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Comparison of the Prediction Accuracy of Earning Manipulation in Development of the Beneish Model by combination of Artificial Neural Network and Imperialist Competition and Particle Swarm Optimization Algorithms

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Abstract

According to Beneish (1999), "earnings manipulation happens as an instance where management violates Generally Accepted Accounting Principles (GAAP) in order to beneficially represent the firm's financial performance." In this research, the development of the Beneish model (DBM) was done through emphasizing non-accounting variables, including the Information Asymmetry (IS) and Product Market Competition (PMC). The data was collected for 184 companies listed in Tehran Stock Exchange (TSE) during the past 11 years 2006-2017. The predictive accuracy of research models by combination of Artificial Neural Network(ANN) and Imperialist Competition Algorithm (ICA) compared to Particle Swarm Optimization(PSO) in the detect and identification of earning manipulator companies after estimation. The area under curve(AUC) of Receiver Operating Characteristic (ROC) of Beneish Model (BM) and the research proposed model (DBM) by the combined neural network and ICA were estimated at 0.6001 and 0.6108, respectively, and by the combined neural network and PSO were estimated at 0.538 and 0.3355, respectively. The prediction accuracy of BM and DBM by the ANN-ICA is 57.55%, 63.86%, respectively and by the ANN-PSO algorithm are 55.71% and 59.84%, respectively. Also, the reduction rate of prediction error by ANN-ICA has increased from 3.77 % to 6.13%. The AUC of the ROC in the BM was in the fail testing range, and the ability of the BM to detect and identify earning manipulator companies was rejected. With the development of the model and the incorporation of environmental variables including IS and PMC to the BM (1999), this area has increased, passed the fail testing range and improved to poor test range, but is still a poor test result and the DBM does not fully distinguish between the two groups of earning manipulator and non-manipulator companies. Also, the predictive accuracy of the research models BM-DBM by the ANN-ICA has been improved in comparison to ANN-PSO.

Key words

Imperialist competition algorithm, Product competition market, Artificial neural network, Beneish model, Information environment

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Introduction

In (1999), Beneish presented a model in order to detect profit manipulation by choosing eight accounting variables (1). His model showed that with an unusual increase in receivables, a decrease in gross profit margin, a decrease in the quality of assets, growth in sales and an increase in accruals, the possibility of profit manipulation also increases. Beneish's model was based on a study among selected companies from the United States and the studies conducted in other countries showed that the model presented by Beneish cannot have the same performance in all societies and capital markets (2). The applications of accounting figures usually have different functions in different markets, so it is not possible to identify the nature of these figures just by studying a specific market. As a result, in a world with numerous and variable countries in terms of institutions and structures, it is important to understand the applications of accounting numbers in many countries as much as possible (3). Subsequent researches based on the Beneish model to discover profit manipulation showed that the Beneish model does not have the same performance and they need to adjust, localize or use other variables to predict profit manipulation and management (4).

A fraud detection model, although effective in different societies, cannot necessarily be highly accurate and should be localized according to the economic situation of each country. The original Banish model is less accurate than the modified Banish model, which is localized for Iran's economic environment, because it does not consider Iran's economic requirements. Therefore, before the implementation of each model, fraud detection in different countries, these models should be localized based on the economic structure of that country (5). Beneish (1999) used financial ratios and accruals to predict the methods of profit manipulation. He used three sources to select the variables of his model. The first source of variables is related to the future of the firm, because it is assumed that earnings manipulation is likely when the future state of the firm is weak. The second source is variables based on cash flow and commitments based on the models of Jones (1991) and Haley (1985) and finally used the contractual hypothesis based on the affirmative theory of Watts and Zimmerman (1986). The result of his search based on the data of financial statements ended in the development of an eight-variable model.

