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The Role of Financial Ratios in Explaining Information Quality Using the Factor Analysis Approach

Akram Karimi
Department of Accounting, Qom Branch, Islamic Azad University, Qom, Iran
Roya Darabi*
Department of Accounting, South Tehran Branch, Islamic Azad University, Tehran, Iran
Mohammad Reza Poorfakharan, Hossein Moghadam
Department of Accounting, Qom Branch, Islamic Azad University, Qom, Iran

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Abstract

This study aims to investigate and predict information quality ranking using factor analysis and artificial intelligence in firms listed on the Tehran Stock Exchange for nine years from 2011 to 2019. The independent variable used in this study is the financial criteria of the firm, and the dependent variable is the quality measurement criteria of accounting information, in which all criteria have been converted into a single variable according to the factor analysis method. The present study is considered empirical accounting research, and the artificial intelligence method has been used to test the research hypotheses. The results indicate that according to the variable selection method of artificial intelligence, neighbourhood analysis among performance variables, including "Accounts receivable to sales ratio criteria", "Firm size", "Financial risk", "Current assets to total assets ratio", and "Cost to Sales ratio ", firms have the highest correlation with information quality rating. Other results indicate that linear and nonlinear artificial intelligence methods can predict accounting information firms' quality ratings on the Tehran Stock Exchange. Due to the importance of financial information quality in financial reporting, and innovation of the present study is the simultaneous use of all information quality criteria and artificial intelligence to examine research hypotheses.

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*Corresponding Author: Roya Darabi
Email: royadarabi110@yahoo.com
Tel: 09123194494
ORCID: 0000-0003-1385-1034

1. Introduction

The quality of disclosed information is an important management tool for communication between firms and investors since the discussion of financial information quality has gained popularity in professional and scientific research following the financial crises in developed countries and the collapse of large firms such as Enron due to fraud in provided data (Cheng et al., 2013). Investors and users use accounting information to predict the firm's future performance and evaluate the firm. Financial reporting should provide information to investors, creditors, and other users to help them assess investment opportunities and credit and determine the timing and uncertainty of future cash flows, such as dividends or interest. It is expected that the annual reports of firms which explain the firm's financial status and latest related results, can provide financial and non-financial information to stakeholders in a comprehensible, cohesive, comparable, and timely manner; however, it is challenging to directly measure the qualitative characteristics of these reports to evaluate the quality of the reports (Tran, 2022).

Different financial and non-financial scales are used to evaluate firms' performance and value; other models and patterns have been presented for their evaluation so far. This measurement reflects a wide range of functional criteria, including a number of accrued earningss per existing accounting rules, a number of earningss reflecting the central part of operating performance and cash flow criteria, and their relationship to the management of accounting standards, financial reporting quality and auditing quality, which are used as criteria for providing firm performance reporting. (Li, 2017).

As a summary of a firm's past production records, accounting information is the primary source for various business decisions, including operational decisions. This accounting information is used to plan and control performance (Susanto, 2016). How financial information is presented leads to better forecasting of the firm's future cash flows for investors and other users of financial statements. Given that accounting and economics interact, the quality of financial information has economic implications. The usefulness of financial statements or other financial statements is influenced by the quality of financial statements, where consistency and accuracy of information are essential aspects of quality. There is a need to provide high-quality financial reports that influence users' investment decisions and increase market performance and efficiency (Ningtias and Shondhaji, 2018).

The manager's behaviour and decision-making is the main factor in improving the firm's performance. According to the rational expectations theory and management hypothesis, the responsibility of the business unit management is independent monitoring of the firm's performance and accountability to shareholders and stakeholders. Perhaps the primary tool for monitoring the firm's performance is preparation. The importance of the entity's financial statements of accounting information has been proven in many studies (Lo, 2008). Investors are constantly concerned about the quality of accounting information. Because accounting information helps them understand the operating conditions and efficiency of firms and allows them to take the necessary steps to monitor management behavior; therefore, high-quality accounting information enables the shareholders who want to participate in direct or Indirect management of firms to increase their understanding of capital allocation and financial performance, and ultimately to influence the firm's investment choices (Zhai and Wang, 2016).

Therefore, obtaining high-quality accounting information is essential for investors, creditors and corporate managers to take proper decisions regarding investment and credit. Corporate accounting information is considered a vital factor for the capital market; therefore, the quality of accounting information can influence creditors' pricing decisions (Le et al., 2021). Considering the importance of quality accounting information, the use of defined criteria to calculate the quality of information and create a ranking of information quality of firms using the factor analysis method is the innovation of this research the artificial intelligence is introduced. Finally, factors affecting the information

quality ranking of firms listed on the Tehran Stock Exchange are introduced using artificial intelligence.

2. Theoretical Framework and Research Hypotheses Development

The quality of accounting information refers to a situation by which information can better understand the future economic conditions of studied firms. The primary motivation of this study indicates the importance of higher-quality accounting in decision-making. Accounting is a vague theoretical construct, despite the leading determining role of information quality; in addition, accounting information quality is measured using a wide range of criteria and models, the validity or verifiability of which faces considerable ambiguity (Dechow et al., 2010).

2.1. Financial information quality

The most appropriate way to transfer financial information to the firm is through quality financial reporting (Erwin et al., 2021). Thus, the quality of corporate financial reporting plays a vital role in the decision-making process of accounting information users. In some cases, firms may use earnings manipulation in financial statement figures to conceal poor corporate financial performance (Kayhan, 2021).

