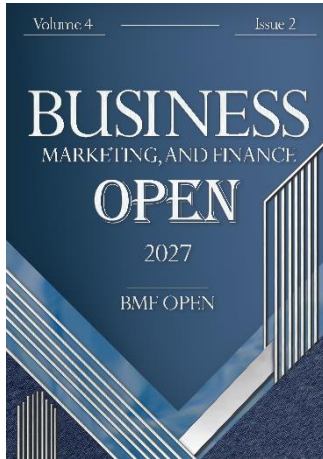


Identifying the Determinants of Financial Statement Restatements Using Artificial Intelligence

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Abstract: The present study aimed to identify the determinants of financial statement restatements using artificial intelligence. Accordingly, due to the application of both qualitative and quantitative analyses, this study is categorized as mixed-method research. In the qualitative phase, the Delphi technique was employed to complete the research model and identify the indicators affecting financial statement restatements based on the opinions of twenty-one experts selected through purposive sampling. Accordingly, twenty-one indicators were identified after two rounds of the Delphi technique. Subsequently, using data from 114 companies operating in the capital market selected through a screening method, and applying the artificial neural network technique, the relative importance weight of each indicator was examined. The findings demonstrated that the twenty-one identified indicators, in order of importance and effect weight, included information asymmetry, audit committee independence, auditor industry specialization, related-party transactions, CEO overconfidence, corporate governance, institutional ownership, financial leverage, financial distress, operating cash flow, cash flow sensitivity, operational complexity, ownership concentration, board independence, board compensation, firm size, audit fees, profitability, social responsibility, industry competition, and auditor size.

Keywords: Financial Statement Restatement, Artificial Intelligence, Delphi Technique

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1. Introduction

Financial statement restatement is one of the most consequential manifestations of financial reporting failure because it signals that previously issued financial statements no longer provide a reliable representation of the firm's economic position and performance. Restatements may arise from errors, misapplication of accounting standards, weaknesses in internal control, managerial opportunism, changes in estimates, or more complex forms of financial misreporting, yet their common consequence is the erosion of confidence in the credibility of disclosed accounting information. In capital markets, accounting information is not merely a historical record; it is a core mechanism through which investors, creditors, auditors, regulators, and other stakeholders evaluate firm value, managerial performance, risk exposure, and future prospects. Therefore, when firms restate their financial statements, the event frequently conveys negative information about the quality of prior reporting, the effectiveness of governance mechanisms, and the reliability of managerial disclosure practices. Early research on material accounting misstatements emphasizes that restatement-

related outcomes are closely connected to accrual quality, earnings manipulation, firm performance, financing needs, and corporate governance characteristics [1]. Subsequent work similarly regards financial restatement as an observable and practically important proxy for reporting failure, because it reflects a correction of previously disclosed information and provides a measurable basis for examining financial reporting quality [2]. In this sense, restatement is not only an accounting correction but also a governance, audit, and market-information event.

The importance of financial statement restatement becomes more pronounced when one considers its economic and reputational consequences. Restatements can affect investors' perceptions, analysts' forecasts, audit relationships, executive turnover, board accountability, and the firm's broader legitimacy in the market. Studies have shown that accounting scandals and restatements may lead to governance consequences such as turnover among top managers, chief financial officers, and auditors, indicating that the market and governance system often interpret restatements as evidence of accountability failure [3]. Similarly, restatements may impose reputational costs on outside directors and audit committee members, particularly when the restatement reflects a serious failure in oversight and monitoring [4]. From a legal and professional standpoint, restatements also raise accounting and regulatory concerns because they involve the correction of financial statements that had already been relied upon by external users [5]. These consequences explain why restatement has become a central topic in accounting, auditing, governance, and capital-market research. In the Iranian context as well, restatement has received considerable attention because repeated corrections of financial statements can reduce earnings persistence, increase uncertainty, and weaken the usefulness of accounting information for decision-making [6]. Evidence from companies listed on the Tehran Stock Exchange also suggests that earnings quality is meaningfully associated with the likelihood of financial statement restatement, making restatement a key indicator for assessing the credibility of financial reports [7].

A major line of research has attempted to identify firm-level, governance-related, and market-related determinants of restatement. Corporate governance mechanisms are particularly important because effective oversight can reduce information asymmetry, constrain opportunistic reporting, and improve the quality of financial disclosure. Board structure, board independence, audit committee effectiveness, and ownership characteristics can influence the probability that errors or misstatements occur, remain undetected, or are corrected through restatement. Research on board characteristics among Tehran Stock Exchange firms indicates that the composition and features of the board of directors may affect restatement behavior [8]. More recent evidence also highlights the relevance of independent directors; for example, tainted independent directors may transmit reputational or monitoring weaknesses that affect restatement risk [9]. Board diversity and board comparability mechanisms may also shape reporting quality by improving decision processes, oversight capacity, and the interpretability of financial information across firms [10]. Audit committee characteristics are similarly important because audit committees occupy a central position between management, internal control systems, external auditors, and financial statement users. In this regard, the role of audit committee effectiveness and information asymmetry has been emphasized in explaining the quality of financial statement restatement processes [11]. These findings collectively suggest that restatement cannot be understood solely as a technical accounting issue; rather, it reflects the quality of the organizational monitoring architecture within which accounting judgments are made and reviewed.

Managerial characteristics and incentives also represent a major source of restatement risk. Financial reporting is partly shaped by managerial judgment, and when managers face strong incentives to meet earnings targets, obtain financing, preserve reputation, or maintain compensation benefits, the probability of aggressive reporting

may increase. Executive overconfidence is particularly relevant because overconfident managers may underestimate risks, overestimate future performance, and initially adopt aggressive reporting assumptions that later require correction. The relationship between executive overconfidence and financial misreporting has been theorized as a gradual “slippery slope,” whereby initially optimistic reporting decisions can accumulate and eventually become material misstatements [12]. CEO overconfidence has also been directly linked to the incidence of financial restatement, suggesting that psychological and behavioral characteristics of top executives should be considered alongside traditional financial and governance variables [13]. Incentive systems may further intensify this problem; tournament incentives, for example, can increase managerial pressure and encourage reporting choices that raise the likelihood of subsequent restatement [14]. Financial expertise within top management is another important factor. The financial expertise of chief financial officers can reduce accounting errors and improve reporting discipline, thereby affecting the probability of restatement [15]. Accordingly, any comprehensive model of financial statement restatement should include both structural governance variables and behavioral-managerial variables.

