Int. J. Nonlinear Anal. Appl. 15 (2024) 1, 291–312
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/ijnaa.2022.28709.3974

Modeling factors affecting the accuracy of management profit forecasts in Iranian companies

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(Communicated by Mohammad Bagher Ghaemi)

Abstract

Earnings forecasting by management is one of the mechanisms through which management provides information about the firm's future profitability status. We conducted this study with the aim of providing a model to identify factors affecting the accuracy of management earnings forecasts (MEF) in Iranian firms on the Tehran Stock Exchange (TSE). This research is analytical, applied, and ex post facto. The empirical analysis comprises a panel data set of 131 listed firms on the TSE from 2010 to 2019. We employ Bayesian averaging and dynamic averaging approaches to determine the optimal model. For identifying the most important influencing variables on the accuracy of MEF used, the BMA, TVP-DMA, TVP-DMS, BVAR and, OLS models. The findings exhibit that the BMA model had the highest efficiency. Based on this, we entered 50 identified variables affecting the accuracy of MEF into 5 categories (including intra-firm, audit, financial ratios, macroeconomic variables, and managerial governance indicators) in the Bayesian averaging model. We identified 13 essential variables that had an impact on the accuracy of the MEF, based on the increase of the posterior probability compared to the prior probability and the posterior probability level being higher than the threshold level. These variables include MEF of the past period, firm profit or loss, discretionary accruals, type of industry, audit committee, Leverage, operational debts ratio, return on equity, economic uncertainty, economic growth fluctuations, inflation, accrual earnings management, and management ability. According to the results, several factors influence the MEF and this indicates that the MEF is the multi-dimensionality. Therefore, managers need to have a systemic perspective to reduce the MEF error.

Keywords: profit management, Bayesian, TVP-DMA
2020 MSC: 68V30, 90B50

1 Introduction

Forecasting the firm future profitability is one of the cases that investors use in decisions related to stock trading and stock valuation, an issue that can be considered both an opportunity and a threat. Some researchers, such as Wang et al. [68], believe that the MEF of listed firms on the stock exchanges can reduce information asymmetry and

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Received: September 2022 *Accepted:* November 2022

capital cost, and improve the efficiency of resource allocation in the capital market. Meanwhile, the laws related to the disclosure of MEF are different in different countries. For example, in China, before 2001, there were no regulations regarding the disclosure of management's earnings forecasts and after 2001, companies were only required to disclose this type of information under certain conditions and in other cases, its disclosure is voluntary. In countries such as America and France, the disclosure of MEF is voluntary and motivated. In some countries, like Japan, disclosure of this information is mandatory. In Iran, the disclosure of MEF was mandatory for firms active in the stock market before 2016, but currently, this disclosure is not done.

It should be noted that in Iran, since 2016, the "Management Interpretive Report" has replaced the annual performance forecast of listed companies. In this report, the managers must disclose the firm's perspective and forward-looking information with a complete analysis. The disclosure of management's earnings forecasts, whether voluntary or mandatory, is an essential source of information in the capital market because it not only provides information about the firm's future to investors and changes investors' expectations [1], but also affects the trading behavior of investors.

Despite the many advantages of disclosing management's earnings forecasts, these disclosures can also be accompanied by errors, so investigating this issue can lead to a better understanding of the value of information disclosure and can be used by investors and standard-setters as well [31, 63]. Generally, the predicted earnings of companies is considered a key element in the decision-making of investors, creditors, enterprise managers, and other economic actors who need to predict profit.

On the other hand, because future earnings forecasts are unreliable, they are associated with the forecasting inherent limitations, and their use may be misleading. This issue is a research gap to conduct more studies in this field. In other words, sufficient evidence regarding the factors that can affect the error rate and accuracy of firm management's earnings forecasts is limited, especially in Iran, where the disclosure of this type of information was mandatory until 2016, and now there is no requirement. Probably, one of the reasons why the Stock Exchange has prohibited companies from separate disclosing of MEF is its unreliable.

As a result, it should be possible to help solve this issue by identifying factors that affect the error and accuracy of firm management's earnings forecasts. Therefore, the problem of the upcoming research can be seen in the lack of sufficient knowledge of the factors affecting the error and accuracy of MEF. Dynamic Bayesian models are a new approach to modeling. In some researches, multi-criteria decision-making methods, especially Analytical Hierarchy Process (AHP) and Analytical Network Process (ANP) have been widely used in prioritizing and determining important variables [13, 19].

Among the disadvantages of these methods is that they are used only if the number of identified factors is limited. The critical point in all these models is that they evaluate and analyze each factor, its importance, and its impact as an abstract concept. Some authors such as Talebi and Iron [67] used the ANP to evaluate and prioritize factors. The main problem is that this method is only used when the number of factors is small so that a pairwise comparison between them is possible, while if the number of identified factors is oversized (which is usually the case for factors effective in predicting profits), then one factor is considered critical if it is present with other factors. Therefore, in addition to identifying the factors, identifying the communication network between them and the characteristics of this network is also very important in analyzing and presenting solutions.

The Bayesian averaging analysis approach can examine and compare a large number of factors in the presence of other factors. In this regard, the main problem of this research is to model the influencing factors on MEF in Iranian companies using Bayesian and dynamic modeling. In this study, we use from Bayesian Averaging Models (BMA), Time-Varying Parameter-Dynamic Models Selection (TVP-DMS), and Time-Varying Parameter-Dynamic Models Averaging (TVP-DMA) to develop a model of MEF accuracy in TSE. Using the above models, we simultaneously examine more than 50 variables affecting the accuracy of MEF, which is the first time such research has been conducted in Iran.

The remainder of the paper is organized as follows: Section 2 covers prior literature. Then, the date and methodology are illustrated in Section 3. Section 4 discusses the findings, and Section 5 concludes.

2 Literature review

The theory of forecasting is based on the premise that current and past knowledge can be used to make predictions about the future [56]. According to Habib and Hansen [27], forecasting means estimating the value of a variable (a set of variables) for a certain time in the future. Also, they documented that forecasting is done to help in decision-making or future planning.

In Iran, before 2016, listed companies were required to submit their budget reports regarding the forecast of the firm's future profits. However, from the end of 2016 until now, the Stock Exchange has required listed companies to submit a "Management Interpretive Report". The range of information disclosed in this report is beyond the budget reports that companies have provided before. However, due to the uncertainty of the future, the Stock Exchange has pushed companies to offer an interpretive report with a complete description of the firm's future status instead of pure budget numbers. However, in the interpretive report, managers disclose future information of the firm, including the firm's profitability and its future trends. Evaluating the opportunities and risks of commercial activities is one of the duties of management, which requires understanding the nature of commercial activities, including the enterprise profitability potential.

The attractiveness of a firm, in addition to its current state, depends on its potential ability to generate future revenues. A firm that is currently profitable and is expected to continue to be profitable in the future is more attractive than a firm whose potential earnings will decrease soon [48]. It can be claimed that the most important criterion for investors to choose investment companies is the current profitability level and their expected future profitability, in the way that investors make decisions based on the companies' profits in different investment strategies [50]. Investors and financial analysts regard earnings as one of the main criteria for evaluating companies and tend to measure the firm's future profitability to decide whether to keep or sell their shares. In this way, by predicting profit, they judge the state of a firm. The importance of this prediction depends on its deviation from reality. The smaller this deviation is, the more accurate the forecast is [44].

In the accounting literature, two different views have been mentioned in relation to management's earnings forecasts; The first view is the signaling view and, the second view is the opportunistic view of management. Based on the signaling perspective, the manager, as the most knowledgeable person about the firm current and future state, translates the firm's information to external people and, in this way, reduces information asymmetry [49]. The research perspective is also in accordance with the signaling view of the MEF, which tries to help re-disclose information of management's earnings forecasts by providing strong documentation about its usefulness. This importance can be realized by identifying the factors that affect the accuracy of these predictions.

The main goal of financial reporting is to provide appropriate information for users to make decisions. One of the characteristics of the relevance of financial and economic data is its usefulness in forecasting. Forecasting helps investors improve their decision-making process and reduce the risk of their decisions [49]. Since the managers have more accurate information about the firm future state and its future profitability trend therefore, it is expected that, based on the signaling theory, the disclosure of the management's earnings forecasts will be beneficial for investors.