The quality of the information disclosed is one of the essential management tools for establishing communication between the firm and investors; Because following the financial crises in developed countries and the collapse of large firms such as Enron, and Worldcom due to fraud in the information provided, the discussion of financial information quality has become one of the topics in professional and scientific research (Huang et al., 2020)

The quality of accounting information with proper disclosure of financial events in firms can provide the necessary basis for monitoring management activities, and this can reduce the opportunistic behavior in managers; Thus, by being aware of oversight by stakeholders on decisions made through management, managers seek to improve investment efficiency by identifying appropriate investment opportunities (Elaoud and Jarboui, 2017).

The primary purpose of financial reporting is to express the economic effects of financial events and operations on the business's financial status and performance to help outsiders make financial decisions about the business. Thus, the financial information published by firms has been identified as the most important tool for potential and actual investors in evaluating the performance of management and the firm (Luthan and Satria, 2016).

According to traditional financial theory, investors are expected to use diversification to eliminate the risk associated with the quality of accounting information and to exclude its impact on their valuation decisions; However, over time and numerous studies in this field, it has been found that many factors, including different levels of investors' ability to form a diverse portfolio, prevent investors from eliminating the risk associated with the quality of accounting information (Easley and O'Hara, 2004). Investors expect rewards when they respond to poor-quality information that does not reflect a clear future picture (Westerholm, 2011).

2.2. Financial Ratios

Evaluating a firm's performance using financial ratios is a traditional but still powerful tool for decision-makers involving business analysts, creditors, investors, and CFOs. This analysis achieved significant results using some financial ratios instead of general values observed in financial statements. Ratio analysis can help shareholders analyze a firm's financial health. Using these financial ratios, comparisons can be made well in firms in the industry, between industries, or in a

single firm. Such a tool can also be used to compare the relative performance of firms of different sizes. Accounting and financial reference books generally classify financial ratios in categories including liquidity, earningsability, the ability to pay long-term liabilities, and the utilization of assets or turnover ratios; liquidity ratios measure a firm's ability to pay a short-term debt, while the ability to pay long-term liabilities measures how risky an investment in a firm is for creditors (Delen et al., 2013). Earningsability ratios test a firm's ability to earnings based on sales, net assets, and capital. The exploitation of assets or turnover examines how a firm generates revenue through the use of assets, the collection of receivables, and the sale of inventories. Financial and accounting ratios are based on historical information, and proponents of these metrics believe in the usefulness of historical information, believing that this information better reflects the entity's historical context as historical financial reporting provides uniformity in the presentation of financial information. It still has a special position maintained due to the matching principle of revenues and expenses and the assumption of monetary stability, the principle of matching income and expenses. At the same time, financial data are more reliable and are invented by creating a link between its data and financial indicators in the form of financial ratios. Scholars have long used these data (Delen et al., 2013).

2.3. Artificial intelligence algorithm

Artificial intelligence is an indispensable component used to enforce the law on the disclosure of information on credit derivatives and some guarantees, and the new requirement of artificial intelligence caused a shock. At this point, the solution of accounting lawmakers was to solve the market problem by using derivatives, which were very complicated to implement manually. It is impossible to implement accounting rules without the support of systems in the complex and large risk coverage programs of SEC members and some private entities. Legislators called for these artificial intelligence solutions to be created effectively. They allowed FAS133[1] to be activated after a one-year delay so that minimal artificial intelligence or "system solutions" were available. This also shows an excellent picture of different performance levels that can develop methods of using artificial intelligence both in the capital market and in the field of accounting information. Artificial intelligence solutions in this field can include external data acceptance, math function automation, the production of complete financial reports and even decision-making (Le Guyader, 2020)

In addition to its applications in various fields, artificial intelligence has long found its place in accounting and finance. Accounting researchers have used artificial intelligence technologies and techniques with great success for specific tasks in financial reporting and analysis, auditing, reassurance, and other areas (Lin and Hwang, 2010).

2.4. Explaining the relationship between information quality rating and financial metrics

Of course, the quality of information has always been a topic of interest for users, standard developers, legislators and researchers since it maintains and strengthens the position of the accounting information system in capital markets and reduces agency costs between managers, shareholders, financiers and other third parties (Cohen, 2008). Gupta and Batra (2016) believe that the better the quality of accounting information, the better the performance of the firm; This is because accounting can be used as an information system, and sometimes decision-makers may use irrelevant and useless information that will mislead users into using irrelevant information and, as a result, jeopardize the firm's performance (Gupta and Batra, 2016). Information quality is a crucial determinant of their decisions and actions. Low-quality information can jeopardize organisations' performance, competition, and success and lead to poor decision-making (Borek et al., 2014). It can

1- Statement of Financial Accounting Standards No. 133, Accounting for Derivatives and Coverage Activities, Known as FAS

also, in many cases, take risks to prevent the proper and optimal performance of the organization (Shamala et al., 2013). The quality of financial reporting directly affects the firm's liquidity, and the choice of financial reporting quality level has a significant relationship with the firm's sales growth (Monica et al., 2005).