Audit-related factors constitute another critical dimension of restatement analysis. Auditors are expected to enhance the credibility of financial reporting by detecting material misstatements, assessing internal control weaknesses, and challenging managerial assumptions. However, audit quality is not uniform across engagements; it may vary according to auditor size, auditor specialization, audit fees, audit partner characteristics, and the nature of the audit-client relationship. Restatements can trigger changes in audit partners and reshape market perceptions of audit quality, especially when restatements suggest insufficient audit scrutiny in prior periods [16]. Interim restatements also have implications for the audit engagement because they reveal issues in the timing, detection, and correction of reporting errors [17]. Audit fees may likewise be associated with restatement risk, especially when audit quality moderates the relationship between audit compensation and financial reporting outcomes [18]. In addition, the textual features of Key Audit Matters reports have recently been used to recognize firms that incur financial restatements, indicating that audit reports may contain valuable signals for detecting reporting risk [19]. These developments show that audit-related information can serve not only as a compliance mechanism but also as a predictive source for identifying restatement-prone firms.

Financial condition and operational complexity are also central to the likelihood of financial statement restatement. Firms facing financial constraints, financial distress, high leverage, weak profitability, complex transactions, and volatile cash flows may encounter stronger incentives or greater difficulty in producing high-quality reports. Financial constraints can increase pressure on managers to present more favorable financial results and may reduce the resources available for robust accounting systems, thereby increasing restatement risk. Evidence from Spain demonstrates that financial constraints can influence accounting restatements [20], while evidence from firms listed on the Tehran Stock Exchange similarly indicates that financial constraints are associated with financial statement restatement [21]. Broader uncertainty may also affect reporting quality. Economic policy uncertainty has been shown to matter for financial reporting quality because uncertainty complicates managerial estimates, increases volatility, and may weaken the reliability of accounting numbers [22]. Knightian uncertainty can further affect financial restatement by creating conditions under which managers face ambiguous risks and may either behave cautiously or opportunistically [23]. Operational indicators also matter; order backlog, for example, can be relevant to revenue restatement because it reflects uncertainty in revenue recognition, delivery obligations, and future sales realization [24]. Therefore, restatement risk emerges from the interaction between financial pressure, operational complexity, managerial judgment, and reporting systems.

The market consequences of restatement further justify the need to identify its determinants accurately. Restatements affect not only internal governance processes but also external users' reactions. Investors, analysts, and other capital-market participants revise their expectations after restatement announcements because such announcements alter perceptions of earnings quality, disclosure reliability, and managerial credibility. Restatement announcements may affect investors differently depending on their size and information-processing capacity [25]. They may also influence sell-side recommendation accuracy, as analysts must reinterpret previously disclosed information and reassess firm prospects after restated reports become available [26]. Customer investors may respond to restatements in distinctive ways because their investment decisions may be shaped by both financial information and product-market familiarity [27]. Moreover, corporate communication after financial restatement plays a role in repairing trust, as firms must manage stakeholder perceptions and restore confidence in their reporting credibility [28]. These market and communication consequences indicate that the identification of restatement determinants is not only an academic concern but also a practical necessity for investors, auditors, regulators, and corporate managers.

Despite extensive prior research, the determinants of financial statement restatement remain difficult to model because restatement is a multidimensional phenomenon influenced by nonlinear relationships among accounting, governance, audit, financial, behavioral, and market variables. Traditional statistical models have contributed significantly to the literature, especially in predicting earnings management and restatement-related misreporting [29]; however, the growing complexity of financial reporting has encouraged researchers to use data mining and artificial intelligence methods. Data mining techniques have been applied to detect financial restatements and identify complex patterns that may not be easily captured by linear models [30]. Artificial neural networks are particularly suitable for modeling nonlinear and interactive effects because they can learn from data, adjust weights through training, and improve predictive performance through iterative optimization. Earlier studies on artificial neural networks in prediction contexts show that neural models can be effective tools for forecasting and classification when relationships among variables are complex and nonlinear [31]. Neural networks have also been used in financial distress prediction, where they are often compared with traditional models to assess predictive accuracy [32]. Since financial distress, leverage, information asymmetry, audit quality, corporate governance, and managerial behavior may simultaneously affect restatement, an artificial neural network provides a suitable methodological framework for weighting and ranking these determinants.

The present study is positioned at the intersection of financial reporting quality, corporate governance, audit research, and artificial intelligence. Prior studies have examined the frequency and importance of financial statement restatement [33], the causes underlying misstatements [34], the accounting conservatism implications of earnings restatements [35], and the consequences of restatement for governance actors and market participants [3, 16]. However, the literature still requires an integrated model that simultaneously identifies relevant indicators through expert judgment and ranks their relative importance using an intelligent data-driven approach. Such an approach is especially valuable in emerging capital markets, where information asymmetry, governance heterogeneity, audit quality differences, related-party transactions, and financial constraints may jointly shape the probability of restatement. By combining the Delphi technique with an Artificial Neural Network, the present study seeks to bridge expert-based conceptual refinement and machine-learning-based prioritization. This combined design allows the research to first validate the set of influential indicators and then determine which indicators contribute most strongly to the prediction of financial statement restatement.

Accordingly, the aim of this study is to identify and rank the determinants of financial statement restatements using artificial intelligence, with particular emphasis on weighting the selected indicators through an Artificial Neural Network model.

2. Methodology

The present study is developmental and applied in terms of objective and was conducted with the aim of identifying the determinants of financial statement restatements using artificial intelligence. In terms of research type, this study adopts a mixed-methods approach and seeks to analyze the subject from both theoretical and data-driven perspectives through the integration of qualitative and quantitative methods. Regarding the analytical approach, the study follows an inductive methodology, meaning that it moves from empirical and detailed data toward identifying patterns and developing a comprehensive model. In the qualitative phase, the Delphi technique was employed to collect the opinions of experts in accounting, financial reporting, and emerging technologies, and the results served as the basis for designing the quantitative instruments. In the quantitative phase, the Artificial Neural Network (ANN) technique was utilized to optimize and assign weights to the final indicators. In terms of data collection procedures, the study was conducted using both library-based and field methods. The theoretical data were gathered through a review of *معتبر* scientific sources, while field data were collected through structured questionnaires and multi-stage implementation of the Delphi technique.