Beneish developed his model using eight accounting variables that he extracted from the financial statements of companies, and ignored the motivational effects of the environment in which the company operates. By examining the studies and divisions made in the field of profit management and manipulation, the influencing and motivational factors for profit manipulation can be divided into accounting and non-accounting data of the company. In other words, in addition to the status of accounting data, non-accounting data such as external and environmental factors can also prepare the necessary incentives for profit manipulation and be effective in profit manipulation and management. The researchers showed that the Beneish model has a prediction power of 70% at best (4), in other words, the Beneish model detects the possibility of profit manipulation in the Iranian capital market with a 30% error, which is a very high percentage of error. Therefore, it seems that by increasing the motivational factors from the environment outside the company to manipulate profits, which have not been considered in Beneish's model, it is possible to increase the degree and predictive power of the model.

The company's competitive environment has been introduced as one of the motivating factors for profit manipulation in researches. According to the signaling hypothesis of companies operating in highly competitive industries, managers have sufficient motivation and tendency to manipulate accounting information, including profit, to signal good information about future performance. They find a company (6). On the other hand, a low competitive environment causes profit manipulation due to less supervision of management activities. But for companies active in industries with more competition, more control and supervision prevail over them than other companies, and the position of profit manipulation for these companies is very limited and weak (7). In general, there is a direct and significant relationship between the indicators of competition in the product market and the quality criteria of financial information (8). Therefore, the current research has chosen the variable of competition in the product mar-

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ket as one of the environmental variables in the development of Beneish's model in order to localize and reduce agency costs.

The resulting information asymmetry along with the theory of conflict of interest between managers and shareholders gives permission and motivation to the company's management to manage the company's information and manipulate the profit according to their will when the company has a poor performance in transparently disseminating information. And there is no monitoring and pressure for clarification, the scope for profit manipulation and providing false information increases (9). Therefore, despite the managers' motivations to apply profit management, it is necessary to examine and specify the relationship between the information environment and profit manipulation in order to provide information for better decision making by the users of these financial statements (10). Considering the effect of information asymmetry on agency costs, the current research has chosen the variable of information asymmetry as another environmental variable in the development of the Beneish model.

Several studies have investigated profit management in different situations. In most studies, it is assumed that profit is managed through accounting accruals. Therefore, models for profit management based on accruals have been developed. However, in a number of studies, the ability of these models to discover earnings management has been questioned. One of the explanations for the poor performance of the existing models is the use of a linear approach for modeling accruals, while some of the existing studies report the existence of a non-linear relationship. One of the proposed alternatives to solve the nonlinear problem is the use of different neural networks (11).

In this research, for the first time in Iran, the condition clauses of the audit report containing profit manipulation are used instead of the recognition models of accrual items to identify profit manipulation companies, because the accrual items models in the recognition of manipulation or profit management are also variables in accordance with the generally accepted principles of accounting. (GAAP) and uses variables inconsistent with generally accepted accounting principles. While the clauses in the audit report of the profit manipulation index are considered to be contradictory to GAAP, because Beneish (1999) also removed the companies that manipulate according to GAAP from the list of samples in his research, in other words only the companies that manipulate contrary to GAAP in Examples have been given. Also, in this research, the development of the Beneish model is done with emphasis on the influential variables, including information asymmetry and competition in the product market, in order to increase the degree of accuracy and predictive power of the model. Due to the fact that the research carried out in the direction of developing the Beneish model was based solely on accounting data, therefore the effects and consequences of non-accounting variables have been ignored in the development of the model, this research tries to investigate the non-linear relationships of accounting variables, consider non-accounting variables and examine the effect of both variables at the same time. In order to achieve the goals, the following questions are asked:

1- Is the Beneish model capable of predicting profit-manipulating companies?

2- Does the proposed model (Beneish's extended model) have better predictive power than the original Beneish model?

3- Is it better to predict the profit manipulation of the Beneish model and the proposed model, using the combination of artificial neural network and the optimization algorithm of cumulative movement of particles, or the combination of artificial neural network and the colonial competition algorithm?

Research Methodology

Beneish (1999) during the period of 1992-1982 has selected the data of 74 profit manipulating companies including 49 companies through SEC reports and the remaining 25 companies through the media and articles exposing profit manipulating companies. The result of their search based on the data of the financial statements was the development of an eight-variable model (as described in Table 1). The research variables are:

A) *Beneish model variables: Beneish Model (BM)*.