The quality of corporate financial reporting changes and decreases under the influence of management actions to better reflect the financial situation. Extensive research has been conducted worldwide on internal and external factors affecting the quality of accounting information; However, according to the literature review, it seems that there are very few studies on the effect of firm characteristics in the form of three variables of firm structure, supervision and performance on information quality (Jaggi and Leung, 2007).

There are three competing perspectives on corporate performance and the quality of financial reporting globally. First, some believe that the structural features of the firm play an essential role in preventing managers from tampering with accounting figures relative to other criteria such as monitoring or performance variables; and second, others believe that regulatory mechanisms better control the opportunistic behavior of management in preparing financial statements, the last view belongs to those who believe that the variables of financial performance of the firm can decrease the performance of unethical accounting activities by managers which reduces the quality of information better than the other two approaches, namely structural and regulatory elements (Jaggi and Leung, 2007).

Francis et al. (2005) showed a positive relationship, and Core (2008) showed a negative relationship between the quality of accounting information and returns. Cohen (2008) and Caskey (2009) also concluded that the quality of accounting information does not affect stock returns.

In his study, Tran (2022) showed that firms with higher reporting quality have lower levels of information asymmetry and lower debt ratios, which is consistent with the theory of hierarchy and agency theory. The results also show that the two aspects of reporting quality, namely qualitative characteristics and earnings quality, in explaining the debt ratio are not replaceable alternatives but complement each other. In addition, it was found that qualitative characteristics play a more important role in reducing information asymmetry than earnings quality. Khoufi (2020) concluded that investors do not value the quality of accounting information in this type of capital market due to the poor quality of accounting information and poor performance of regulatory bodies.

Barth et al. (2022) sought an answer to how the value relationship of accounting information has evolved with economic change. The results showed no decrease in the value relationship of accounting information. In some cases, the value relationship has increased, and the accounting amounts related to intangible assets, growth opportunities and performance metrics have a significant value relationship. Xing and Yan (2019) showed that the quality of accounting information is significantly negatively correlated with systematic risk. By increasing the quality of accounting information, systematic risk and, consequently, the cost of the firm's capital is reduced.

Shao et al. (2019) showed that returns on earnings and earnings announcements reached 15% annual returns in the 1990s to 35% in 2010. Also, disclosure of information before the declaration of earnings, change in preventive disclosure and not simultaneous disclosure of information leads to an increase in the quality of accounting information.

In their research, Nyathi et al. (2018) showed that small and medium-siz firms that are unsuccessful in the industry do not use accounting information to make decisions and are unaware of the rules for providing this information. Therefore, they asked the government to provide the necessary training to the owners and managers of the firms through the relevant ministries to provide them with the necessary skills to do their business effectively.

Dang (2017) showed that the rate of return, change in the rate of return, the ratio of sales changes

and growth rate have a positive relationship with stock returns, While firm size is negatively related to stock returns. Chen and Gong (2019) examined the comparison of accounting, financial reporting quality and pricing of accruals. The findings show that increasing the comparability of accounting benefits producers and users of financial statements.

Nyathi et al. (2018) revealed that small and medium-sized firms that are unsuccessful in the industry do not use accounting information to make decisions.

In this study, thus, the following hypotheses have been developed according to the role and importance of financial criteria as the characteristics of the firm as well as the theoretical foundations:

H1: Financial metrics affect the quality of a firm's information quality.

An important factor affecting the correct decision-making by the shareholders of firms is the appropriate information related to the decision on investment or non-investment, which will have negative effects on the individual or institution decision if not properly provided and processed. On the other hand, the type and manner of access to information are also necessary. The most critical need of a manager is to have accurate information to make the right and timely decision. Financial information is provided for decision-making when it is not effective or relevant, and its deterrent ability to prevent violations and inappropriate decisions has been lost. In order to solve these problems, the question came to mind whether it is possible to use a tool in reporting to prepare appropriate reports promptly and per the users' understanding while observing the rules, principles and procedures of accounting. The above cases led to whether artificial intelligence in the accounting information system can provide quality information for timely decision-making for users and prevent financial irregularities and deviations (Wardani and Nugroho, 2018).

Abdelraheem et al. (2021) showed that the dimensions of information technology (collection, processing, storage and transmission of data and information) affect the dimensions of accounting information quality (relevance, reliability, comprehensibility, compatibility, and comparison).

H2: Linear artificial intelligence algorithm has a higher power than nonlinear one to predict the quality of firm information rank.

3. Research Methodology

In terms of objective and retrospective, this paper is applied in terms of research information collection (research plan) since it has used the previous information of the sample firms. This paper is also descriptive-correlation in terms of the data collection method. The systematic elimination method is used to have an appropriate agent from the statistical population among the statistical sample, and 4 criteria are defined; a firm that meets all these criteria is selected as the study sample.

1- To increase comparability, the financial year should be on March 20, and the firm should not change its fiscal year and type of operation during 2011-2019.
2- Due to their peculiar reporting structure, the investment firms and financial intermediaries (leasing, insurance, holdings, banks, and financial institutions) are omitted from the sample.
3- Financial information should be available during 2011-2019.
4- Sample statistical firms should be active during the period of the study.

Regarding the above conditions, a total number of 174 firms is selected during 9 years for hypothesis testing.

3.1. Research variables

In this paper, financial criteria are considered as initial independent variables:

Account receivable to sales ratio: obtained from account receivable to total sales ratio (Leopold et al., 2000).

Fixed assets to sales ratio: obtained by dividing total fixed assets by total sales (Leopold et al.,

2000).