On the other hand, according to the opportunistic point of view, the manager uses the information asymmetry between himself and external persons for his own benefit this means he tries to transfer the flow of benefits to himself [41]. However, according to the efficient market hypothesis, the more efficient the market, the less managers can benefit from the opportunistic view of disclosing management's earnings forecasts because in TSE, which is not very efficient [18], this issue is not very important. Several variables affect the prediction of management earnings, which can be classified into two general categories.

2.1 A: Macro indicators and accuracy of managers' profit forecast

One of the crucial items of financial statements that investors and managers pay attention to is the firm earnings. On the one hand, investors use earnings per share forecasts to comprise a profitable stock portfolio, and on the other hand, managers use it in making important decisions such as operational budgeting, capital expenditures, and other decisions related to the resource allocation of the firm [71]. MEF is discretionary, however, there are economic reasons exist for it. For example, concerns about disclosure costs, insider buying and selling of shares, and fear of laws that can affect management's decision to release voluntary forecasts of bad news are among the reasons for managers' earnings forecasts.

The initial research on earnings forecasts by managers indicated that these forecasts have informational content, so the publication of such forecasts causes a sharp increase in price volatility. One of the hypotheses of managers' voluntary forecasts is that these forecasts align investors' expectations with more information that the manager has. This hypothesis indicates that the management's earnings forecasts are better than the market's expectation of earnings at the time of management's forecasts [40].

In some studies, such as Naqdi [51], he uses past earnings to predict future earnings. He believes that the only way to predict future earnings is to use the average of past earnings. This idea was also taken into consideration by other researchers, still, it should be noted that other information than the time series of past earnings can be effective in

predicting future earnings. For example, some fundamental variables (financial ratios) affect the prediction of future earnings, and the use of financial statement information can improve the prediction of future earnings [55].

In addition to the uncertainty about which of the financial statement information can be a suitable predictor for the future performance of companies and important variables such as the firm's future earnings by managers, another hypothesis has been proposed regarding the more accurate prediction of earnings by managers. In this hypothesis presented by Kim et al. [34], the position of macroeconomic variables in influencing these predictions is pointed out. According to the information channel hypothesis, two theories can be presented regarding the influence of macroeconomic variables on earnings forecast fluctuations. The first theory states that managers predict earnings based on the firm's internal information and based on this forecast, managers provide users with information about the firm's economic prospects.

In the second theory, it is believed that the economic situation of the country affects management projections. According to this theory, managers' decisions and forecasts will be influenced by economic conditions. As a result, it can be claimed that managers make decisions about the firm's activities under the influence of internal factors. Therefore, managers' forecasts based on these internal factors are expected to be caused by economic variables. For example, in a country like Iran that suffers from a high inflation economy, the effect of macroeconomic variables such as interest rate, inflation and gross domestic product, liquidity, and trade balance on the accuracy of earnings forecast by managers is obvious. As a result, based on this hypothesis, it is better that in countries with an unstable economic situation, the impact of macroeconomic factors should also be considered by managers in earnings forecasts. In general, the conditions and operating environment of a firm can be influenced by various factors. In a general classification, these factors can be divided into two systematic and non-systematic categories [34].

Unsystematic factors are factors that are specific to a particular firm. These factors, such as entering a new market, acquisition, and merging a new firm, can affect the activity of a particular firm. Also, the most crucial point related to these factors is that firms have the ability to react to these unsystematic factors and even eliminate them. The most curcial feature of systematic factors such as inflation and interest rate is that these factors are not under the control of a particular firm. However, firms can react to systematic factors, but they cannot remove them [34].

Uncertainty in macroeconomic variables can cause managers to confront problems in accurately predicting the firm's earnings. In this way, economic variables can be considered as effective variables on the correctness and accuracy of earnings forecasts by managers. Variables of exchange rate, inflation rate, gross domestic product, balance of payments, and liquidity are among the most important macroeconomic indicators in Iran, which have experienced severe fluctuations in recent years. The importance of the selected indicators is the reason that, for example, when inflation increases due to the direct effect of the inflation rate on profit, investors are interested in knowing how much earning is affected by inflation and inflationary expectations. However, despite the two-digit inflation conditions in the country, the earnings predicted by the managers will be affected by the inflation conditions [63].

GDP is one of the most important macroeconomic variables of the country, which embrace the overall result of the country's economic activities. Gross domestic product is an indicator through which one can be aware of the expansion, depression, growth, and decline trend of the country's economy. If a reasonable prospect of GDP growth is expected, the predicted earnings is also optimistic according to this economic growth. Therefore, if the economic growth is not realized, the earnings forecast accuracy will decrease. On the other hand, in the conditions of inflation, the interest areas and manager's attention and investors change significantly.

The exchange rate can also be effective in companies from two aspects: First, the companies' income that import and export has a direct relationship with the exchange rate. Second, the currency is a competitive asset in the portfolio of economic participators, is effective on their decisions in trading shares [45, 63]. For this reason, if the exchange rate fluctuates as a macroeconomic indicator, the forecasting accuracy of managers will also fluctuate. Due to the unfair sanctions imposed by the Western countries against our country in recent years, the fluctuation of this index has caused some problems for the companies listed on the TSE. In this regard, the research conducted in Iran has shown that fluctuations in liquidity and balance of payments lead to changes in current costs and ultimately lead to inflation, therefore, such a rise in the society's liquidity does not lead to an increase in the gross domestic product and is considered a booster factor of inflation [61].

2.2 B: Micro indicators and accuracy of managers' earnings forecast

Agency theory explains the agency problems between the owner (shareholder) and the agent (manager) due to information asymmetry. In this regard, regulatory structures help to prevent conflicts of interest between managers and shareholders. In other words, these structures motivate the management to increase the value of the firm. Therefore, the firm's higher return depends on the improvement of the control structures and, as a result, a more accurate

prediction of the stock price. This leads to the reduction of agency costs, higher stock valuation, as a result, better performance in the long run. Various factors affect the reduction of information asymmetry and, consequently the accuracy of firm earnings forecasting, some of which are as follows [42]:

Size: Kiel and Nicholson [33] believe that the firm size, including total assets, total sales, equity market value, and firm value, are directly related. The firm size determines the volume and extent of the activity of a firm. Larger companies have less commercial risk due to more communication with stakeholders and the existence of more control mechanisms. On the other hand, Watts and Zimmerman[69] claim that large companies are forced to disclose more due to bearing more political costs. In large companies, the establishment of precise control and monitoring systems, the use of expert employees and managers, are responding to a wide range of investors, creditors, and employees are among the reasons for the need for more accuracy in earnings forecasting. Therefore, it is expected that there is a positive relationship between firm size and earnings forecast accuracy.

Firm age: Old firms have more experience in earnings forecasting than young companies. Therefore, it is expected that there is a positive relationship between the firm age and the earnings forecasting accuracy.

Leverage: It is the existence of fixed costs in the firm's total costs. Leverage is total liabilities scaled by total assets. The greater the degree of financial leverage, the greater the degree of financial risk because if the degree of leverage is high, with a relatively small decrease in the EBIT, the earnings per share may become negative. The presence of risk indicates the impossibility of precision in predicting earnings. Therefore, it is expected that there is a negative relationship between leverage and earnings forecasting accuracy.

Forecast period: The forecast period means the interval between the firm's entry into the stock market and the end of the financial year. It is expected that there is a negative relationship between the forecasting period and the accuracy of earnings forecasting.

Auditor's opinion: financial statements audited by independent auditors are considered a very suitable means of transmitting information. An earnings forecast is one of the most essential information that is considered by stakeholders. If this prediction is confirmed by the auditors, it will also affect the user's decisions of the financial statements. In this research, the type of auditor's opinion on last year's financial statements is divided into unqualified and qualified based on the auditor's opinion.

Floor and type of industry: Based on the classification the stock exchange, the firms are placed in the main or subsidiary floor. Firms are classified into different industries. The industry type means any of each listed firms is in which of the classified industries.

Revision frequency: Revision times in the last year are the number of times the firm has changed the provided forecast.