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Table 1. Beneish model variables

Index name	Index fragments	Equation
Days' Sales in Receivables Index	REC	$DSRI = \frac{REC_t / SALES_t}{REC_{t-1} / SALES_{t-1}}$
Gross Margin Index	Sales, COG	$GMI = \frac{(SALES_{t-1} - COG_{t-1}) / SALES_{t-1}}{(SALES_t - COG_t) / SALES_t}$
Asset Quality Index	CA, PPE, ASSETS	$AQI = \frac{1 - (CA_t + PPE_t) / TotalASSETS_t}{1 - (CA_{t-1} + PPE_{t-1}) / TotalASSETS_{t-1}}$
Sales Growth Index	Sales	$SGI = \frac{SALES_t}{SALES_{t-1}}$
Depreciation Index	DEP, PPE	$DEP = \frac{DEP_{t-1} / (DEP_{t-1} + PPE_{t-1})}{SEP_t / (DEP_t + PPE_t)}$
Sales, General, and Administrative Expenses Index	SGA.EXP, Sales	$SGAI = \frac{(SGA, EXP)_t / TotalASSETS_t}{(SGA, EXP)_{t-1} / TotalASSETS_{t-1}}$
Total Accruals to Total Assets Index	ACC, ASSETES	$ATA = \frac{ACC_t}{TotalASSETS_t}$
Leverage Index	LTD, CL, ASSETS	$LVGI = \frac{(LTD_t + CL_t) / TotalASSETS_t}{(LTD_{t-1} + CL_t) / TotalASSETS_{t-1}}$

In his model, Beneish used the explanatory variables of both groups of profit manipulating and non-manipulating companies using Probit analysis. He assigned the number 1 to the manipulative companies and zero to the non-manipulative companies and calculated the coefficients of the independent variables. The cutoff point of this model was -1.78. Therefore, if the calculated score (M-Score) is more than -1.78, it is likely that the company is a manipulator. The overall accuracy of the model was 76 percent.

In Iran, the authority or independent body of profit manipulating companies is not announced so that samples can be easily selected like Beneish, and in previous researches, accrual models including Jones model, modified Jones model, Kothari, etc. have been used. The models use both variables in accordance with the generally accepted accounting principles (GAAP) and variables inconsistent with the generally accepted accounting principles in identifying profit-manipulating companies. On the other hand, in the current research, if these models were used to select sample companies that manipulate profits, the results of the research would be flawed, because the purpose of this research is to test the Beneish model for companies that manipulate profits, because in identifying companies that manipulate or manage profits with The use of accruals models uses variables that are used in the Beneish model, so the results of the research were flawed.

To fix the mentioned problems, an alternative solution that can be used is audit reports. Because in the audit reports, the clauses indicating the profit manipulation index are considered to be contradictory to GAAP, and also in Iran, the only independent authority regarding the financial statements prepared by the companies are only the auditors who comment on the financial statements. In this research, the auditor's re-

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port was used as an alternative solution, and the review process was such that the audit report of the sample companies was fully reviewed and studied, and if it was classified as an indicator of profit manipulation (regardless of the type of report, acceptable - conditional - Rejected and no comments) is selected as a profit manipulator and the number 1 is chosen. Also, if there are no condition clauses for the profit manipulation indicator, for example, the report is conditioned for another reason, it is chosen as no profit manipulator and the number zero is chosen.

Findings

In Table 2, descriptive statistics are presented according to profit manipulation levels. According to Beneish (1999), the largeness of each of the indicators indicates the possibility of increasing profit manipulation. The descriptive mean of the indicators of days of credit sales, gross profit margin, asset quality, sales growth, total accruals of assets shows that among the indicators of the model, these indicators are more at the high level than at the low level of profit manipulation. Contrary to the belief of Beneish (1999), among the indicators of the Beneish model, the indicators of depreciation cost, general, administrative and sales expenses and the financial leverage index are lower at the high level compared to the low level of profit manipulation. Also, with the development of the model, the Herfindahl index is more at the high level of profit manipulation than at the low level of profit manipulation, and information asymmetry is less at the high level than at the low level of profit manipulation.