In the qualitative phase, the statistical population consisted of experts serving on the expert panel, including university faculty members with more than ten years of professional experience who were active in the fields of auditing, accounting, or finance and possessed expertise in financial statement restatements, along with published studies and articles in this domain. Using the snowball sampling technique, the number of experts was determined to be twenty-one individuals. Among them, fourteen participants were male and the remaining participants were female. More than 50% of the participants were between 40 and 50 years old, and the majority held doctoral degrees. The statistical population in the quantitative phase included all companies listed on the Tehran Stock Exchange during the period from 2019 to 2023. The research sample was selected systematically, resulting in 114 firms, subject to the following criteria: the company's financial information had to be available during the study period; the company had to be listed on the Tehran Stock Exchange before 2019; the company's fiscal year had to end in March to ensure data homogeneity; the company should not have changed its fiscal year during the study period; all required research data had to be fully available throughout the period under investigation; and the company should not belong to the financial sector, including investment companies, banks, insurance companies, and financial institutions.

To collect data related to the development of the research literature, library-based methods and documentary studies were employed. To obtain the data required for processing the research hypotheses, information was extracted from the CODAL database and the Rahavard Novin software platform. It should also be noted that the data required for the qualitative phase were collected through semi-structured questionnaires administered in the form of expert interviews.

To analyze the relationships among variables, two techniques were employed: the Delphi technique for the qualitative phase and artificial intelligence methods for the quantitative phase. In the qualitative phase, the preliminary indicators were first extracted from the research literature, and the Delphi technique was subsequently used, through semi-structured questionnaires and expert opinions, to evaluate the inclusion or exclusion of these indicators within the model. In fact, to ensure that no potentially influential indicators were overlooked while

simultaneously validating the identified indicators, additional influential indicators were identified through the qualitative Delphi method based on expert consensus.

In the next stage, the Artificial Neural Network (ANN) technique was employed to determine the significance of each factor. This technique is based on training the neural network and identifying the optimal neural structure for estimation purposes. Accordingly, 70% of the data were allocated to the training phase and 15% to the testing phase in order to identify the optimal ANN model. Subsequently, by executing the model using the remaining 15% of the data, the predictive capability of the network in identifying the importance of the indicators was evaluated. The preliminary default structure of the ANN model is presented below.

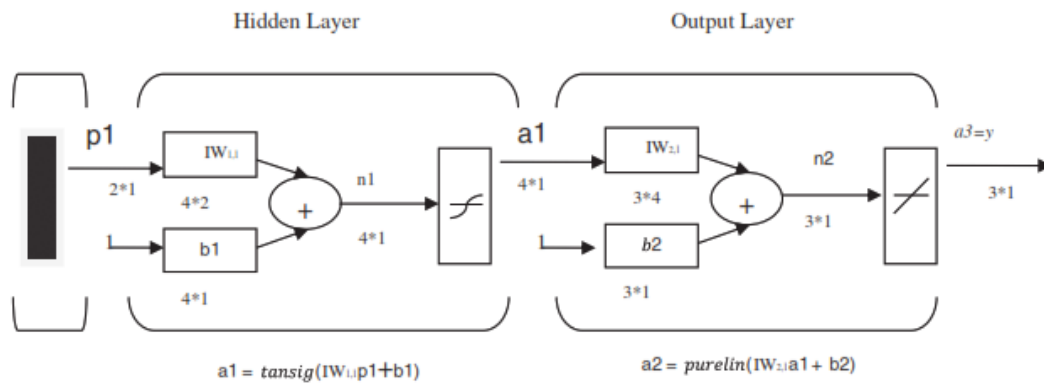


Figure 1. Preliminary Model of the Artificial Neural Network Technique Used

In the artificial intelligence process using the Artificial Neural Network, the procedure was conducted as follows: after identifying all variables included in the model, all predictor variables were simultaneously entered into the trained neural network, along with the target variable, namely financial statement restatement. The network was then executed, and the model estimation error was determined using the Root Mean Square Error (RMSE) index. Subsequently, the network was executed repeatedly based on the number of predictor variables, with one predictor variable removed from the model in each run and replaced by another variable in the subsequent execution. In each execution, the estimation error was recalculated. The purpose of this process was to determine which predictor variable, when excluded, would lead to the greatest increase in estimation error. The variable generating the highest increase in error was considered to have greater importance in estimating the behavior of financial statement restatements. Based on this procedure, the variables were ranked according to their relative importance.

3. Findings and Results

At this stage, the researcher initially identified a list of influential factors or indicators through an extensive review of the research literature and other available sources. Subsequently, a preliminary screening process was conducted, during which duplicate or conceptually similar indicators were eliminated. Ultimately, as explained in Chapter Three, fifteen influential indicators and four consequences were identified.

Following the identification of the preliminary indicators, a semi-structured questionnaire was designed based on these indicators. The questionnaire developed at this stage is referred to as the initial questionnaire or the first-round Delphi questionnaire. It should be noted that the questionnaire items were, in fact, the same identified indicators or factors presented in the form of questions. At this stage, panel members were requested not only to respond to the closed-ended questions but also to provide their opinions regarding the possible existence of other

influential indicators at the end of the questionnaire. Table 1 presents the aggregated responses of the panel members in the first Delphi round.