Long-term liability to total assets ratio: Long-term liability to total assets (Linda, 2022).

Firm size: the natural logarithm of total assets is used to calculate the variable (Gordon et al., 2009).

Financial risk: total liabilities is divided into total assets to compute the variable (Demirguc et al., 2013).

Current debt to total assets: current debt to total assets (Linda, 2022).

Return on equity: the dividend is obtained by dividing net earnings into dividends (Linda, 2022).

Divided earnings to assets ratio: the divided ratio of the firm is divided into total assets (Gombola et al., 2016).

Stock return: the following method is used to compute the stock return (Iyke and Ho, 2021):

$$\frac{\begin{array}{c}\text{capital enhancement from cash and demands} - \text{approved stock earnings} + \\ \text{the market value of the firm at the beginning of the year} - \\ \text{market value at the end of the year}\end{array}}{\text{the market value of the firm at the beginning of the year}}$$

Earnings to price ratio per share: dividing the stock price at the end of the year by earnings per share (İskenderoğlu and Karadeniz, 2022).

Operational cash flow ratio: dividing cash obtained from operational activity into total assets (Wiguna and Murwaningsari, 2022).

Return on sales: dividing net earnings into sales (Kariyawasam, 2014).

Operational earnings margin: dividing operational earnings into sales (Brown and Abraham, 2012).

Tobin's Q: total market of the firm and book value of debt divided by total assets (Butt et al., 2021).

Systematic risk (Beta): the severity of the desired stock return changes to the market that is computed as follows (Insana, 2022):

$$\frac{\text{cov (stock return، return market)}}{\text{var (market return)}}$$

Operational cash flow risk: standard deviation of the operational cash flow (Harris and Rorak, 2019).

Stock price risk: standard deviation of stock price (Hutton et al., 2009).

Return on assets: dividing net earnings by total assets (Linda, 2022).

Current assets to current debt ratio: listed firms' current assets to current debt (Langemeier, 1996).

Current assets to total assets: dividing current assets by total assets (Langemeier, 1996).

Fixed assets to total assets ratio: obtained from fixed assets to total assets ratio (Langemeier, 1996).

Cash to total assets ratio: to calculate the variable, the total firm cash sum is divided into total assets (Langemeier, 1996).

Final price to sales income: obtained from dividing final cost into sales (Langemeier, 1996).

In this paper, information quality criteria are considered as initial dependent variables:

-Information quality of earnings quality method

Penman and Penman (2010) compute earnings quality through operational cash flow divided by net earnings. The smaller the ratio, the higher the quality of earnings.

$$EQ = \frac{CFO}{NI}$$

-Information quality of earnings sustainability method

To measure the earnings sustainability, the defined equation by Freeman, named Ohlson and Penman (1982), is used wherein the coefficient, that is, Alpha in the following equation, shows earnings sustainability, so the closer the coefficient to 1, the higher the earnings sustainability would be (higher earnings quality).

$$Earning_{t+1} = \alpha_0 + \delta_1 Earning_t + \upsilon_t$$

EARNING: The firm's operational earnings equals the earnings obtained from those operations that are pivotal to generative activities. The figure is extracted directly from the earnings and loss statements of firms. The coefficient of the descriptive variable of EARNi(t), namely $\lambda_{1\,i}$ in the above model, a first-order regression model (AR1) defines earnings sustainability. When the obtained value for the descriptive coefficient $\lambda_{1\,i}$ is closer to 1, earnings sustainability is higher, and when it is closer to 0, the temporariness of earnings is higher.

-Information quality of earnings prediction method

The standard deviation of residuals (errors) in the above first-order auto-regression equation is a criterion for earnings predictability since, according to Lipe (1990), the more the amount of model error, the less the earnings predictability and vice versa. The said criterion is calculated as follows:

$$\text{Predictability} = \sqrt{\sigma^2\ (\varepsilon_{it})}$$

Bigger (smaller) values of the above criterion are indicative of low (high) predictability (reverse earnings quality).

- Information quality of earnings smoothness method

This paper uses the Eikel smoothness index for earnings smoothness (Bouwman, 2014).

$$\frac{CV\Delta I}{CV\Delta S}$$

Where

ΔI: is earnings changes during several periods

ΔS: are sales change during several periods

CV: is the changes coefficient for the desired variable (obtained from dividing the standard deviation of the desired variable by the mean of that variable). If the Eikel index is smaller than 1, earnings manipulation occurs.

-Information quality of earnings relatedness method

The simplest model for earnings-relatedness calculation is that of Filip and Raffournier (2012) as follows:

$$R_{i,t} = \alpha_0 + \alpha_1 \frac{E_{it}}{P_{it-1}} + \varepsilon_{i,t}$$

$R_{i,t}$ is the market return of the firm i at the end of year t

$E_{i,t}$ is earnings per share of the firm i at the end of year t

P_{it-1} is the market price per share of the firm i at the end of year t

Accounting earnings figures within the framework are called relatedness features if their regression coefficient is statistically significant.