Mohammadi [46] investigated the factors affecting the earnings forecasting accuracy of firms. The results indicate that among the considered financial factors, only the revision frequency variable and among the non-financial variables, only the board changes are effective on the accuracy of earnings forecasting.

Ghadrdan et al. [26] investigated the role of stock returns on the accuracy of management forecasts by moderating information asymmetry. The results suggest that there is no significant relationship between stock returns and the accuracy of earnings forecast by management. Still, there is a significant relationship between information asymmetry and the accuracy of MEF. Also, the results show that information asymmetry does not moderate the relationship between stock returns and management's earnings forecast accuracy. Oskou and Fakhari [54] tried to provide a model for MEF bias. The findings of the research indicate that the aforementioned composite index included criteria such as the MEF error in the current period and the previous period, total accrual items of the current period and the previous period, management bonus changes, and changes in operating cash flow. Among these criteria, according to the experts, the MEF error in the last period is the worst criterion, and management bonus changes are the best criteria for measuring the MEF bias.

Mohammadian et al. [47] investigated the effect of complexity and environmental uncertainty on the accuracy of MEF, emphasizing audit quality as a moderating variable. The results exhibit that the complexity and environmental uncertainty have a negative and significant effect on the accuracy of the MEF, and the effect of audit quality on the accuracy of the MEF is positive and significant. Also, the results show that audit quality as a moderating variable affects the relationship between complexity and environmental uncertainty with the accuracy of the MEF.

Dang and Vu [17] examined the influence of business characteristics on earnings persistence in Vietnam. This study used OLS, REM, FEM, and GLS regression methods and research data on listed companies in the Vietnam stock market from 2010 to 2018 with 3677 observations. The results have identified factors such as firm size, revenue growth rate, accruals, and dividend policy that positively affect earnings persistence while the financial structure has

the opposite effect on the persistence of earnings. Besides, the liquidity only has an unclear influence on the persistence of earnings.

Zou [72] investigated how inflation affects the MEF. The results reveal that when inflation rate rises, not only management's possibility of making earnings forecasts but also the precision and accuracy of management forecasts declines, ceteris paribus. Furthermore, the results suggest that when inflation rate rises, the state-owned nature of enterprises will aggravate the decline in the precision and accuracy of listed companies' earnings forecasts. In the unique context of semi-mandatory disclosure rules in China, if companies voluntarily disclose more performance-related information, it usually means that the managers are more capable, more confident. Finally, he finds that the precision and accuracy of the earnings forecasts will further decline for companies with higher debt ratios, indicating that liabilities may be one of the paths of inflation affecting voluntary information disclosure.

Albring and Xu [2] investigated the relationship between MEF, managerial incentives, and risk-taking. They predict a negative relation between disclosure and firm's risk-taking activities. They also predict that the negative relation is attenuated by managerial stock ownership, suggesting that managerial ownership can attenuate the decreased risk-taking activities associated with disclosure. Specifically, they find a robust negative relation between disclosure and risk-taking and that a higher level of managerial ownership attenuates the relation. Buchner, Mohamed and Saadouni [11] examined the level of earnings management for large IPOs that provide earnings forecasts and those that do not provide forecasts in the IPO prospectus. They find that the level of earnings management is lower for IPOs that provided earnings forecasts, than for those which did not provide a forecast. Further tests reveal that IPOs that provide forecasts outperform their counterparts in the long run, using various long term performance measures.

Wang et al. [68] examined whether and how stock sales by majority shareholders in China affect the MEF (MEFs) of listed Chinese firms. The findings imply that the selected characteristics of MEFs matched with the majority stockholders' stock sales decrease the quality of information disclosure and reduce the efficiency of capital allocation in Chinese capital market. Jiang, Song and Zhu [30] examined whether MEF (MEFs) help reduce the stock return seasonality associated with earnings seasonality around earnings announcements (EAs) in Chinese A-share markets. They find that firms in historically low earnings seasons outperform firms in high earnings seasons by 2.1% around MEFs.

Firms in low earnings seasons also have higher trading volume and return volatility than their counterparts around EAs and MEFs. Ishinagi and Shiiba [29] investigated the manager's earnings forecasting strategy when financial statement complexity becomes a significant issue in capital markets. They find that a manager's forecasting strategy depends on whether financial statement complexity stems from business or reporting complexity. Specifically, They indicate, among other observations, that managers who initially announced optimistic earnings forecasts will revise and release pessimistic earnings forecasts when financial statement complexity stems from reporting complexity.

3 Managers' earnings forecast

To check the accuracy of managers' earnings forecast, the model used in the study by Zhang [71], which is the adjusted model of Rogers and Stocken [57], has been used. The mentioned features are the accuracy of managers' previous forecast, forecast time horizon, forecast difficulty, and forecast news. The first pattern for prediction accuracy is as follows:

$$\begin{aligned} ActualAccuracy_{i,t} = \alpha_0 &+ \alpha_1 PriorAccuracy_{i,t} + \alpha_2 ForcastHorizon_{i,t} \\ &+ \alpha_3 ForecastDifficulty_{i,t} + \alpha_4 ForecastDifficulty2_{i,t} \\ &+ \alpha_5 ForecastNews_{i,t} * GoodNews_{i,t} \\ &+ \alpha_6 ForecastNews_{i,t} * BadNews_{i,t} + \alpha_7 CAR_{i,t} \\ &+ \alpha_8 Concentration_{i,t-1} + \alpha_9 Distress_{i,t-1} + \alpha_{10} MB_{i,t-1} \\ &+ \alpha_{11} Size_{i,t-1} + \alpha_{12} Bundle_{i,t} + \epsilon_{i,t} \end{aligned}$$

In this way, the first model is specified, and after checking the possibility of explaining the accuracy by means of forecasting features, the effect of calculated forecasting accuracy (estimated forecasting accuracy) through the first model is determined on the drift after the earnings announcement. The second model to investigate the drift is a model that was chosen based on Zhang [71], and in that, unexpected earnings enter the model alone and interactively with other control variables. The effect of the accuracy of the earnings forecast on the drift after the earnings announcement is checked using the following model.

$$\begin{aligned} ADJ-RET_{i,t} = {} & \beta 0 + \beta 1 NSUE_{i,t} + \beta 2 BUNDLE_{i,t} + \beta 3 NSUE_{i,t} * BUNDLE_{i,t_{i,t}} \\ & + \beta 4 NSUE_{i,t} * BUNDLE_{i,t} * Accuracy_{i,t} + \beta 5 NSUE_{i,t} * NME_{i,t} \\ & + \beta 6 NSUE_{i,t} * NVOL_{i,t} + \beta 7 NSUE_{i,t} * NPRC_{i,t} \\ & + \beta 8 NSUE_{i,t} * NINS_{i,t} + \beta 9 NSUE_{i,t} * NEP_{i,t} + \beta 10 NSUE_{i,t} * BADNEWS_{i,t} \\ & + \beta 11 NME_{i,t} + \beta 12 NVOL_{i,t} + \beta 13 NPRC_i, t \\ & + \beta 14 NINS_i, t + \beta 15 NEP_{i,t} + \beta 16 BADNEWS_{i,t} + \epsilon_{i,t} \end{aligned}$$

Time series pattern in earnings forecasting

There are seven-time series patterns

Moving average pattern

$$EPS_t = 1/5 \sum_{i=1}^{5} EPS_{t-i}$$

$Ln(EPS_t) = \alpha + \beta_t + \epsilon_t$ Exponential trend pattern

$EPS_t = \alpha + \beta_t + \epsilon_t$ Linear trend pattern

$EPS_t = \alpha + \beta(EPS_{t-1}) + \epsilon_t$ First-order autoregression model

$EPS_t = \alpha + \beta(EPS_{t-1}) + \theta\epsilon_{t-1} + \epsilon_t$ Mean autoregression model Moving 1 and 1 (first and first order)

$EPS_t = \alpha + \beta_1(EPS_{t-1}) + \beta_2 EPS_{t-2} + \epsilon_t$ Second-order auto-regressive pattern

$EPS_t = \alpha + \beta_1(EPS_{t-1}) + \beta_2 EPS_{t-2} + \theta\epsilon_{t-1} + \epsilon_t$ Average autoregressive pattern

EPS is the earning per share

Bias in earnings forecasting by management. Kato, Skinner and Kunimura [31] model is used to measure the MEF bias. In this model, the MEF bias is divided into two components including forecast growth and forecast error. How to calculate the MEF bias is as follows:

$$FI = (\bar{E}_t - E_{t-1})/TA_{t-1}$$

$$FE = (E_t - \bar{E}_t)/TA_t$$

In which FI: forecast growth; E: the expected earnings of each period; $\bar{E}$: lagged actual earnings; TA_{t-1}: lagged total assets; FE: prediction error; E: real earnings of each period; TA: the total assets at the period end. Bidlow et al. [12] model was used to measure the investment behavior of companies. This model for typical investment at the firm level expresses the total investment as a function of the firm's growth opportunities:

$$Investment_{i,t+1} = \alpha_0 + \alpha_1 SalesGrowth_{i,j} + \epsilon_{i,t+1}$$

In which, Investment is the net increase in tangible and intangible fixed assets by total assets and Sales Growth is the percentage change in sales from year t+1 to year t.