Table 1. Aggregation of Respondents’ Opinions for the First-Round Questionnaire on Influential Factors

| No. | Research Questions / Indicators | Very Low (1) | Low (2) | Moderate (3) | High (4) | Very High (5) |
|-----|---------------------------------|--------------|---------|--------------|----------|---------------|
| 1 | Firm Size | 0 | 2 | 3 | 8 | 8 |
| 2 | Ownership Concentration | 0 | 1 | 2 | 8 | 10 |
| 3 | Institutional Ownership | 2 | 3 | 5 | 7 | 4 |
| 4 | Board Independence | 2 | 3 | 4 | 8 | 4 |
| 5 | Board Size | 6 | 7 | 6 | 2 | 0 |
| 6 | Board Compensation | 1 | 3 | 5 | 7 | 5 |
| 7 | Information Asymmetry | 0 | 0 | 2 | 6 | 13 |
| 8 | Related-Party Transactions | 0 | 0 | 2 | 8 | 11 |
| 9 | Audit Committee Independence | 2 | 3 | 4 | 9 | 3 |
| 10 | Auditor Size | 1 | 3 | 5 | 8 | 4 |
| 11 | Auditor Specialization | 0 | 2 | 5 | 8 | 6 |
| 12 | Audit Fees | 0 | 2 | 4 | 8 | 7 |
| 13 | Financial Leverage | 0 | 1 | 5 | 6 | 9 |
| 14 | Profitability | 1 | 4 | 5 | 8 | 3 |
| 15 | Financial Distress | 0 | 1 | 4 | 9 | 7 |

It should be noted that the Cronbach’s alpha coefficient for the first-round questionnaire was calculated at 0.88, which exceeded the threshold value of 0.70, thereby confirming the reliability of the questionnaire.

Subsequently, the fuzzy values for each research question were calculated based on the opinions of the panel members. In order to determine the significance level of each question, the fuzzy values were converted into defuzzified values to enable comparison with the threshold value (score of 3). For this purpose, the following formula was used:

$$S_j = \frac{L_j + 2M_j + U_j}{4}$$

Table 2 presents the fuzzy values and defuzzified values for all questions related to the first-round Delphi questionnaire.

Table 2. Fuzzy Values and Defuzzified Values of the First-Round Questionnaire Items

| No. | Questions (Indicators) | L | M | U | Defuzzified Value |
|-----|------------------------------|---|-------|---|-------------------|
| 1 | Firm Size | 2 | 3.912 | 5 | 3.706 |
| 2 | Ownership Concentration | 2 | 4.187 | 5 | 3.843 |
| 3 | Institutional Ownership | 1 | 3.093 | 5 | 3.046 |
| 4 | Board Independence | 1 | 3.304 | 5 | 3.152 |
| 5 | Board Size | 1 | 1.967 | 5 | 2.483 |
| 6 | Board Compensation | 1 | 3.339 | 5 | 3.169 |
| 7 | Information Asymmetry | 3 | 4.468 | 5 | 4.234 |
| 8 | Related-Party Transactions | 3 | 4.374 | 5 | 4.187 |
| 9 | Audit Committee Independence | 1 | 3.102 | 5 | 3.051 |
| 10 | Auditor Size | 1 | 3.304 | 5 | 3.152 |
| 11 | Auditor Specialization | 2 | 3.916 | 5 | 3.708 |
| 12 | Audit Fees | 2 | 3.818 | 5 | 3.659 |
| 13 | Financial Leverage | 2 | 3.976 | 5 | 3.738 |
| 14 | Profitability | 1 | 3.163 | 5 | 3.081 |
| 15 | Financial Distress | 2 | 3.946 | 5 | 3.723 |

As can be observed, except for the variable of board size, all variables exhibited defuzzified values above 3 and therefore remained in the final set of variables. Furthermore, the panel members collectively introduced seven additional indicators that could potentially be influential. These indicators were added to the second-round questionnaire, and the second round of the Delphi technique was implemented. Accordingly, the Delphi process was repeated for the new questions and indicators, and the final table of this round was obtained as follows.

Table 3. Aggregation of Respondents’ Opinions for the Second-Round Questionnaire on Influential Factors

| No. | Research Questions | Very Low (1) | Low (2) | Moderate (3) | High (4) | Very High (5) |
|-----|------------------------------|--------------|---------|--------------|----------|---------------|
| 1 | Firm Size | 0 | 2 | 4 | 8 | 7 |
| 2 | Ownership Concentration | 0 | 1 | 3 | 8 | 9 |
| 3 | Institutional Ownership | 2 | 3 | 5 | 7 | 4 |
| 4 | Board Independence | 1 | 4 | 4 | 8 | 4 |
| 5 | Board Compensation | 1 | 2 | 6 | 7 | 5 |
| 6 | Information Asymmetry | 0 | 0 | 1 | 7 | 13 |
| 7 | Related-Party Transactions | 0 | 0 | 2 | 9 | 10 |
| 8 | Audit Committee Independence | 1 | 3 | 5 | 8 | 4 |
| 9 | Auditor Size | 2 | 2 | 6 | 7 | 4 |
| 10 | Auditor Specialization | 0 | 2 | 5 | 9 | 5 |
| 11 | Audit Fees | 1 | 2 | 5 | 7 | 6 |
| 12 | Financial Leverage | 0 | 2 | 4 | 7 | 8 |
| 13 | Profitability | 1 | 4 | 4 | 8 | 4 |
| 14 | Financial Distress | 0 | 0 | 4 | 9 | 8 |
| 15 | Corporate Governance | 0 | 0 | 6 | 7 | 8 |
| 16 | Operating Cash Flow | 0 | 2 | 4 | 8 | 7 |
| 17 | Social Responsibility | 2 | 3 | 6 | 6 | 4 |
| 18 | Cash Flow Sensitivity | 1 | 2 | 5 | 8 | 4 |
| 19 | Industry Competition | 0 | 2 | 5 | 7 | 7 |
| 20 | Operational Complexity | 1 | 1 | 4 | 8 | 7 |
| 21 | CEO Overconfidence | 1 | 4 | 5 | 6 | 5 |

In addition, the fuzzy and defuzzified scores are presented below. As shown, all twenty-one questions (variables) were considered influential by the respondents, namely the twenty-one members of the expert panel.