-Information quality of earnings transparency method

The criterion for measuring earnings transparency (TRANSi,t), following that of Barth and Clinch (2009), is the R2 coefficient of determination of the regression obtained from stock return on earnings and change in earningsability as follows:

$$R_{i,t} = \alpha_0 + \alpha_1 \frac{E_{i,t}}{P_{i,t-1}} + \alpha_2 \frac{\Delta E_{i,t}}{P_{i,t-1}} + \varepsilon_{i,t}$$

Where

$R_{i,t}$ s the annual return of stock i in the year t

$E_{i,t}$ earnings per share before abnormal items of the firm i in the year t

$\Delta E_{i,t}$ change in earnings per share before abnormal items from year t-1 to t

P_{it-1} the stock price at the end of year t-1

-Information quality is close to the cash method (Dhieux et al., 2015)

Close to cash (EQs) is computed by applying the net earnings coefficient of the model as follows:

$$CFO_{i,t} = \beta_0 + \beta_1 NI_{i,t} + \varepsilon_{i,t}$$

$CFO_{i,t}$: operational cash flow divided by the total assets of the firm

$NI_{i,t}$: net earnings divided by the total assets of the firm

This variable is obtained from the (β 1) coefficient of net earnings (NIi,t)

-Information quality of the awareness method

The variable is computed as follows:

$$RET_{i,t} = \beta_0 + \beta_1 NI_{i,t} + \beta_2 \Delta NI_{i,t} + \varepsilon_{i,t}$$

$RET_{i,t}$: Mean 12-month return of firm stock

$NI_{i,t}$: Net earnings divided by total assets of the firm

The variable is calculated according to the adjusted coefficient of determination of the model

-Information quality of the conservative method

The model of Givoly and Hayn (2000) is used to measure the conservative accounting index, which is calculated according to the followings:

Accounting conservativeness = operational accruals/total assets in the first period × (-1)

-Information quality of timeliness method

The number of days passed from the financial yearend until the delivery time of audited financial statements is called financial statement timeliness.

-Information quality using the earnings management method

In the adjusted model of Jone's, the accruals are first computed using the following model:

$$TA_{t,i} = \Delta CA_{t,i} - \Delta CL_{t,i} - \Delta CASH_{t,i} + \Delta STD_{t,i} - DEP_{t,i}$$

After calculating total accruals, a1, a2, and a3 parameters are estimated as follows to determine nondiscretionary accruals as follows:

$$TA_{i,t}/A_{i,t-1} = \alpha_1\ (1/A_{i,t-1}) + \alpha_2[(\Delta REV_{i,t} - \Delta REC)/A_{i,t-1}] + \alpha_3\ (PPE_{i,t}/A_{i,t}) = +\varepsilon_{i,t}$$

After calculating a1, a2, and a3 parameters via the minimum squares, nondiscretionary accruals (NDA) can be obtained from the following equation:

$$NDA_{t,i} = \alpha_1\ (1/A_{i,t-1}) + \alpha_2[\ (\Delta REV_{i,t} - \Delta REC)/A_{i,t-1}] + \alpha_3\ (PPE_{i,t}/A_{i,t-1})$$

And finally, after determining the NDA, discretionary accruals (DA) are computed as follows:

$$DA_{i,t} =\ (TA_{i,t}/A_{i,t-1}) - NDA_{i,t}$$

Where
$TA_{i,t}$: Total accruals of the firm i in the year t
$\Delta REV_{i,t}$: Change in sales income of the firm i between the years of t and t-1
ΔREC : Change in accounts receivable of the firm i between the years of t and t-1
PPE_{it}: Gross properties, machinery, and instruments of the firm i in the year t
$A_{it,-1}$: Total book value of firm assets of firm i in the year t
ε_{it}: Undefined effects of random factors
$\alpha_3\ \alpha_2\ , \alpha_1$: Estimated parameters of the firm i

4. Research Findings

Descriptive statistics
Table 1 presents the indicators of descriptive statistics

4.1. Factor analysis

As shown in Table 2, the KMO value for the first order factor is approximately equal to 0.7, which indicates factor analysis appropriateness which is an appropriate value. The other index displayed in the table is Bartlett's test of sphericity, which attempts to explore a new structure based on the correlation between variables and factors after providing the possibility of a hidden factor. Hence, for Bartlett's test statistic, given the above table, the appropriateness of research variables exists to detect and define a new factor based on the correlation of variables.