4 Data and methodology

This study is analytical, applied and ex post facto. We extract the information includes 5 main categories: intra-firm, auditing, financial ratio, Macroeconomic and corporate governance indicators. We extract financial ratios are from the financial statements. We obtain Information on corporate governance, audit from footnotes and information on macro indicators from the website of Central Bank and government financial statistics. The time horizon of this research is a nine years period from 2011 to 2020 for companies listed on the TSE. Based on the systematic elimination method, we select 131 firms. Table 1 shows variables affecting the MEF and how to measure them.

Table 1: Introduction of research variables

Calculation method	Variable	Agents
Calculation of the model based on the first order autoregressive $ROA_{t+1} = \alpha_0 + \alpha_1 ROA_t + e_t$ The difference between the predicted value and the realized value =prediction error	MEF	
$ROA_t = \alpha_0 + \alpha_1 ROA_{t-1} + e_t$ Calculation of the model based on the second order autoregressive	MEF for the past period	
Natural logarithm of the total asset	size	
Using the Harishman index of the top 4 companies in the industry in selected companies	Intensity of industry competition	
Being among the top 50 companies annually. In every year that the firm has been among the top companies. Coded 1 if it has been assigned, 0 otherwise.	The superiority of the firm	
Income changes compared to the first year	Revenue growth	
Net profit and loss	Firm profit or loss	
Using the GARCH model to extract the volatility of stock returns	Volatility of stock returns	
Short-term assets to short-term liabilities	Liquidity index	
Profit after tax minus operating cash flow divided by total assets	Discretionary accrual items	
Average education level of human resources (diploma 1), associate degree (2), bachelor degree (3), Master's (4), and Doctorate (5)	Quality of staff	Intra-firm variables
The amount of cash created as a result of the firm's normal operations is obtained after deducting all operating expenses.	changes in operating cash flow	
$TACC_{i,t} = \Delta CA_{i,t} - \Delta CL_{i,t} - DP_{i,t}$ $\Delta CA_{i,t}$: Change in current assets other than cash of i firm in year t to t-1 $\Delta CL_{i,t}$: Change in current liabilities i firm in year t to t-1 $DP_{i,t}$: Depreciation cost of i firm in year t The change in current assets other than cash (ΔCA) is calculated based on the following equation: $\Delta CA_{i,t} = \Delta AR_{i,t} + \Delta INV_{i,t} + \Delta OCA_{i,t}$ $\Delta AR_{i,t}$: Change in accounts and notes receivable i firm in year t to t-1 $\Delta INV_{i,t}$: Change in the inventory i firm in year t to t-1 $\Delta OCA_{i,t}$: Change in other current assets i firm in year t to t-1 The change in current liabilities is calculated based on the following relationship: $\Delta CL_{i,t} = \Delta AP_{i,t} + \Delta TXP_{i,t} + \Delta OCL_{i,t}$ $\Delta AP_{i,t}$: Change in accounts payable i firm in year t to t-1 $\Delta TXP_{i,t}$: Change in income tax payable by i firm in year t to t-1 $\Delta OCL_{i,t}$: Change in other current liabilities i firm in year t to t-1	Total accruals	
The first lagged of total accruals	Total accrual items of the previous period	
Dividend per share	dividend	
Year of establishment of the firm	Age of the firm	
The length of the forecast period. which is presented in the form of 3, 6, 9, and 12 months forecast.	Earnings forecast period	
The presence of the firm in the main or sub floor. Coded 1, if present in the main floor, 0 otherwise.	Floor type	
According to the ISIC code. If the selected firm is located in any industry, the ISIC code of the industry is considered.	Type of industry	
The type of auditor's opinion on last year's financial statements is divided into unqualified and qualified opinion. Coded 1, if it is unqualified, 0 otherwise.	Auditor's opinion type	audit
It is the number of times the firm has revised the earnings forecast.	Revision frequency	

Coded 1, if there is an audit committee, 0 otherwise.	Audit committee	
Percentage changes in current year's sales over last year's sales	Sales growth ratio	Financial Ratio
Ratio of the total liabilities to total assets	Leverage	
The percentage of changes in the current year's net operating assets on the last year's net operating assets	Net growth of operating assets	
Operating income divided by last year's net operating assets	Return on operating assets	
Current year's sales scaled by last year's net operating assets	Operating assets turnover ratio	
Operational liabilities scaled by operational assets	Operating debts ratio	
Operating profit to current year's sales	Profit margin ratio	
Advertising expenses on the current year's sales	The intensity of advertising expenses	
Current assets divided by current liabilities	Current ratio	
Cash plus short-term investment divided by current liabilities	Cash ratio	
Current assets minus inventories divided by current liabilities Acid-test ratio	Acid-test ratio	
Net income divided by equity	Return on equity	
Net income before tax divided by average assets	Return on assets	
Research and development costs scaled by current year's sales	The intensity of R&D costs	
The ratio of accounts receivable to total assets	Activity ratio	
Extracted conditional variance of GARCH model	Economic uncertainty	Macroeconomic variables
The difference between actual GDP and potential GDP based on the Kalman filter	Fluctuations in economic growth	
Percentage of relative changes in consumer price index	inflation	
Exchange rate indexed on the central bank website	exchange rate	
The difference between exports and imports	Trade balance	
The volume of money plus the volume of quasi-money	Liquidity	
Coded 1 if the government has a share in corporate, 0 otherwise.	State ownership	Corporate governance
It has been obtained from the collection of shares held by banks and insurance companies, holding companies, investment companies and pension funds on the total outstanding shares.	Institutional ownership	
Coded 1 if bonus is paid to the board directors in year t, 0 otherwise.	Board Bonus	
Modified version of Kothari, Leone and Wasley [40] model: $TACC_{i,t} = b_0 + b_1 PPE_{i,t} + b_2 \Delta SALE_{i,t} + b_3 ROA_{i,t} + \varepsilon_{i,t}$ $TACC_{i,t}$: The total accruals are difference between cash flows from operations and net profit after taxes, divided by total assets at the beginning of the period. $PPE_{i,t}$: Gross property, plant and equipment divided by the total assets at the beginning of the previous year, $\Delta SALE_{i,t}$: Annual changes in the firm's sales, which is the annual changes in the sales of the current year compared to the previous year, divided by the total assets at the beginning of the period $ROA_{i,t}$: Return on assets in the current period, which is obtained by dividing the profit before tax by the total assets. $\varepsilon_{i,t}$: non-discretionary accrual part	Accrual earnings management	