Table 4. Fuzzy Values and Defuzzified Values of the Second-Round Questionnaire Items

| No. | Questions (Indicators) | L | M | U | Defuzzified Value |
|-----|------------------------------|---|-------|---|-------------------|
| 1 | Firm Size | 2 | 3.818 | 5 | 3.659 |
| 2 | Ownership Concentration | 2 | 4.087 | 5 | 3.793 |
| 3 | Institutional Ownership | 1 | 3.093 | 5 | 3.046 |
| 4 | Board Independence | 1 | 3.241 | 5 | 3.121 |
| 5 | Board Compensation | 1 | 3.404 | 5 | 3.202 |
| 6 | Information Asymmetry | 3 | 4.530 | 5 | 4.265 |
| 7 | Related-Party Transactions | 3 | 4.328 | 5 | 4.164 |
| 8 | Audit Committee Independence | 1 | 3.304 | 5 | 3.152 |
| 9 | Auditor Size | 1 | 3.153 | 5 | 3.077 |
| 10 | Auditor Specialization | 2 | 3.687 | 5 | 3.594 |
| 11 | Audit Fees | 1 | 3.142 | 5 | 3.071 |
| 12 | Financial Leverage | 2 | 3.859 | 5 | 3.679 |
| 13 | Profitability | 1 | 3.241 | 5 | 3.121 |
| 14 | Financial Distress | 3 | 4.122 | 5 | 4.061 |
| 15 | Corporate Governance | 3 | 4.011 | 5 | 4.005 |
| 16 | Operating Cash Flow | 2 | 3.818 | 5 | 3.659 |
| 17 | Social Responsibility | 2 | 3.051 | 5 | 3.275 |
| 18 | Cash Flow Sensitivity | 1 | 3.197 | 5 | 3.098 |
| 19 | Industry Competition | 2 | 3.766 | 5 | 3.633 |
| 20 | Operational Complexity | 1 | 3.694 | 5 | 3.347 |
| 21 | CEO Overconfidence | 1 | 3.231 | 5 | 3.115 |

As demonstrated, the defuzzified values of all variables (questions) exceeded the threshold value of 3. Therefore, all variables were identified as influential, indicating that the employed technique had reached saturation. Under these conditions, confidence can be established regarding the comprehensive identification of all influential indicators and factors.

As previously explained, one of the objectives of this study is to rank the most important factors affecting financial statement restatements using an Artificial Neural Network (ANN). To achieve this objective, it is first necessary to design the optimal ANN and subsequently employ it to rank the relevant indicators. In order to select the most accurate and appropriate model among the examined models, the present study utilized various analytical criteria. However, to fulfill the primary objective of comparing the predictive power of the models, the Mean Squared Error (MSE) criterion was employed. In practice, after estimating and specifying the models, the model exhibiting the lowest estimation error was selected as the best-fitting model. Since obtaining an optimal neural network is only possible through a trial-and-error process, nineteen different networks containing between 2 and 20 hidden neurons were designed and compared in terms of estimation error, after which the optimal network was selected. The results are presented in Table 5.

Table 5. Estimation Error of All Artificial Neural Networks

| No. | Number of Hidden Layer Neurons | Testing Error (MSE) | No. | Number of Hidden Layer Neurons | Testing Error (MSE) |
|-----|--------------------------------|---------------------|-----|--------------------------------|---------------------|
| 1 | 2 | 0.508 | 11 | 12 | 0.202 |
| 2 | 3 | 0.262 | 12 | 13 | 0.425 |
| 3 | 4 | 0.553 | 13 | 14 | 0.443 |
| 4 | 5 | 0.662 | 14 | 15 | 0.221 |
| 5 | 6 | 0.346 | 15 | 16 | 0.330 |
| 6 | 7 | 0.456 | 16 | 17 | 0.288 |
| 7 | 8 | 0.421 | 17 | 18 | 0.169 |
| 8 | 9 | 0.398 | 18 | 19 | 0.471 |
| 9 | 10 | 0.119 | 19 | 20 | 0.332 |
| 10 | 11 | 0.114 | | | |

As is well established, the MSE criterion is recognized as a standard measure for comparing the predictive capability of different estimation models. In an ideal situation, this value would equal zero, indicating a perfectly accurate estimation. However, achieving an exact value of zero in practice is highly optimistic. Nevertheless, based on this comparative criterion, the superior model is the one whose MSE value is closer to zero. As indicated in the above table, the neural network containing 11 neurons in the hidden layer exhibited the lowest estimation error. The structure of this network is illustrated in Figure 2.

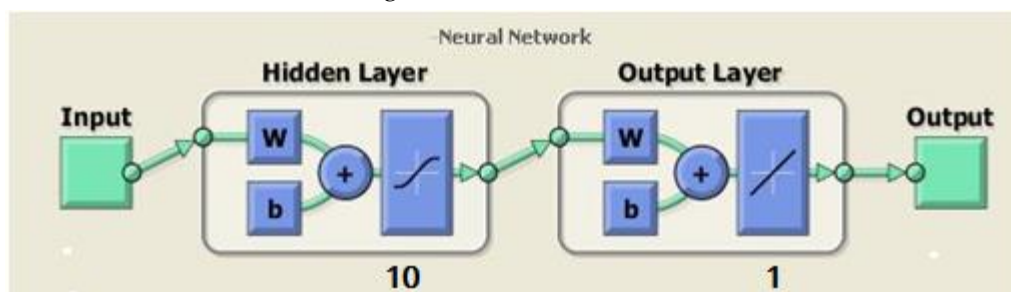


Figure 2. Structure of the Optimal Neural Network

In the optimal model of the present study, the selected neural network consists of three layers, namely an input layer including three inputs, a hidden layer containing eleven feedforward neurons with a nonlinear hyperbolic tangent activation function, and finally an output layer consisting of a single neuron equivalent to one output.

Another influential factor in designing the optimal neural network concerns the allocation of input data into the three sections of training, validation, and testing. Here as well, the optimal condition can only be achieved through trial and error. The results of this process, consistent with many neural network studies such as those conducted by Chen et al. (2011) and Maharlooei et al. (2016), indicate that the optimal ANN structure involves a 70–15–15 distribution for the aforementioned sections, respectively. Therefore, as shown in Figure 3, out of the total 570 observations corresponding to five years of information from 114 companies under investigation, 398 observations (70%) were allocated to the training section, while each of the validation and testing sections contained 86 observations (15%).