Table 1. The Descriptive statistics of the study

Variable	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis

Earnings quality	0.710	0.802	457.191	0.336-	101.810	1045.120	-31.510
Earnings sustainability	0.370	0.313	5.832	-7.761	0.928	11.539	-0.197
Earnings prediction	0.077	0.066	0.435	0.000	0.053	0.66	1.901
Earnings smoothness	-0.110	1.273	163.342	-1052	36.44	616.303	-21.880
Earnings relatedness	0.202	0	1	0	0.400	1.100	1.451
Earnings transparency	0.677	0.757	0.998	0.000	0.275	-0.466	-0.758
Cash closeness	0.100	0.199	37.433	-97.566	3.635	470.141	-15.715
Awareness	0.160	0.22	0.998	-0.999	0.570	-0.115	-0.300
Conservativeness	-0.033	-.0.11	2.360	-.1.998	0.200	26.468	-0.088
Timeliness	83.441	85	163.341	19	26.600	0.300	0.144
Earnings management	1.125	0.088	2.233	0.000	0.135	68.6	5.827
Accounts receivable to assets	0.400	0.300	0.213	0	0.365	15.411	2.712
Fixed assets to sales	0.415	0.223	16.900	0.011	0.765	206.518	11.337
Long-term liabilities to total assets	0.075	0.040	0.936	0	0.089	16.465	3.161
Firm size	14.235	14.100	20.14	10.166	1.445	1.322	0.746
Financial risk	0.585	0.952	1.563	0.033	0.200	0.0513	0.055
Current debt to total assets	0.510	0.523	1.148	0.020	0.183	-0.228	0.033
Dividend	0.161	0.24	0.48	-72.963	2.368	797800	-26.353
Earnings are divided into assets	0.000	0.000	0.066	0	0.000	484.718	18.833
Stock return	0.999	0.270	24.240	-0.655	2.045	26.200	4.053
Price to earnings per share	117.745	7.885	79360	-1446.87	2361.213	1107.983	33.055
Operational cash flow	0.113	0.099	0.685	-0.466	0.138	1.619	0.475
Return on assets	0.150	0.100	7.800	-138	0.335	+234.433	10.899
Operational earnings margin	0.163	0.145	0.979	-1.393	0.213	7.167	-0.869
Tobin's q	2.610	1.541	168.500	0.585	7.759	301.65	16.42
Systematic risk	0.67	0.62	5.94	-2.820	0.900	2.398	0.498
Operational cash flow risk	463643.68	76376.29	36809396.67	467.93	175368.60	158.64	11.70
Stock price risk	3796.14	1520.11	73221.61	10.58	6361.06	26.08	4.19
Return on assets	0.11	0.09	0.623	-0.408	0.130	1.240	0.490
Current assets to current debt	1.578	1.319	22.313	0.205	1.279	83.303	7.145
Current assets to total assets	0.670	0.705	0.975	0.065	0.191	-0.683	-0.258
Fixed assets to total assets	0.245	0.209	0.933	0.01	0.179	0.932	1.129
Cash to total assets	0.045	0.027	0.599	0.0002	0.053	3.725	19.743
The final cost to sales income	0.750	0.779	1.410	0.175	0.176	0.228	-0.363
Information quality	2.581	0.30	4.500	-.31.199	1	831.945	-0.414

Table 2. The results of factor analysis on research variables

Statistic/test	Value for first-order factor
KMO criterion	0.640

Bartlett's test	Approximate chi-square	740.970
	Degree of freedom	55
	Significance value	0.000

Source: NCSS Software output

Table 3. The factor load estimation

Variable	Statistic	Value	Variable	Statistic	Value
X1 Information quality of earnings quality method	Factor load estimation	5.832	X7 Information quality of close-to-cash method	Factor load estimation	0.336
	Standard deviation	.		Standard deviation	0.069
	t statistic	.		t statistic	4.826
	Probability value	.		Probability value	<.0001
X2 Information quality of earnings sustainability method	Factor load estimation	0.255	X8 Information quality of awareness method	Factor load estimation	0.269
	Standard deviation	0.038		Standard deviation	0.326
	t statistic	6.548		t statistic	8.265
	Probability value	<.0000		Probability value	<.0001
X3 Information quality of earnings predictability method	Factor load estimation	0.020	X9 Information quality of conservativeness method	Factor load estimation	0.028
	Standard deviation	0.004		Standard deviation	0.006
	t statistic	4.548		t statistic	4.158
	Probability value	<.000		Probability value	<.0001
X4 Information quality of earnings smoothness method	Factor load estimation	3.545	X10 Information quality of timeliness method	Factor load estimation	6.026
	Standard deviation	0.534		Standard deviation	0.681
	t statistic	6.637		t statistic	8.845
	Probability value	<.0001		Probability value	<.0001
X5 Information quality of earnings relatedness method	Factor load estimation	0.206	X11 Discretionary accruals (earnings management)	Factor load estimation	0.024
	Standard deviation	0.024		Standard deviation	0.004
	t statistic	8.537		t statistic	5.384
	Probability value	<.0001		Probability value	<.0001
X6 Information quality of earnings transparency method	Factor load estimation	0.142	GFI= 0.89, AGFI=0.86 SRMR= 0.02 Chi-Square=1248.29, Chi-Square DF=43 Pr > Chi-Square=0.00 NFI=0.89		
	Standard deviation	0.016			
	t statistic	8.602			
	Probability value	<.0001			

Regarding the results of Table 3 and research variables fitting for a factor using the confirmatory factor analysis, the factor load of each variable is estimated using full information maximum likelihood (FIML). Table 4 shows factor loads estimation. According to the table, all factor loads are significant statistically since the probability value is smaller than 0.05.

Table 4 shows the percentage of total items variance determined by each factor. In the table, specific values are variance percentages and described accumulated variance percentages from total data by each factor. The table results show that 99% of variable changes can be explained by one

factor.

Table 4. Total explained variance

Factor No.	Specific value	Explained Variance Percentage	Explained Variance Accumulated Percentage
1	1.292	99.680	99.688
2	0.417	32.213	131.894
3	0.0842	6.555	138.393
4	0.0531	4.100	142.498
5	0.007	0.559	1430.35
6	-0.001	-0.154	142.891
7	0.017	-1.316	141.580
8	0.58	-4.489	137.177
9	-0.086	-6.663	130.449
10	-0.153	-11.859	118.591
11	0.241	18.595	100

Source: NCSS Software output

4.2. Selecting independent variables for analyzing neighbourhood components Suggested approach

This section proposes the suggested approach for selecting independent variables. The approach includes two phases: selecting a subset of independent variables using the Neighborhood Components Analysis Algorithm and model construction. The outlook of the proposed method can be seen in figure 1. First, data will be classified using the 10-fold validation method into two classes training and evaluation. The Neighborhood Components Analysis Algorithm proposes a subset of independent variables.