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Table 2. Descriptive statistics of model variables according to profit manipulation levels

Variable	Year	Min.	Max.	Mean	SD
Credit sales days index	900	0.01	9.43	1.285	1.22
Gross profit margin index	900	-5.95	8.29	1.012	0.75
Asset quality index	900	0.01	9.91	1.077	0.84
Sales growth index	900	0.46	3.42	1.147	0.25
Depreciation cost index	900	0.00	9.33	1.134	0.71
Index of general administrative costs of sales	900	0.06	9.65	1.158	0.65
Index of total accrual items to assets	900	-0.75	0.49	0.008	0.12
Financial leverage index	900	0.34	3.83	1.018	0.24
Herfindahl index	900	1.3e+۰۱	1.3e+۰4	9.0e+۰2	1.2e+۰3
Information asymmetry index	900	0.00	0.64	0.025	0.03
Credit sales days index	940	0.00	9.99	1.332	1.22
Gross profit margin index	940	-6.36	8.64	1.013	0.85
Asset quality index	940	0.00	8.66	1.096	0.78
Sales growth index	940	0.51	4.25	1.178	0.26
Depreciation cost index	940	0.00	9.82	1.090	0.81
Index of general administrative costs of sales	940	0.02	9.60	1.107	0.72
Index of total accrual items to assets	940	-0.85	0.98	0.028	0.13
Financial leverage index	940	0.27	2.99	1.013	0.23
Herfindahl index	940	9.9e+۰0	9.9e+۰3	1.3e+۰3	1.5e+۰3
Information asymmetry index	940	0.00	0.11	0.023	0.01

Figure (1) shows the training process of neural networks with the algorithm of colonial competition and cumulative movement of particles for Beneish and proposed model. The training process of convergence continued and then stopped. In the colonial competition algorithm, in comparison with the algorithm of cumulative movement of particles, convergence was achieved with more repetitions and a longer time,

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while in the algorithm of cumulative movement of particles, less time was spent for convergence. For this reason, the algorithm of colonial competition was executed once with 10,000 repetitions and the algorithm of cumulative movement of particles was executed 10 times with 300 repetitions. By increasing the number of repetitions, the amount of error is reduced and according to the values in Table 2, the combined neural network and colonial competition algorithm and the combined method of neural network and cumulative movement of particles in the proposed research model are more. Also, the amount of error reduction in the combined method of the neural network and the colonial competition algorithm is higher in the comparison of the combined neural network and the particle cumulative motion algorithm, and the error rate of each method is reported in Table 2.