$\frac{CFO_{i,t}}{AT_{i,t-1}} = \alpha_1 \frac{1}{AT_{i,t-1}} + \alpha_2 \frac{Sales_{i,t}}{AT_{i,t-1}} + \alpha_3 \frac{\Delta Sales_{i,t}}{AT_{i,t-1}} + \varepsilon_{i,t}$ CFO: Operating Cash Flows AT: Total assets SALE: Net sales of the firm $\Delta SALE$: Changes in the firm's net sales ε is the residual of the regression model, which is the abnormal cash flow. For the variables of production costs and discretionary costs, the following models are examined, based on the view of Roychowdhury [58], the error part is the unexpected part of the model. $\frac{PROD_{i,t}}{AT_{i,t-1}} = \alpha_1 \frac{1}{AT_{i,t-1}} + \alpha_2 \frac{Sales_{i,t}}{AT_{i,t-1}} + \alpha_3 \frac{\Delta Sales_{i,t-1}}{AT_{i,t-1}} + \varepsilon_{i,t}$ $\frac{DISK_{i,t}}{AT_{i,t-1}} = \alpha_1 \frac{1}{AT_{i,t-1}} + \alpha_2 \frac{Sales_{i,t-1}}{AT_{i,t-1}} + \varepsilon_{i,t}$	Real earnings management
Coded 1 if the directors board have a degree related to the firm's activity, 0 otherwise.	Board expertise
Coded 1 if the earnings predicted by the management of firm i is more than the actual earnings at year t, 0 otherwise.	Overconfidence of the CEO
$\max_{i,t} \theta = \frac{Sales_{i,t}}{(\delta_1 CGS_{i,t} + \delta_2 SG\&A_{i,t} + \delta_3 PPE_{i,t} + \delta_4 Intan_{i,t})}$ Firm efficiency is measured by considering cost of goods sold, CGS, selling and general administrative expenses, SG&A, property, plant and equipment, PPE, and intangible assets, Intan, as input variables and sales as output variables. In this model, a specific coefficient (δ) is considered for each of the input variables; Because the effect of all input variables on output (sales) is not the same. The value calculated for the efficiency of the firm is in the range of 0 to 1. Companies with an efficiency score 1, are companies that are very efficient, and companies with a score less than 1, are below the efficiency frontier and must reach the efficiency frontier by reducing costs or increasing revenues. The purpose of calculating the firm's efficiency is to measure the management's ability, and since the inherent characteristics of the firm are also involved in the calculations related to the efficiency, it is not possible to measure the management's ability correctly; Because it is calculated more or less than the actual value due to these characteristics. The efficiency measurement criteria in the above way can be attributed to both "manager" and "firm" factors. To attribute the efficiency to the manager and specify the role and "management ability", all variables resulting from the role of the "firm" are separated from the total efficiency through the following model [20]: $Firm\ Efficiency = \beta_0 + \beta_1 Ln(Total\ Assets) + \beta_2 Market\ Share + \beta_3 Positive\ Free\ Cash\ Flow + \beta_4 Ln(Age) + \beta_5 Foreign\ Currency\ Indicator + Year\ Indicators + \varepsilon$ $Ln(Total\ Assets)$:Logarithm of total assets Market share: Firm sales divided by total industry sales Positive free cash flows: (cash to the total assets of the beginning period) $Ln(Age)$: Logarithm of the life of the firm Foreign Currency Indicator: 1 if the firm exports, and zero otherwise ε: is the residual of model and it is the main criterion for measuring management ability.	Management ability

5 Findings

Many studies have investigated macro variables using a non-linear approach. These studies examined the ability of nonlinear models such as Markov switching [28] and SETAR models [15] to provide forecasts of economic variables. For example, Clements and Krolzig [14] compared the performance of the MS and ESTAR models in the post-World War II period for US country macro variables. The results suggest that these models did not have the ability to predict with higher accuracy compared to competing models, although, they were superior to linear models.

A part of the financial literature in recent decades has examined the amount of information necessary to achieve a robust estimate of the forecast of economic and financial variables [9, 10, 16, 25, 43]. One of the crucial achievements in this regard was the use of various econometric methods to use extensive data information (big data) for forecasting. In such an approach, factor models are more important, and their use has become widespread. Factor models summarize information from a voluminous set (big data) of indicators into a small number of unobservable fundamental components.

Stock and Watson [64, 65] studies for the United States; Forni et al. [25], Marcellino, Stock and Watson [65] and Angelini et al. [3] for the Eurozone; Artis et al. [4] for England and Schumacher [62] for Germany, they are examples of empirical studies using factorial models. Extracting information from large data (big data) can significantly help improve the forecasting process, while the preliminary results of prediction in experimental studies in this regard have been very promising [52, 65]. Stock and Watson [66] pointed out that by using more than 215 variables, they predicted the macro variables of the United States.

Time-Varying Parameter (TVP) models employ state-space methods (such as the Kalman filter) that are commonly used in empirical macroeconomic research for structural analysis and forecasting. If a large data set is used to predict macroeconomic variables, TVP models tend to overfit within the sample. Therefore, they will have poor prediction performance outside the sample. To amend these shortcomings in TVP models, Dynamic Model Selection (DMS) and Dynamic Model Averaging (DMA) models have been used [5].

The training period of this research is from 2011 to 2018, and the period of forecasting performance is from 2019 to 2020. Forecasts using TVP-AR (1)-X DMA and TVP-AR (1)-X DMS such that "-X" represents the exogenous predictor variables present in addition to the AR (1) dynamics. The values of the omitted factors for the DMA and DMS models are ($\alpha = \lambda = 0.99$) similar to various empirical studies, including Ferreira and Palma [23], Filippo [24], Aye et al. [5], Drachal [22] and Naser and Alaal [53], have been considered; Also, the values ($\alpha = \lambda = 0.95$) of the forgotten factors for the DMA and DMS models are similar to various experimental studies, including Koop and Korobilis [37], Belmonte and Koop [8], Saleille [60], Ferreira and Palma [23], Filippo [24], Naser[52], Baur, Beckmann and Czudaj [7] and Drachal [22] have been considered.

Also, the values ($\alpha = \lambda = 0.90$) of the forgotten factors for the DMA and DMS models have been considered similarly to various experimental studies, including Nicoletti and Parso [51], Baur, Beckmann and Czudaj [8] and Drachal [22]. Also, the values of ($\alpha = 0.99, \lambda = 1$), the forgotten factors for DMA models, have been considered similar to various empirical studies, including Ferreira and Palma [23], Filippo [24], and Aye et al. [5]. Finally ($\alpha = 0.95, \lambda = 1$), the values of the forgotten factors for DMA models have been considered as in Filippo [24]. The values ($\lambda = 1$) indicate that there is no missing weight on the time-varying coefficients. In other words, all the past errors in the updated estimated coefficients and also in the prior probabilities are equally weighted. To compare DMS and DMA models, the following prediction models have been used:

BMA is a particular case of DMA in the form of forgotten values ($\alpha = 1, \lambda = 1$), which is a model in which the coefficients evolve very slowly (as in regression OLS estimation) and the combination of models (on average) in the sample length is fixed (as in the Bayesian averaging model). For this reason, this model is considered as TVP-AR (1)-X BMA, as in the study of Koop and Korobilis [36]. In this model, there is no missing weight on the time-varying coefficients ($\lambda = 1$), and there is no lost weight on the probabilities ($\alpha = 1$).

In other words, all the past errors in the updated estimated coefficients as well as the posterior probabilities, are equally weighted. Then, time-varying parameter models with the forgotten factor have been used. First, forecasts are evaluated from a single TVP-AR (1) model (earnings forecast), estimator with a forgotten factor, for $\lambda = 0.99$, where the coefficients of relatively smooth motion, as in the study of Koop and Korobilis [36][37], Ferreira and Palma [23], Buncic and Moretto [12] and Naser and Alaal [53] and have $\lambda = 0.95$, where the coefficients of rapid movement are similar to the study of Koop and Korobilis [36, 37].

Finally, two AR (1) models were used using the OLS method. In the AR (1)-X model, all the relevant variables are used, and in the AR (1) model, only the earnings' forecast variable is used, as in the study of Koop and Korobilis [36, 37]. To evaluate the forecasting performance from the Mean Square Forecasting Error (MSFE), the Mean Absolute

Forecasting Error (MAFE), Mean Absolute Percentage Errors (MAPE), the bias of the forecasting error (Bias), and the Forecasting Error Variance (FEV) and the logarithm of prior probabilities was used. The following table shows the performance of MEF in different models in three forecasting horizons (h=1,4,8). In the prediction horizon (h=1) by checking the criteria (MSFE), (MAFE), (MAPE), and (FEV) of the TVP-AR (1) DMA model ($\alpha = \lambda = 0.90$) and with the criterion (Bias) of the TVP- model AR (1) DMS($\alpha = \lambda = 0.90$) were optimal. As can be seen, DMA and DMS have performed worse than the BMA model in all forecast horizons.