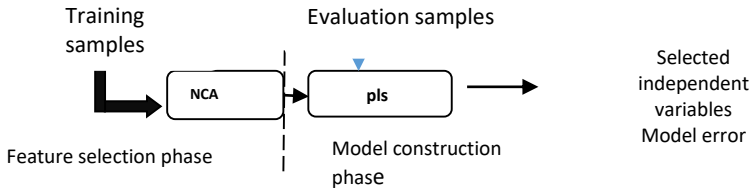

Figure 1. The Independent variable selection and training process

The Neighborhood Components Analysis Algorithm is a proxy for selecting independent variables. NCA is a nonparametric and embedded method for selecting features to maximize the prediction accuracy of regression and classification algorithms. For this purpose, the multiclass classification using the training set includes n observations, each of which is a firm-year:

$$S = \{(x_i, y_i)\}, i = 1,2, \dots, n$$

Where

$x_i \in \mathbb{R}^p$ is vectors of the independent variable of firms (feature), $y_i \in \{1,2, \dots, c\}$ dependent variable (label), and C is the number of classes. The aim is to learn $f: \mathbb{R}^p \to \{1,2, \dots, c\}$ class, such that by giving independent variables of a firm to that, namely F(X), it predicts the dependent variable.

Firm-year data are given to the NCA algorithm, the parameters of which are displayed in the following table.

Table 5. The Neighborhood Components Analysis Algorithm parameters

exact	FitMethod
lbfgs	Solver
100	IterationLimit
1e-5	GradientTolerance
True	Standardize
empirical	Prior

The following results were obtained after applying the NCA feature selection method. These weights only show the significance of the variable and cannot be considered linear regression coefficients. The results of the NCA algorithm showed in figure 2 for financial variables.

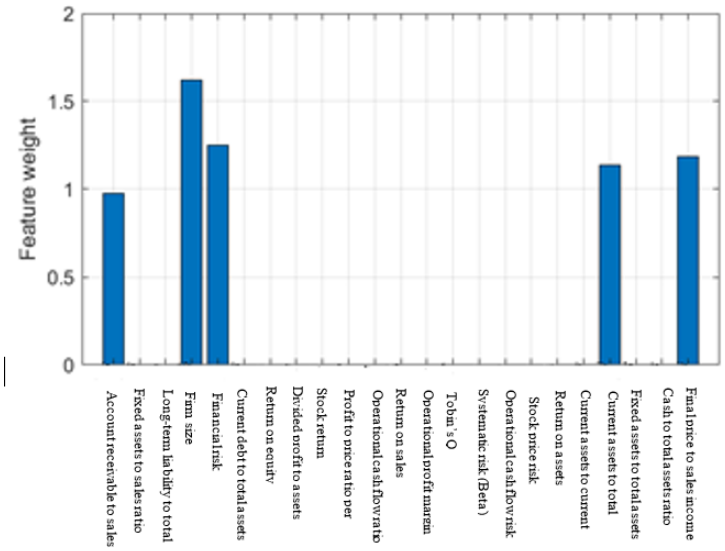

Figure 2. Top five variables from the NCA algorithm perspective for predicting information quality

After selecting the independent variables of the problem, the variables will be given partial least squares regression for model construction. The algorithm is in the class of linear and nonlinear regression algorithms. After dividing firm-years into two groups of training-validation data and testing using mutual 10-fold validation, two evaluation criteria, named mean absolute error (MAE) and mean squared error (MSE), is used for examining linear and nonlinear models. These criteria are computed as follows:

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|y_i - d_i|$$

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - d_i)^2$$

Where

y_i and d_i are dependent and predicted dependent variables by models for ith firm-year, and n is the number of firm-years (in training or test phases).

4.3. Evaluating the learning and prediction potentiality of models

In this stage, using a 10-fold mutual validation method (expressed in the previous section), total training-validation data will be assigned to two linear PLS and nonlinear PLS algorithms referred to

as KPLS. The algorithms learn their parameters and macro parameters using the data. Total samples will be given once to the two algorithms by financial information criteria (selected by the algorithm) as dependent variables (features) and the dependent variable of information quality.

PLS algorithm is a method for modelling linear connection between a set of variables' outputs (responses) $\{y_i\}_{i=1}^{n} \in R^L$ and a set of input variables $\{x_i\}_{i=1}^{n} \in R^N$ (regressors). In the first step, PLS creates non-related hidden variables that are a linear combination of the main regressors. An essential fact of the method is that weights are used to determine the linear combination of the main regressors proportionate to covariance among input and output variables. The least squares regression in the extracted hidden variables subset would lead to a biased variance estimation but less than regression coefficients compared to the main Ordinary Least Squares (OLS) (Rosipal and Trejo, 2001).