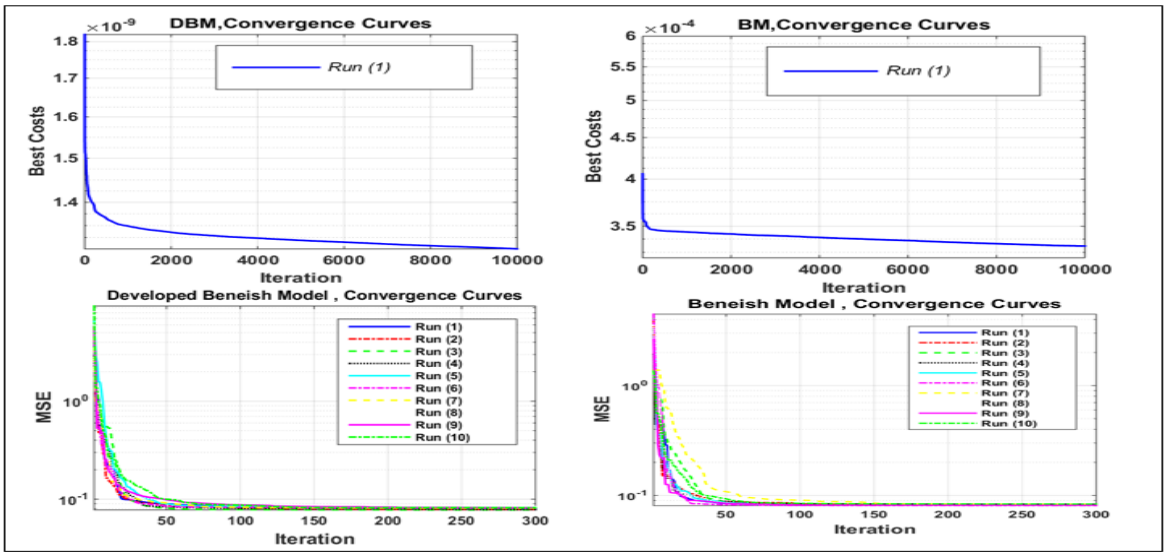

Figure 1. Convergence of MSE of the Beneish model (right) and the proposed model (left) with 10,000 iterations

As can be seen in Table 3, with the development of the Beneish model, the combined method of the neural network and the colonial competition algorithm, the training error has decreased from -4.3e to -9.30e and the combined method of the neural network and the cumulative motion algorithm of the particles has decreased from 0.0807 to 0.0777. The amount of validation error is less than the training error and it shows that by stopping at a certain number of repetitions, overtraining of the neural network has been prevented.

Table 3. The results of the models test

Method	Research model	Educational error	Validity error	Test error
Synthesis of neural network and colonial competition algorithm	Beneish model	3/3e -4	3/22e -4	3/4e -4
	Suggested model	1/30e -9	1/2e -9	1/32e -9
Synthesis of neural network and particle cumulative motion algorithm	Beneish model	0.0816	0.0743	0.0825
	Suggested model	0.0788	0.0704	0.0798

Table 4 shows the final results of the rock radar analysis test of both methods. The amount of AUC or the area under the curve of Beneish model and the proposed research model in the combined method of

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neural network and colonial competition algorithm, respectively, 0.6001 in the confidence interval 0.574-0.626 and 0.6810 in the confidence interval 0.657-0.705 and in the combined method of neural network and particle cumulative movement algorithm , 0.5538 in the confidence interval of 0.528-0.580 and 0.6335 in the confidence interval of 0.608-0.659 were estimated respectively. The level under the rock curve in the Beneish model is in the range of 0.5-0.6, and the ability of the Beneish model to detect and identify profit manipulating companies is rejected. This level has increased in the proposed model and is in the range of 0.6-0.7. Therefore, the level under the rock curve in the proposed model has passed the rejection range and has improved to the weak range, but the result of the test is still weak and the ability to separate the two groups of profit-manipulating and non-profit-manipulating companies is not complete. Also, the comparison between the combined method of the colonial competition algorithm network and the combined neural network method of the particle cumulative movement algorithm shows that the level under the rock curve in both models of the combined neural network and the colonial competition algorithm is higher than the combined neural network method and the cumulative particle movement algorithm, and it indicates the improvement of predicting the profit manipulation of the combined neural network algorithm Colonial competition in the comparison of combined neural network and cumulative movement algorithm of particles.

Table 4. Rock curve analysis

Method	Model	AUC	SD	Confidence interval	Standard AUC	p-value
Synthesis of neural network and colonial competition algorithm	Beneish model	0.6001	0.0131	0.574-0.626	7.63	1.2e-14
	Suggested model	0.6810	0.0123	0.657-0.705	14.679	0
Synthesis of neural network and particle cumulative motion algorithm	Beneish model	0.5538	0.0134	0.528-0.580	4.0287	2.8e-5
	Suggested model	0.6335	0.0129	0.608-0.659	10.009	0

According to the results of Table 4 and Figures 2 and 3, it can be seen that in each of the combined methods of the neural network and the colonial competition algorithm and the combined method of the neural network and the cumulative movement of the particles, the surface under the Rock curve or AUC is increased with the development of the model.