On the other hand, the results of (MSFE), (MAFE), (MAPE), (FEV) and Bias are not strong compared to the forecast probabilities, and they have differences. Because these measures only use point predictions, while prediction probabilities use the entire predictive distribution. Therefore, by examining the models based on using the Log (PL) criterion, it was concluded that the TVP-AR (1) BMA ($\alpha = 1, \lambda = 1$) model is the optimal model in all prediction horizons. Regarding the comparison of TVP-AR models, as can be seen in the forecast horizon h (1), according to (MSFE) and (MAFE) criteria, the TVP-AR (1) BMA model ($\alpha = 1, \lambda = 1$) is a better performance.

According to other measures and forecasting horizons, TVP-AR (1) BMA ($\alpha = 1, \lambda = 1$) models still have better performance. So, when there are more temporal changes in the parameters (α and λ), the prediction performance is better than when (α and λ) is low. In addition, DMA and DMS always have a lower performance than the BMA model with parameters with slow, very slow changes. This issue shows that these changes in parameters and models do not have better performance in forecasting. The BVAR model has the weakest performance in almost all forecast horizons compared to other used models. The result of comparing AR (1)-X OLS and AR (1) OLS models show that in all forecast horizons, AR (1)-X OLS and AR (1) OLS models have worse performance than TVP-AR (1) DMA ($\lambda = 0.99$). In the generality of the above explanations, it should be stated that the main purpose of providing these explanations is to determine the optimal method among BMA, TVP-DMA, TVP-DMS, BVAR, and OLS models to identify the most important variables affecting the accuracy of MEF.

Table 2: Forecast performance criteria in different forecast horizons

	h=1					
	Log (PL)	**MAFE**	**MSFE**	**MAPE**	**FEV**	**Bias**
$TVP-AR(1)-X \quad DMA(\alpha=\lambda=0.99)$	73.36	0.0752	0.0101	0.1987	0.0098	0.0178
$TVP-AR(1)-X \quad DMA(\alpha=\lambda=0.95)$	81.18	0.0658	0.0077	0.1947	0.0074	0.0154
$TVP-AR(1)-X \quad DMA(\alpha=\lambda=0.90)$	82.98	0.0602	0.0067	0.1789	0.0065	0.0142
$TVP-AR(1)-X \quad DMS(\alpha=\lambda=0.99)$	74.19	0.0810	0.0113	0.2030	0.0110	0.0192
$TVP-AR(1)-X \quad DMS(\alpha=\lambda=0.95)$	85.62	0.0708	0.0087	0.1800	0.0085	0.0118
$TVP-AR(1)-X \quad DMS(\alpha=\lambda=0.90)$	106.70	0.0560	0.0061	0.1613	0.0059	0.0157
$TVP-AR(1)-X \quad DMA(\alpha=0.99,\lambda=1)$	70.85	0.0773	0.0102	0.2067	0.0099	0.0172
$TVP-AR(1)-X \quad DMA(\alpha=0.95,\lambda=1)$	75.58	0.0711	0.0081	0.2351	0.0075	0.0243
$TVP-AR(1)-X \quad BMA(\alpha=\lambda=1)$	116.7	0.0147	0.0023	0.1123	0.0221	0.0048
$BVAR-Minnesota$	–	0.500	0.341	0.761	0.117	0.473
$TVP-AR(1) \quad DMA(\lambda=0.99)$	–	0.0831	0.0119	0.2430	0.0109	0.0317
$TVP-AR(1) \quad DMA(\lambda=0.95)$	–	0.0878	0.0130	0.2240	0.0122	0.0287
$AR(1)-X\ OLS$	–	0.1061	0.0186	0.3235	0.0161	0.0492
$AR(1)(OLS)$	–	0.1416	0.0304	0.4638	0.0182	0.1106

				h=4			
$TVP-AR(1)-X$	$DMA(\alpha=\lambda=0.99)$	69.49	0.0791	0.0109	0.1943	0.0105	0.0208
$TVP-AR(1)-X$	$DMA(\alpha=\lambda=0.95)$	76.76	0.0662	0.0078	0.1823	0.0076	0.0162
$TVP-AR(1)-X$	$DMA(\alpha=\lambda=0.90)$	78.05	0.0606	0.0068	0.1699	0.0066	0.0149
$TVP-AR(1)-X$	$DMS(\alpha=\lambda=0.99)$	69.59	0.0841	0.0121	0.1990	0.0116	0.0216
$TVP-AR(1)-X$	$DMS(\alpha=\lambda=0.95)$	79.87	0.0723	0.009	0.1775	0.0089	0.0100
$TVP-AR(1)-X$	$DMS(\alpha=\lambda=0.90)$	97.92	0.0609	0.0071	0.1709	0.007	0.0100
$TVP-AR(1)-X$	$DMA(\alpha=0.99,\lambda=1)$	67.06	0.0789	0.0106	0.197	0.010	0.016
$TVP-AR(1)-X$	$DMA(\alpha=0.95,\lambda=1)$	73.10	0.070	0.007	0.206	0.007	0.022
$TVP-AR(1)-X$	$BMA(\alpha=\lambda=1)$	99.25	0.0174	0.0029	0.1054	0.0026	0.0151
$BVAR-Minnesota$		–	0.514	0.389	1.096	0.153	0.486
$TVP-AR(1)$	$DMA(\lambda=0.99)$	–	0.106	0.036	0.426	0.034	0.036
$TVP-AR(1)$	$DMA(\lambda=0.95)$	–	0.093	0.031	0.375	0.030	0.031
$AR(1)-X\ OLS$		–	0.109	0.019	0.315	0.017	0.048
$AR(1)(OLS)$		–	0.147	0.032	0.435	0.019	0.115
				h=8			
$TVP-AR(1)-X$	$DMA(\alpha=\lambda=0.99)$	65.44	0.081	0.011	0.549	0.011	0.011
$TVP-AR(1)-X$	$DMA(\alpha=\lambda=0.95)$	72.49	0.066	0.007	0.402	0.007	0.013
$TVP-AR(1)-X$	$DMA(\alpha=\lambda=0.90)$	73.55	0.060	0.006	0.317	0.006	0.014
$TVP-AR(1)-X$	$DMS(\alpha=\lambda=0.99)$	63.3	0.085	0.012	0.552	0.012	0.010
$TVP-AR(1)-X$	$DMS(\alpha=\lambda=0.95)$	76.27	0.076	0.011	0.460	0.010	0.009
$TVP-AR(1)-X$	$DMS(\alpha=\lambda=0.90)$	90.7	0.065	0.008	0.428	0.008	0.012
$TVP-AR(1)-X$	$DMA(\alpha=0.99,\lambda=1)$	67.21	0.078	0.010	0.568	0.010	0.011
$TVP-AR(1)-X$	$DMA(\alpha=0.95,\lambda=1)$	72.55	0.066	0.007	0.473	0.006	0.013
$TVP-AR(1)-X$	$BMA(\alpha=\lambda=1)$	83.25	0.017	0.002	0.079	0.005	0.002
$BVAR-Minnesota$		–	0.336	0.197	0.911	0.187	0.096
$TVP-AR(1)$	$DMA(\lambda=0.99)$	–	0.099	0.141	3.64	0.102	0.199
$TVP-AR(1)$	$DMA(\lambda=0.95)$	–	0.093	0.083	2.55	0.083	0.089
$AR(1)-X\ OLS$		–	0.103	0.017	0.895	0.016	0.037
$AR(1)(OLS)$		–	0.146	0.032	1.025	0.019	0.111

According to the results in Table 2, the BMA model has better performance in all modes. Considering the Table 2, and using the maximum likelihood index (Log (PL), which indicates the accuracy of the estimated model, it can be seen that in three time periods h=1, 4, 8, the optimal model is the Bayesian averaging approach. As a result, the results of the BMA model will be analyzed in the following. In this approach, explanatory variables are regressed on the dependent variable for all possible situations.

In this method, several points are important: First, one variable is not present in all possible models.

Second, the mentioned variable does not necessarily have a significant effect on the dependent variable in all the present models. Based on this, the ratio of the number of models in which the mentioned variable is significant to the number of models current, it is an indicator of the presence of the said variable in the optimal model.

