[19] Namazi, M., Investigating Application of Agency Theory in Management Accounting, *Journal of Social Sciences and Humanities of Shiraz University*, 2006; 22(43):147-164.

[20] Nevisi, F., Allivar, A., Nazari, R., Changes in Accounting and Correction of Mistakes, *Journal 65 of Accounting Organization*, 8th Edition, 2005

[21] Nikbakht, M., Rafiei, A., Compiling the Model of Factors Affecting Financial Restatements in Iran, *Knowledge of Accounting*, 2012; 3 (9):167-194.

[22] Oanh, Nguyễn Thị Kim, Nguyen Van Dinh, Nguyen Cam VAN, Associations of Board Size, Audit Reputation, and Debt with Financial Restatement: Evidence in Vietnam, *Proceedings of the International Conference on* Emerging Challenges: Business Transformation and Circular Economy, ICECH ,2021. Doi: 10.2991/aebmr.k.211119.012

[23] Palmrose, Z. V, Richardson, V. J, Scholz, S., Determinants of market reactions to restatement announcements, *Journal of Accounting and Economics*, 2008; 37(1): 59-89. Doi: 10.1016/j.jacceco.2003.06.003

[24] Papik, Mário, Papikova, Lenka, Detection Models for Unintentional Financial Restatements, *Journal of Business Economics and Management*, 2020; (21): 64-86. Doi: 10.3846/jbem.2019.10179

[25] Radestani, G., Tatlli, R., Prediction of Profit Manipulation: Developing a Model, *Accounting and Auditing Analyses*, 2016; 23(1):73-96. Doi: 10.22059/ACCTGREV.2016.57021

[26] Rezaee, Z., Causes, consequences and deterrence of financial statement fraud, *Critical Perspectives on Accounting*, 2005;16(3): 277-298. Doi: 10.1016/S1045-2354(03)00072-8

[27] Saei, Mo., Bagherpoor Valashani, M., Mousavi Bayegi, S., Investigating Frequency and Importance of Financial Restatements, *Financial Accounting Studies*, 2013; 5(1): 67-86.

[28] Svabova, L., Kramarova, K., Chutka, J., Strakova, L., Detecting earnings manipulation and fraudulent financial reporting in Slovakia, *Oeconomia Copernicana*, 2020; 11(3): 485-508. Doi: 10.24136/oc.2020.020

[29] Unegbu, A. O., Advances in modeling for falsified financial statements, *International Journal of Finance and Accounting*, 2013; 2 :37-54. Doi: 10.5923/j.ijfa.20130201.06

[30] Valaskova, K., Fedorko, R., Beneish M-score: A measure of raudulent financial transactions in global environment? *SHS Web of Conferences* ,92: 02064, EDP Sciences 2021.