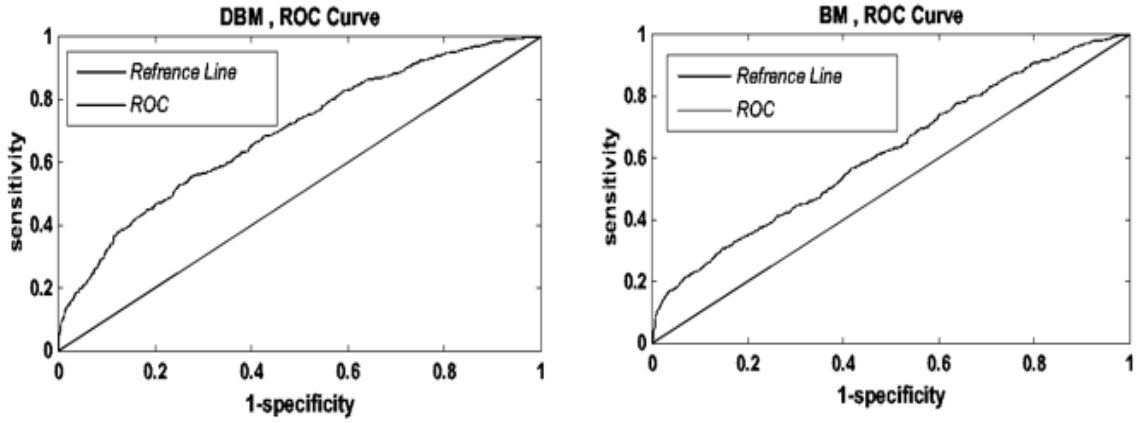

Figure 2. Rock analysis of the Beneish model (right) and the proposed model (left) in the combined method of neural network and colonial competition algorithm

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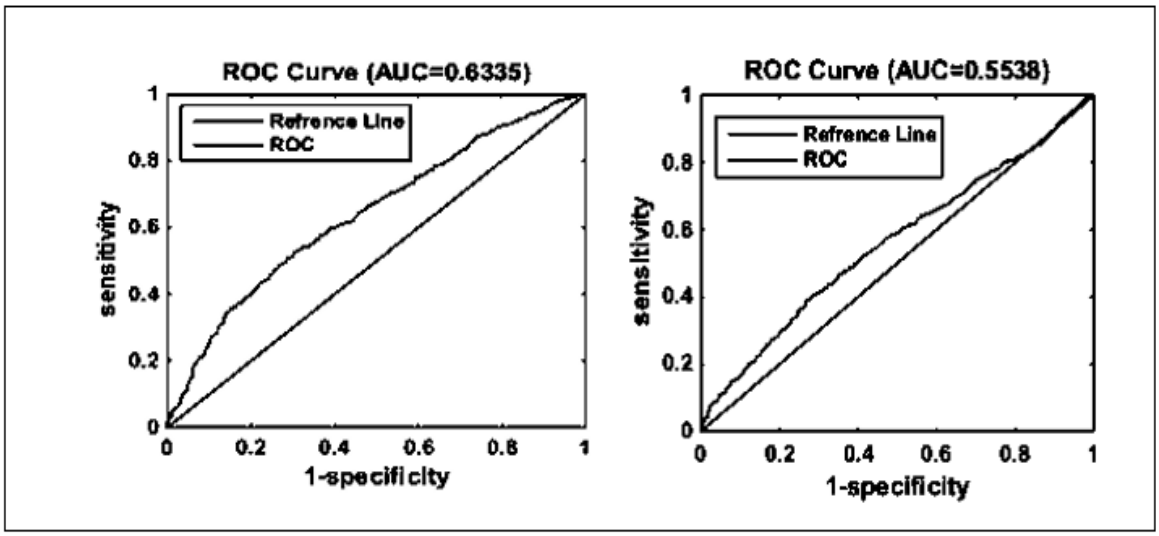

Figure 3. Rock analysis of the Beneish model (right) and the proposed model (left) in the combined method of neural network and particle cumulative motion algorithm