Third, when the number of variables increases, it becomes complicated and impossible to calculate all states. As a result, according to Sala-i-Martin's [59] point of view, from several estimates onwards (about 100 to 200 million regressions), the ratio of the significant presence of a variable to all states tends to a specific number.

As a result, there is no need to estimate all states. Finally, there is a need for a decision threshold to eliminate variables. To determine the optimal limit, the ratio of k divided by the total variables has been used (k is the number of proposed variables that have the highest impact on the dependent variable from the researcher's point of view). This k is experimental and is chosen based on the researcher's point of view.

To reach the result, calculations must be done on all the models in the model space. According to the number of investigated variables, the number of available models (based on the presence or absence of each variable) in the model space equals 250 models, which is more than 1125 billion regression models.

In other words, the model space includes 250 models, and according to the assumption of model uncertainty, that is, far from applying personal opinion in choosing the model, all models should be examined, and the information of all models should be used to reach the result.

Following Sala-i-Martin's [59], the value of k in this study is considered equal to 10. Although it is expected that eventually, this number will introduce ten variables as unviolated variables by the calculation process, it is possible that in the end, their number is less or more than ten unviolated variables.

In MATLAB software version 2021, first, by obtaining a sample containing ten million regressions from the model space, the coefficients and posterior probability of each variable were calculated. Next, ten million regressions were added to the first sample, calculations were made for twenty million regressions, and coefficients and posterior probabilities were obtained.

By continuing this process in a sample that included fifty million regressions, convergence was achieved. Based on this, there is no need to increase the sample size to determine non-fragile variables (Table 3). To introduce a non-fragile variable, two conditions must be fulfilled:

1) An increase in the posterior probability of each variable than the prior probability.

2) The posterior probability level is higher than the defined threshold level (initial threshold level = 12 divided by 50 = 0.24.

It is necessary to state that in the first stage, non-data information was used due to the uncertainty assumption, and in the second stage, data information was used due to faster convergence.

Also, the variables that had a posterior probability lower than the prior probability were removed from the model due to being fragile compared to other variables (in the first stage, there were 35 non-fragile variables, and in the second stage, we will continue the calculations with these variables that have a higher posterior probability than the prior probability).

Table 3: The first stage of the sampling process and calculations assuming $\overline{K} = 12$

The first example includes 100 million regression		The first sample includes 10 million regression		Variable
Posterior probability	Posterior coefficient	Prior probability	Prior coefficient	
0.321	0.132	0.207	0.032	MEF for the past period
0.092	0.003	0.073	0.004	size of the firm
0.246	0.023	0.170	0.024	Intensity of industry competition
0.178	0.176	0.135	0.319	The superiority of the firm
0.269	0.127	0.145	0.417	Revenue growth
0.455	0.209	0.318	0.428	Firm profit or loss
0.294	0.788	0.207	0.147	Volatility of stock returns
0.381	0.034	0.270	0.029	Liquidity index
0.588	0.051	0.407	0.080	Discretionary accrual items
0.222	0.068	0.199	0.111	Quality of staff
0.247	0.400	0.122	0.093	Changes in operating cash flow
0.441	0.007	0.222	0.006	Total accruals
0.261	0.127	0.102	0.599	Total accrual items of the previous period
0.362	0.022	0.130	0.039	profit sharing
0.319	0.718	0.179	0.692	Age of the firm
0.230	0.025	0.173	0.015	Forecast period
0.225	0.000	0.152	0.016	Hall type
0.290	0.188	0.138	0.059	Type of industry
0.421	0.955	0.162	0.489	Auditor's opinion type
0.195	0.044	0.190	0.189	Revision frequency
0.428	0.000	0.109	0.039	Audit committee
0.218	0.546	0.123	0.129	Sales growth ratio
0.279	0.014	0.205	0.017	Leverage
0.398	0.034	0.106	0.002	Net growth of operating assets
0.796	0.031	0.691	0.060	Return on operating assets
0.283	0.020	0.164	0.034	Operating assets turnover ratio
0.492	0.057	0.317	0.187	Operating debts ratio
0.263	0.002	0.073	0.002	Profit margin ratio
0.398	0.000	0.239	0.102	The intensity of advertising expenses
0.195	0.007	0.122	0.006	current ratio
0.127	0.013	0.102	0.006	cash ratio
0.132	0.216	0.230	0.394	Acid-test ratio
0.529	0.001	0.157	0.002	Return on equity
0.214	0.188	0.073	0.059	The intensity of R&D costs
0.264	0.721	0.180	0.721	activity ratio
0.831	0.366	0.708	0.346	Economic uncertainty
0.433	0.044	0.190	0.189	Fluctuations in economic growth
0.650	0.204	0.460	0.203	inflation
0.165	0.366	0.132	0.346	exchange rate
0.160	0.152	0.208	0.083	Trade balance
0.298	0.337	0.106	0.193	Liquidity
0.112	0.005	0.123	0.013	State ownership
0.253	0.020	0.164	0.034	Institutional ownership
0.259	0.955	0.162	0.489	Board Bonus
0.545	0.002	0.473	0.002	Accrual earnings management
0.211	0.000	0.139	0.000	Real earnings management
0.383	0.002	0.186	0.003	Board expertise
0.498	0.005	0.306	0.006	Overconfidence of the CEO
0.423	0.002	0.326	0.002	Management ability

In the following, all the steps performed in the first step have been applied to the remaining 39 variables in the second step. In the second stage, a sample including 5 million regressions was used to 39 selected variables, and coefficients and posterior probabilities were calculated. Then, by using the mentioned two conditions and considering the secondary threshold level (12 divided by 39 = 0.3076), the most significant variables affecting the accuracy of MEF will be identified. The results can be seen in Table 4.

Table 4: The second stage of the sampling process and calculations assuming $\overline{K} = 12$

The first example includes 50 million regression		The first sample includes 5 million regression		Variable
Posterior probability	Posterior coefficient	Prior probability	Prior coefficient	
0.896	0.180	0.133	0.002	MEF for the past period
0.239	0.804	0.190	0.003	Intensity of industry competition
0.309	0.035	0.281	0.020	Revenue growth
0.702	0.052	0.455	0.271	Firm profit or loss
0.259	0.069	0.185	0.364	Volatility of stock returns
0.212	0.408	0.400	0.025	Liquidity index
0.450	0.007	0.176	0.068	Discretionary accrual items
0.223	0.732	0.169	0.094	Changes in operating cash flow
0.337	0.026	0.189	0.005	Total accruals
0.230	0.000	0.087	0.509	Total accrual items of the previous period
0.235	0.192	0.196	0.033	profit sharing
0.316	0.974	0.147	0.013	Age of the firm
0.499	0.045	0.203	0.000	Type of industry
0.244	0.014	0.275	0.110	Auditor's opinion type
0.406	0.035	0.090	0.002	Audit committee
0.412	0.032	0.587	0.051	Sales growth ratio
0.387	0.020	0.203	0.000	Leverage
0.396	0.058	0.189	0.005	Net growth of operating assets
0.238	0.002	0.427	0.005	Return on operating assets
0.206	0.000	0.451	0.335	Operating assets turnover ratio
0.401	0.007	0.218	0.002	Operating debts ratio
0.342	0.013	0.232	0.013	Profit margin ratio
0.245	0.220	0.202	0.294	The intensity of advertising expenses
0.439	0.026	0.391	0.173	Acid-test ratio
0.418	0.192	0.333	0.294	Return on equity
0.348	0.373	0.090	0.164	Return on assets
0.238	0.045	0.105	0.011	activity ratio
0.663	0.208	0.147	0.002	Economic uncertainty
0.469	0.155	0.218	0.000	Fluctuations in economic growth
0.304	0.344	0.260	0.005	inflation
0.218	0.005	0.219	0.071	exchange rate
0.298	0.000	0.453	0.002	Liquidity
0.391	0.002	0.139	0.107	Institutional ownership
0.208	0.005	0.111	0.273	Board Bonus
0.545	0.155	0.280	0.111	Accrual earnings management
0.219	0.732	0.306	0.006	Real earnings management
0.286	0.148	0.258	0.083	Board expertise
0.391	0.000	0.107	0.692	Overconfidence of the CEO
0.896	0.180	0.164	0.126	Management ability

In the second stage, 24 variables were selected to determine the non-fragile variables using the conditions. That is, 24 variables had a higher posterior probability than the prior probability, and these 24 variables had a higher posterior probability level than the threshold level of 0.50.