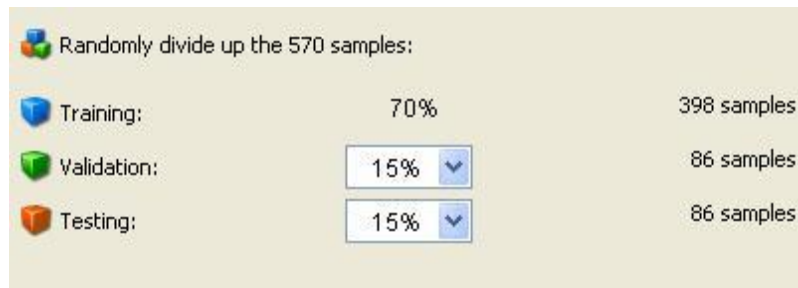


Figure 3. Allocation of Input Data into the Three Sections

To confirm the fitting capability of the selected neural network, it should be noted that, as illustrated in Figure 4, the selected network demonstrates a very high level of fitting power in all stages. In this figure, the diagonal line indicates the fitting quality of the results for the three stages of learning, validation, and testing against the observed data. The ideal value is 1, and the closer the obtained value is to 1, the greater the fitting capability of the network. The diagrams indicate that the fitting level in the testing phase exceeds 99%. The results of model fitting are also illustrated in Figure 4. The coefficient of determination (R^2) for the testing section, which is the square of R (0.9926), equals 0.9853.

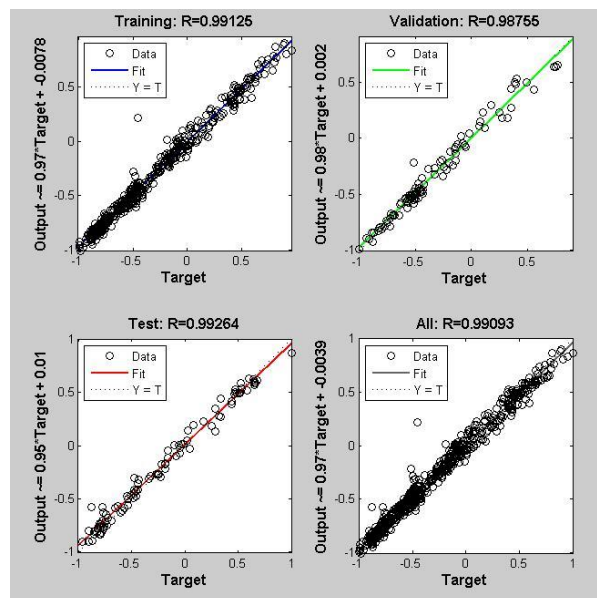


Figure 4. Fitting Performance Across All Stages

In this section as well, the network achieved this level of capability, as illustrated in Figure 5, after ten repetitions of the three-stage process of training, validation, and testing. Beyond this point, any additional repetition of the process increased the estimation error of the network. In other words, after ten iterations, the network succeeded

in proposing a structure with an estimation error equal to 0.004. This issue is illustrated in Figure 5. Furthermore, Figure 6 presents the distribution of errors for all 570 observations around the zero axis.

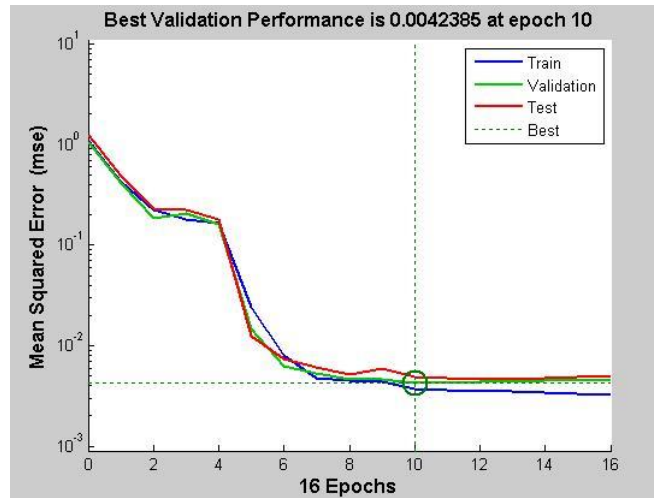


Figure 5. Number of Iterations Required to Reach Minimum Error

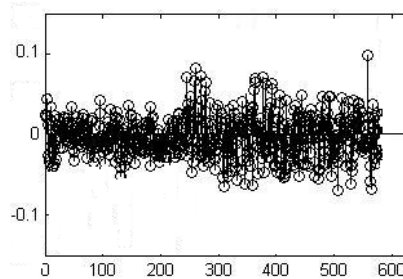


Figure 6. Error Distribution Plot of the Optimal Model

The following figure presents the histogram of error distribution. As shown in Figure 7, the residual error distribution is normal for all three stages, indicating the high performance quality of the network and the reliability of the model in all sections, particularly in the testing phase.

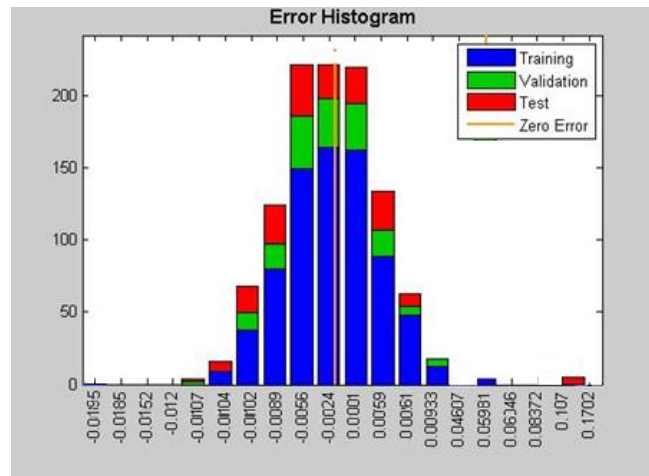


Figure 7. Histogram of Error Distribution

At this stage, after ensuring that all necessary conditions for the optimal network were satisfied, the network was employed to rank the influence and importance of the twenty-one predictor variables of financial statement restatements (the target variable). As previously explained, the basis of this procedure is to calculate the change in estimation error resulting from the removal of each variable. The variable whose removal causes the largest increase

in estimation error is considered to possess the greatest importance, whereas the variable whose removal causes the smallest change in estimation error is considered to have the lowest importance.

Following the design of the optimal neural network, the twenty-one predictor variables were ranked according to their influence on the target variable based on the results of the MSE criterion. The results of this process are presented in Table 6.