The validation criteria of the model are reported in Table 5, which shows that the best prediction accuracy of the Beneish model and the proposed research model in the combined method of the neural network and the colonial competition algorithm are 57.55% and 63.86%, respectively, and in the combined method of the neural network and the cumulative particle movement algorithm, respectively. It is 55.71% and 59.84%. In the combined method of the neural network and colonial competition algorithm, the accuracy of the proposed model has improved from 57.55% to 63.86%, and in the combined method of the neural network and the cumulative movement of particles, it has increased from 55.71% to 59.84%. Also, the results of Table 5 show that the accuracy of the research models using the combined method of the neural network and the colonial competition algorithm has improved in comparison to the combined neural network and the particle cumulative movement algorithm.

Table 5. Validation criteria of research models

Method	Model	Best accuracy	Best sensitivity	Best feature
Synthesis of neural network and colonial competition algorithm	Beneish model	57.55	77.77	36.44
	Suggested model	63.86	55.53	72.56
Synthesis of neural network and particle cumulative motion algorithm	Beneish model	55.71	39.04	73.11
	Suggested model	59.84	41.38	79.11

According to Derrac (2011) findings, correct statistical tests should be performed to evaluate the performance of heuristic algorithms. The mean and standard deviation cannot be enough to compare the mod-

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els. In order to judge whether the results of the proposed model are significantly different in comparison with Beneish model of the combined neural network and the colonial competition algorithm and the combined method of the neural network and the cumulative particle movement algorithm, the statistical significance method of the Wilcoxon non-parametric statistical test was performed at a significance level of 5%. The calculated P-value of the Wilcoxon test will be less than 5% as evidence against the null hypothesis and the opposite hypothesis (research hypothesis).

Table 6. The results of the Wilcoxon-Man-Whitney test

Method	Distribution	z-value	One way p-value	Two way p-value	Result
Synthesis of neural network and colonial competition algorithm	Normal	54.105	0	0	Null hypothesis rejected
Synthesis of neural network and particle cumulative motion algorithm	Normal	14.91	0	0	Null hypothesis rejected

The results of the Wilcoxon test are reported in Table 6. The z-value of the Wilcoxon test in each of the combined methods of the neural network and the colonial competition algorithm and the combined method of the neural network and the cumulative movement of particles is greater than the critical value of 1.64 and the significance level of the test is less than 0.05. Also, the average rank of the Wilcoxon test before the development of the model was 5.548 and after the development of the model was 5549.7, so the null hypothesis based on the absence of a significant difference between Beneish's model and the proposed research model is rejected and the research hypothesis is confirmed.

Discussion

In this research, with the combined method of neural network and colonial competition algorithm and the combined method of neural network and cumulative movement of particles, the forecasting ability of profit manipulating companies was investigated using the Beneish model, and then according to the necessity of its localization, two additional variables were used in addition to the main variable used in the model. Beneish has taken a step towards the development of the model and the predictive power of the proposed research model is also measured based on selected environmental variables and a comparison is made between the accuracy of the proposed model (developed by Beneish) and the original model of Beneish based on each method in identifying profit-manipulating companies.

The surface under the curve of the Beneish model was estimated to be 0.6001 in the combined method of the neural network and the colonial competition algorithm, with a confidence interval of 0.574-0.626, and 0.5538 in the combined method of the neural network and the cumulative particle movement algorithm, with a confidence interval of 0.528-0.580. The level under the rock curve in the Beneish model is in the range of 0.5-0.6, and the result of the test of the Beneish model in the detection and identification of profit manipulating companies is rejected. Therefore, it can be seen that the separation of two groups of profit manipulating and non-profit manipulating companies is not significantly different from chance separation, and it can be stated that the Beneish model in the Tehran Stock Exchange is a completely random model and cannot be used to identify profit manipulating companies. Also, the best prediction accuracy of the Beneish model, the combined method of the neural network and the colonial competition algorithm, and the combined method of the neural network and the cumulative movement algorithm of particles are estimated to be 57.55% and 55.71%, respectively. The findings show that the error of the primary vision model is relatively high.