In the following, all the steps performed in the first and second steps have been applied on the remaining 24 variables in the third step. In the third stage, a sample containing 1 million regressions was used to 20 selected variables, and coefficients and posterior probabilities were calculated. Next, using the two mentioned conditions and considering the secondary threshold level (12 divided by 24 = 0.50). The most significant variables affecting management earnings will be identified. The results can be seen in Table 5.

Table 5: The third stage of the sampling process and calculations assuming $\overline{K} = 12$

The first sample includes 1 million regression		The first sample includes 1 million regression		Variable
Posterior probability	Posterior coefficient	Prior probability	Prior coefficient	
0.723	0.385	0.501	0.023	MEF for the past period
0.346	0.028	0.298	0.021	Revenue growth
0.926	0.436	0.482	0.287	Firm profit or loss
0.423	0.054	0.196	0.386	Liquidity index
0.764	0.187	0.424	0.027	Discretionary accrual items
0.437	0.201	0.092	0.540	Total accruals
0.325	0.003	0.208	0.035	Age of the firm
0.514	0.146	0.156	0.014	Type of industry
0.518	0.336	0.215	0.134	Audit committee
0.399	0.021	0.292	0.117	Sales growth ratio
0.664	0.427	0.095	0.002	Leverage
0.452	0.027	0.215	0.109	Net growth of operating assets
0.548	0.546	0.453	0.035	Operating debts ratio
0.483	0.214	0.478	0.355	Profit margin ratio
0.328	0.005	0.231	0.002	Acid-test ratio
0.727	0.367	0.246	0.014	Return on equity
0.403	0.002	0.638	0.312	Return on assets
0.632	0.754	0.414	0.183	Economic uncertainty
0.741	0.252	0.353	0.312	Fluctuations in economic growth
0.503	0.318	0.111	0.012	inflation
0.323	0.185	0.125	0.134	Liquidity
0.349	0.828	0.276	0.143	Board Bonus
0.923	0.565	0.125	0.231	Accrual earnings management
0.449	0.828	0.276	0.015	Overconfidence of the CEO
0.896	0.480	0.164	0.126	Management ability

In the third step, using conditions, 13 variables were selected to determine the non-fragile variables. Table 5 shows these variables in bold. That is, 13 variables had a higher posterior probability value than the prior probability, and these had a posterior probability level higher than the threshold level of 0.50.

Considering that the calculated K is very close to the proposed K, the calculations have been stopped (according to Koop and Korobilis [38], if the difference between the proposed K and the obtained K is less than 10%, the researcher can use the K obtained from the model). Based on the results, the researcher's suggested K is 12, and the model's K is 13, and due to the difference of 8.5% in the results, K=13 was chosen.

Therefore, 13 variables were selected strong or non-fragile, which affect the accuracy of MEF. The rest of the variables with a lower posterior probability than the prior probability is called violator, and their impact on the accuracy of MEF is weak. Table 6 shows non-fragile variables and T-statistics.

Based on the results, the variables with the highest ratio of T-statistic are more critical in the MEF. The priority of influencing variables on management earnings is displayed in the last column. Based on this prioritization, the variable "firm profit or loss" has the highest priority, the variable "Type of industry" has the lowest priority.

Table 6: Prioritization of variables affecting management earnings in the optimal model

Priority	**Regressions t-stat** ≥ 2	**The first sample includes 4 million regression**		**The first sample includes 5 million regression**
		Posterior probability	Posterior probability	
2	0.861	0.723	0.185	MEF for the past period
1	0.932	0.926	0.036	Firm profit or loss
3	0.858	0.764	0.007	Discretionary accrual items
13	0.464	0.514	0.046	Type of industry
9	0.584	0.518	0.036	Audit committee
10	0.575	0.664	0.227	Leverage
11	0.506	0.548	0.046	Operating debts ratio
8	0.618	0.727	0.000	Return on equity
7	0.646	0.632	0.754	Economic uncertainty
4	0.788	0.741	0.152	Uncertainty of monetary and financial policies
12	0.491	0.503	0.018	Fluctuations in economic growth
5	0.772	0.923	0.185	inflation
6	0.701	0.896	0.180	Accrual earnings management

Finally, according to the data analysis and researchers computed, the research final model in five dimensions and consisting of 13 unviolated variables that are effective on the accuracy of the MEF is extracted and presented as described in Figure 1.

6 Discussion and conclusion

Based on the results, among the BMA, TVP-DMA, TVP-DMS, BVAR, and OLS models to identify the most important influencing variables on the accuracy of MEF, the BMA model had the highest efficiency. Based on this, 50 identified variables affecting the accuracy of MEF were entered in the Bayesian averaging model in 5 categories (including intra-firm, auditing, financial ratios, macroeconomic variables, and corporate governance indicators).

Based on the increase of the posterior probability compared to the prior probability and the posterior probability level being higher than the threshold level, we identified 13 variables as essential variables that had an impact on the accuracy of the MEF. These variables include MEF of the past period, firm profit or loss, discretionary accruals, type of industry, audit committee, leverage, operational debts ratio, return on equity, economic uncertainty, economic growth fluctuations, inflation, accrual earnings management, and management ability.

The results of the current research are in line with the results of Mohammadi [46], Ghadrdan, Hematian and Moghaddam [26], Oskou and Fakhari [54], Mohammadian, Heidari and Chalaki [47], Dang and Vu [17], Zou [72], Albring and Exo [2], and Buchner, Mohamed and Saadouni [48]. Based on the study results, we offer the following suggestions:

- Considering the diversity of dimensions of indicators affecting the accuracy of MEF and the inability of the human mind to identify and separate these indicators, a systemic perspective is necessary in this regard. Therefore, it

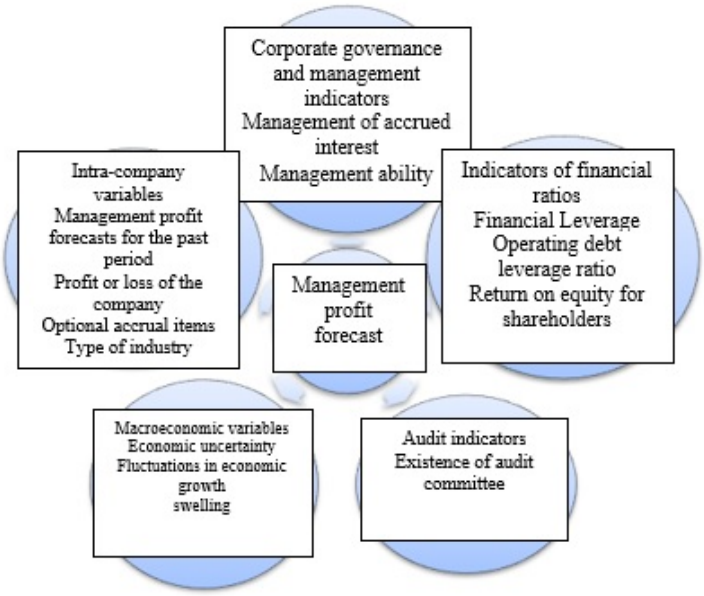

Figure 1: The research's final model

is suggested that the Stock Exchange prepare computer programs based on statistical models to predict future earnings based on the components of past earnings and put them at the disposal of those who want to use these types of advanced models to predict earnings. Also, considering the different effects (positive and negative) of the effective indicators on the accuracy of the management's earnings forecast, providing a composite index in this regard can help the decisions of managers, investors, and policymakers.

- Considering the many factors affecting the accuracy of MEF, investors, analysts, and other stakeholders are advised to consider the thirteen variables identified in this research along with different forecasting manners.
- In Iran, because most of the companies are state-owned, there is no proper mechanism for punishing the managers whose earnings are predicted by them with the necessary precision. Therefore, it is recommended that due to the importance of the expected earnings for investors, the stock exchange should provide conditions so that the earnings forecast is considered as an indicator of the reputation and quality of the managers.

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