Table 6. Ranking of Factors Affecting Financial Statement Restatements

| Variable Name | MSE Value | Change in MSE | Rank |
|--------------------------------------------|-----------|---------------|------|
| Presence of All Variables | 0.1142 | — | — |
| Removal of Information Asymmetry | 0.1921 | 0.0779 | 1 |
| Removal of Audit Committee Independence | 0.1897 | 0.0755 | 2 |
| Removal of Auditor Industry Specialization | 0.1886 | 0.0743 | 3 |
| Removal of Related-Party Transactions | 0.1801 | 0.0659 | 4 |
| Removal of CEO Overconfidence | 0.1783 | 0.0641 | 5 |
| Removal of Corporate Governance | 0.1742 | 0.0600 | 6 |
| Removal of Institutional Ownership | 0.1711 | 0.0569 | 7 |
| Removal of Financial Leverage | 0.1643 | 0.0501 | 8 |
| Removal of Financial Distress | 0.1600 | 0.0458 | 9 |
| Removal of Operating Cash Flow | 0.1533 | 0.0391 | 10 |
| Removal of Cash Flow Sensitivity | 0.1512 | 0.0370 | 11 |
| Removal of Operational Complexity | 0.1467 | 0.0325 | 12 |
| Removal of Ownership Concentration | 0.1430 | 0.0288 | 13 |
| Removal of Board Independence | 0.1407 | 0.0265 | 14 |
| Removal of Board Compensation | 0.1390 | 0.0248 | 15 |
| Removal of Firm Size | 0.1374 | 0.0232 | 16 |
| Removal of Audit Fees | 0.1335 | 0.0193 | 17 |
| Removal of Profitability | 0.1288 | 0.0146 | 18 |
| Removal of Social Responsibility | 0.1246 | 0.0104 | 19 |
| Removal of Industry Competition | 0.1200 | 0.0058 | 20 |
| Removal of Auditor Size | 0.1183 | 0.0041 | 21 |

As can be observed, the removal of each variable from the overall model led to an increase in estimation error, thereby confirming the importance of all identified factors. However, as shown, the removal of the information asymmetry variable generated the greatest increase in model error. In other words, excluding this indicator caused the model estimation error to increase more substantially than the exclusion of any other indicator. Therefore, this variable exhibited the highest importance in estimating the dependent variable and ranked first in significance. As can also be seen, the indicators of industry competition and auditor size generated the smallest changes in prediction error and therefore possessed the lowest importance, ranking at the bottom of the table. Similarly, the ranking of the remaining factors can also be observed in the above table.

4. Discussion and Conclusion

The present study aimed to identify and rank the determinants of financial statement restatements using artificial intelligence techniques. The findings demonstrated that all twenty-one identified variables were recognized as influential factors affecting the likelihood of financial statement restatement. Furthermore, the Artificial Neural Network (ANN) analysis revealed that information asymmetry, audit committee independence, auditor industry specialization, related-party transactions, CEO overconfidence, corporate governance, institutional ownership, and financial leverage were among the most influential predictors of financial statement restatements. These findings

confirm that financial statement restatement is a multidimensional phenomenon shaped simultaneously by governance mechanisms, managerial behavior, audit quality, financial conditions, and informational environments. The results also indicate that artificial intelligence techniques are capable of effectively identifying and prioritizing nonlinear relationships among determinants of financial reporting quality. This finding is consistent with prior studies emphasizing the usefulness of data mining and neural-network approaches in detecting and predicting financial reporting irregularities and restatement behavior [30-32]. The strong predictive performance of the designed neural network further supports the argument that intelligent computational techniques can provide more flexible and accurate modeling frameworks than many traditional statistical approaches when dealing with highly interactive accounting variables.

Among all identified factors, information asymmetry was ranked as the most influential determinant of financial statement restatement. This finding suggests that when the information gap between managers and external stakeholders increases, the probability of reporting errors, aggressive accounting choices, or delayed correction of accounting distortions also rises. Under high information asymmetry conditions, external monitoring becomes less effective, investors face greater uncertainty, and managers possess broader discretion in financial reporting decisions. Consequently, financial statements may become more vulnerable to misstatements that eventually require correction through restatement. This finding is strongly aligned with research emphasizing the role of information asymmetry in reducing financial reporting quality and increasing the likelihood of restatement [11]. It is also conceptually consistent with studies on material accounting misstatements and earnings management, which argue that opaque reporting environments create opportunities for manipulation and delayed disclosure correction [1, 29]. Moreover, uncertainty-driven environments may intensify information asymmetry and reporting ambiguity, thereby increasing restatement risk [22, 23]. Therefore, reducing information asymmetry through transparent disclosure practices, stronger internal controls, and more effective governance mechanisms appears essential for improving reporting reliability.

The findings also showed that audit committee independence represents one of the strongest determinants of financial statement restatement. Independent audit committees are expected to improve oversight effectiveness by strengthening monitoring over financial reporting processes and reducing managerial opportunism. When audit committee independence is weak, the likelihood of inadequate supervision over accounting practices and internal controls increases, which may result in misstatements remaining undetected until restatement becomes unavoidable. This finding aligns with prior evidence emphasizing the role of audit committees in enhancing reporting quality and reducing information asymmetry [11]. It is also compatible with broader governance research indicating that ineffective monitoring structures increase the probability of accounting irregularities and reporting failures [3, 4]. The result additionally reinforces the view that governance quality is not solely dependent on formal structures but also on the independence and effectiveness of oversight bodies responsible for financial reporting integrity.

Another important finding concerns auditor industry specialization, which ranked among the most influential predictors of financial statement restatement. Industry-specialized auditors generally possess deeper knowledge of sector-specific accounting practices, operational risks, and reporting complexities, allowing them to detect irregularities more effectively. Firms audited by less specialized auditors may therefore face a higher probability of undetected misstatements and eventual restatements. This result supports the growing literature emphasizing the importance of audit quality in financial reporting outcomes [16, 17]. It is also consistent with evidence showing that audit expertise and professional competence significantly influence the detection and prevention of material

accounting errors [15]. The findings regarding audit fees similarly support the argument that audit characteristics influence reporting quality. Although audit fees were ranked lower than some governance variables, their significance suggests that the economic structure of the audit engagement remains relevant to financial reporting credibility [18]. Moreover, textual analysis of Key Audit Matters has recently demonstrated that audit-related disclosures may contain predictive information regarding future restatement risk [19]. Collectively, these findings highlight the central role of external auditing in mitigating financial reporting failures.