In the first phase (stage) of training after learning, linear and nonlinear models will be given the same training validation data without a dependent variable to predict the values of the information quality variable. Then, by computing two error criteria of MAE and MSE, the models' learning potentiality and learning error will be examined. Table 6 displays the error criteria for the training phase. The presented values in each table box from left to right (AVG ± STD) are the mean reported errors of the 10-fold mutual validation method and the standard deviation of 10 reported errors. It is expected that the standard deviation to be close to zero for different performances since the closer to zero, the more dependent the learning process to input data of the problem. For more readability of the table, we attempted to round up the figures to a maximum of 4 decimal places. In all these errors, the closer the error to zero, the higher the learning potentiality of the subsequent algorithm and the better the algorithm's performance would be. For each criterion, errors for the current and upcoming years are reported. For example, comparing the MAE error in the current and upcoming years using nonlinear PLS financial information criteria is better than the linear PLS. Similarly, we will have the same results if the comparison is carried out with corporate governance criteria. The learning potentiality of linear models is extremely low, and both errors indicate the issue properly. The error difference between linear and nonlinear models is so considerable that we can claim that linear models are inefficient in predicting information quality. Such a result from the complication of the problem input space shows that the nature of information quality is based on nonlinear financial information and corporate governance criteria, so no appropriate linear model can be found to operate better or closer to the nonlinear ones. Since the current year's model is independent of the future year, we expect reported errors in the current year to be close to that of the upcoming year, and this is obvious in the tables. In reported errors, those of the current and upcoming years are close to each other, which indicates good learning of both models.

Table 6. The evaluation of the learning potentiality of models using two error evaluation criteria of MAE and MSE in the training phase

Training phase		
Criteria	Financial information	
MAE	Current year	Upcoming year
Linear PLS	0.213±0.001	0.214±0.002
Kernel PLS	0.044±0.0003	0.043±0.001
Training phase		
Criteria	Financial information	
MSE	Current year	Upcoming year
Linear PLS	0.064±0.001	0.064±0.001
Kernel PLS	0.03±0.00005	0.003±0.0001

The next issue to be addressed is the models' prediction power and preventing overfitting in the

learning phase process. In the test phase (step), since test data are set aside within the process of 10-fold mutual validation and will be given to the learnt models to examine their prediction power for those samples that have not been observed yet, it is expected that the error difference between training and testing phase not to be that much evidence. In table 7, similar to the training phase, the mean and standard deviation of all errors are shown on financial information and corporate governance criteria. As can be seen, the difference between reported errors in tables 6 and 7 is trivial, so the overfitting phenomenon did not occur, and all proposed facts in the training phase are also correct in the evaluation phase.

Table 7. The mean and standard deviation of error criteria to assess the prediction power of models in the test phase

Training phase		
Criteria	Financial information	
MAE	Current year	Upcoming year
Linear PLS	0.214±0.011	0.215±0.019
Kernel PLS	0.044±0.003	0.043±0.005
Training phase		
Criteria	Financial information	
MSE	Current year	Upcoming year
Linear PLS	0.065±0.008	0.065±0.012
Kernel PLS	0.003±0	0.003±0.007

5. Conclusion

Accounting information quality by presenting transparent and related information to users can cause the management to choose some methods to lower the cost of financial supply and pave the way for optimal utilization of resources by the managers. In this regard, transparency and reflection of the measures performed by the management via accounting information can enhance the ability of beneficiaries to analyze and supervise the management performance in the firm. In general, these features can remarkably level up investment efficiency. Financial reporting quality affects firms' investment efficiency (Boubaker et al., 2018). Higher quality and information transparency are opportunities for reflecting the stock price. This, in turn, can absorb some new investors (Predana, 2018). High-quality financial information can be improved by lowering information inconsistencies. Financial information utilizes by the shareholders to supervise the managers and is a significant source for investors to monitor the firm's financial performance (Tanha and Dempsey, 2015). This paper assesses the ranking prediction of information quality using factor analysis and artificial intelligence approaches in listed firms on the Tehran Stock Exchange for 9 years from 2011 to 2019. The independent variables used in this paper are financial criteria. The dependent variables are accounting information quality criteria converted to a single unit based on the factor analysis method. The present study is among empirical accounting studies, and the artificial intelligence method is used for hypothesis testing. Results of the study indicate that according to the variable selection method of artificial intelligence, the neighbourhood analysis among the performance variables of “accounts receivable to sales”, “firm size”, “financial risk”, “current assets to total properties”, and “final price to sales income” in firms have the highest correlation and information quality rank.

Frost and Pownall's (1994) study shows that financial reporting quality is associated with firm size. Results show that firm size positively affects accounting information quality since larger firms usually benefit from robust internal control and corporate governance systems, can access high-quality services of large and authentic audit firms, and maintain their fame. The results of the present study are in line with that of Lambert and Verrecchia (2010), Kim and Qi (2008), Ng (2011), Cohen

(2008), Pástor and Pietro (2003), and Barth et al. (2001). Other study results reveal that non/linear artificial intelligence methods are highly competent in predicting the accounting information quality rank of listed firms on the Tehran Stock Exchange. Calderon (1999) observes that neural networks predict financial information better than traditional methods.

Recommendations

We recommend that the Tehran Stock Exchange provide some mechanisms to oblige the firm to disclose financial information quality reports since they can be useful for investors.

The most salient result of the study is better prediction accuracy of nonlinear patterns, compared to the linear ones, in prediction information quality. However, the study's results generally indicate that both algorithm types have acceptable results, so we recommend the nonlinear algorithm be used for predicting financial criteria in the listed firms on the Tehran Stock Exchange.

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