By introducing the environmental variables of competition in the product market and information asymmetry and developing the Beneish model, the surface under the curve of the proposed research model in the

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combined method of the neural network and the colonial competition algorithm is 0.6810 in the confidence interval 0.657-0.705 and in the combined method of the neural network and the cumulative movement of particles 0.6335 in the confidence interval 0.608 Estimate 0.659-0. This level has increased in the proposed model and is in the weak range of 0.6-0.7. Therefore, the test result of the proposed model in detecting and identifying profit manipulating companies has passed the test rejection range and improved to the weak range, but the test result is still weak and it can be said that the proposed model is also an almost random model. Also, the best forecasting accuracy of the model proposed by the research was estimated to be 63.86% and 59.84%, respectively.

Also, the comparison between the combined method of the colonial competition network and the combined method of the neural network and the cumulative particle movement algorithm shows that the level under the rock curve in both models, both the combined neural network and the cumulative particle movement algorithm, has increased. In addition, the estimated rock sub-curve of the combined neural network and algorithm has increased. The colonial competition is more in the comparison of combined neural network barouche and cumulative particle movement algorithm. In the combined method of neural network and colonial competition algorithm, the accuracy of the proposed model has improved from 57.55% to 63.86%, and in the combined method of neural network and cumulative particle movement algorithm, it is evident from 55.71% to 59.84%. Also, their findings showed that the prediction accuracy of the research models using the combined method of the neural network and the colonial competition algorithm has improved in comparison to the combined neural network and the particle cumulative movement algorithm.

Increasing the accuracy of the prediction of the proposed model, the effectiveness of the introduction of environmental variables into the Beneish model, because this issue leads to a not so significant reduction in the prediction error of the wind model, the combined method of the neural network and the cumulative movement algorithm of the particles and the combined method of the neural network and the movement algorithm of the colonial competition, respectively, from 29 44.5% to 40.52% or 3.77% and from 42.45% to 36.32% or 6.6% and it has improved the predictive power of Beneish model to some extent.

Although the reduction of profit prediction error of the combined neural network and the colonial competition algorithm is more than the reduction of the prediction error of the combined neural network and particle cumulative movement algorithm, but it can be seen that relying only on these variables, it is easy to identify companies that manipulate profit and non-manipulating profit. Considering that the development of the Beneish model with the variables of competition in the product market and lack of information asymmetry has caused a significant improvement in the prediction accuracy of the Beneish model, it can be seen that there is a non-significant relationship between these variables and the profit manipulation variable, which has improved the prediction accuracy of the Beneish model. In this regard, the results of this research are consistent with the findings of other researchers (7, 9, 10, 12-14).

Since Beneish's primary model does not have good power to identify profit manipulation levels and has low accuracy in forecasting, and nonlinear methods are superior to linear methods, it can be stated that the results of this research are in line with the findings of other researchers' studies (3, 6, 15, 16). But regarding the modified and developed models of Beneish (1999) in other studies (4-6, 16, 17) which are able to identify profit manipulators and non-manipulator companies, it is contradictory with the findings of this research.

It is recommended for users to pay attention to accounting variables and financial statement items in order to discover profit manipulation, to pay enough attention to non-accounting, motivational, environmental, etc. variables. Although the findings of the research are not very meaningful, the environmental variables of competition in the product market and information asymmetry have been proven, but still the attention and study of other variables affecting the information environment (stock turnover frequency, illiquidity criterion, company size, company growth opportunities, volatility of stock returns, institutional own-

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ership, number of shareholders) , the life of the company, etc.) the development of Beneish's model seems necessary and necessary. It is also suggested to those interested to study profit manipulation modeling by benefiting from other meta-heuristic algorithms and comparing its results with the algorithm of cumulative movement of particles in order to reduce the prediction error.

Conclusion

Failure to prepare a list of profit manipulating companies by a specific institution or organization in Iran is considered as a limitation of the research. Also, considering the conditions governing the economic and reporting environment of Iran, clauses containing profit manipulation are possible for various reasons, including sample handling in the audit report. Not to be disclosed is considered as another limitation of the research.

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