The significance of related-party transactions in predicting financial statement restatement also deserves attention. Related-party transactions often involve complex contractual arrangements, valuation ambiguities, and potential conflicts of interest, all of which may reduce transparency and increase opportunities for opportunistic reporting. In environments with weaker governance or monitoring systems, these transactions may be used to manipulate earnings, conceal financial weaknesses, or transfer resources among affiliated parties. Consequently, firms engaging extensively in related-party transactions may exhibit greater restatement risk because such transactions increase reporting complexity and reduce the clarity of financial disclosures. This interpretation aligns with the broader literature on earnings management and reporting opacity [2, 7]. It also supports the argument that operational and contractual complexity can intensify accounting uncertainty and reporting failure risk [24].

CEO overconfidence emerged as another highly influential predictor of financial statement restatement. This finding indicates that managerial psychological characteristics play an important role in financial reporting behavior. Overconfident executives may overestimate future performance, underestimate risks, and adopt excessively optimistic accounting assumptions. Such managers may initially engage in aggressive reporting strategies believing that future performance improvements will justify their decisions, but when actual outcomes fail to materialize, restatement becomes necessary. This finding is highly consistent with the theoretical and empirical literature on executive overconfidence and financial misreporting [12, 13]. It also supports studies indicating that incentive pressures and managerial behavioral biases can significantly increase the probability of reporting irregularities [14]. Therefore, financial statement restatement should not be interpreted purely as a technical accounting failure but also as a behavioral and organizational outcome shaped by managerial cognition and incentives.

Corporate governance and institutional ownership were also identified as influential determinants of restatement behavior. Effective governance systems reduce opportunistic reporting by strengthening accountability, monitoring managerial decisions, and improving internal control quality. Institutional investors may also exert monitoring pressure on management, thereby discouraging aggressive accounting behavior. However, when governance quality weakens or institutional monitoring becomes ineffective, the probability of financial reporting distortions increases. These findings are aligned with evidence suggesting that governance mechanisms significantly affect financial reporting outcomes and restatement incidence [3, 8]. They are also compatible with more recent governance-oriented studies emphasizing the role of board quality, independent directors, and governance structures in enhancing reporting comparability and reliability [9, 10]. The importance of board independence and board compensation in the present study further reinforces the notion that governance effectiveness is multidimensional and extends beyond formal compliance structures.

Financial leverage and financial distress were additionally identified as major determinants of restatement. Firms facing high leverage or financial distress may experience stronger incentives to manipulate earnings or delay the recognition of unfavorable financial conditions. Such firms may attempt to maintain investor confidence, avoid debt covenant violations, or secure external financing through aggressive accounting practices. However, these

reporting distortions frequently become unsustainable and later require correction through restatement. These findings are consistent with prior research linking financial constraints and economic pressure to lower reporting quality and higher restatement probability [20, 21]. They also align with research on financial misstatement prediction emphasizing the role of financial pressure in motivating aggressive reporting behavior [1]. Operating cash flow and cash flow sensitivity were similarly significant, indicating that firms with unstable or sensitive cash flows may encounter greater reporting uncertainty and managerial pressure, thereby increasing restatement risk.

The findings regarding profitability, firm size, ownership concentration, operational complexity, and industry competition further demonstrate the multifaceted nature of restatement determinants. Larger firms may possess more complex operations and disclosure systems, thereby increasing the probability of reporting errors, although they also generally face stronger monitoring pressures. Operational complexity itself increases the difficulty of accurate financial reporting and may intensify estimation uncertainty. Industry competition may create incentives for managers to present more favorable financial results in order to maintain market reputation and investor confidence. However, in the present study, industry competition and auditor size exhibited the lowest relative importance among the identified variables. Although these variables remained significant, their comparatively weaker effects suggest that internal governance mechanisms, managerial characteristics, and informational conditions may play more direct roles in explaining restatement behavior. Nevertheless, the significance of all twenty-one variables confirms that financial statement restatement is generated by the interaction of numerous organizational, financial, and behavioral dimensions rather than by a single isolated factor.

An important contribution of the present study lies in the integration of the Delphi technique with Artificial Neural Networks. The Delphi process enabled the identification and validation of influential indicators through expert consensus, while the ANN approach provided a sophisticated framework for weighting and ranking the determinants based on predictive significance. This methodological integration offers a more comprehensive understanding of financial statement restatement than approaches relying exclusively on traditional regression techniques. The findings therefore contribute not only to the literature on financial reporting quality and restatement determinants but also to the growing body of research applying artificial intelligence techniques in accounting and auditing contexts [30, 31]. The high predictive accuracy of the neural network additionally demonstrates the practical applicability of intelligent systems for early detection of financial reporting risk in capital markets.

One limitation of the present study relates to the scope of the sample, which was restricted to firms listed on the Tehran Stock Exchange during a specific time period. Consequently, the generalizability of the findings to other institutional and regulatory environments may be limited. Another limitation concerns the reliance on available financial and governance data, as some potentially influential behavioral or organizational variables could not be directly measured. Additionally, although the Artificial Neural Network demonstrated strong predictive capability, neural-network models are often characterized by limited interpretability compared with traditional statistical techniques, which may constrain the direct explanation of causal relationships among variables.

Future research could extend the present study by examining restatement determinants across different industries, countries, or institutional environments in order to compare the stability of the identified predictors. Researchers may also integrate alternative machine-learning techniques such as deep learning, support vector machines, or ensemble models to improve predictive performance and compare methodological efficiency. Furthermore, future studies could incorporate textual analysis, real-time disclosure information, social media

sentiment, or managerial behavioral indicators to develop more comprehensive predictive models of financial reporting quality and restatement risk.

From a practical perspective, the findings suggest that regulators, auditors, investors, and corporate boards should pay greater attention to information asymmetry, audit committee independence, managerial behavioral characteristics, and governance quality when assessing financial reporting reliability. Companies should strengthen internal controls, enhance disclosure transparency, improve audit committee effectiveness, and adopt governance mechanisms capable of reducing opportunistic reporting behavior. Auditors and regulatory authorities may also employ artificial intelligence techniques as part of early-warning systems designed to identify firms with elevated restatement risk. Such measures can improve investor confidence, reduce reporting uncertainty, and enhance the overall credibility and efficiency of capital markets.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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