



Ranking of Banks' Risk Reporting Using Data Envelopment Analysis

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ABSTRACT

The present study aimed at ranking banks in terms of board of directors' report and notifying the users of reports. In addition, we evaluated factors affecting risk disclosure from the perspective of corporate governance. Moreover, we assessed risk disclosure based on linguistic analysis of board report text and capital adequacy ratio. Words were applied as measurement units to measure risk disclosure. The advantage of this technique is the unique analysis of words. According to the theoretical foundations presented in the present study, we primarily identified risk disclosure words in reports provided to financial information users and divided them into two categories of positive and negative risk disclosure words. Another variable selected for risk disclosure was capital adequacy ratio. Effective variables in corporate governance system in banks included board independence, duality of CEO duties, and major shareholders as input variables in data envelopment analysis (DEA) model. On the other hand, the BCC model of DEA was selected as output-based nature. The statistical population included all banks listed in Tehran Stock Exchange. In total, 20 year-bank units listed during 2016-2017 were assessed. In the end, seven year-bank units were considered efficient while the rest were inefficient. Moreover, we estimated the amount of shortage in outputs of inefficient banks to achieve the desired level of efficiency.

1. Introduction

Data Envelopment Analysis technique was presented in the CCR paper by Charnes et al. [14], and since then has been developed by various researchers. In this method, the relative efficiency of a set of DMUs which use similar types of (multiple) resources to produce similar types of (multiple) outputs is computed. Finally, DMUs are divided into two groups of efficient and inefficient DMUs. In ordinary DEA models, the input and output values are assumed to be definite. Managers have always considered DEA to be a suitable instrument for evaluation of organizations' performance. This method as a nonparametric method which does not need the function of identified production, can enable managers and directors of organizations having corrective evaluation of self-set to have recognitions of capacity of self-power and weakness points in corrective path to attain the goals [27]. Evaluating the overall performance and monitoring the financial condition of commercial banks has been the focus of

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numerous research studies [16,17,18]. This methodology was proposed by Charnes et al. [16], for the first time and it is based on Farrell's [16] idea. Charnes et al. [16] proposed the first DEA model that was based on the constant returns to scale (CRS) assumption and it is called the CCR model. Then, Banker et al. [6] developed CCR model based on the variable returns to scale (VRS) assumption and they called it the BCC model. Board of Directors and its composition are important corporate governance mechanisms. Effective monitoring of the board of directors is one of the stimulants which increase the qualitative features of financial information due to granting more independence in decision making. According to agency theory, the presence of non-executive directors in the corporate board of directors and their supervisory performance as independent individuals help to reduce the conflicts of interest between managers and stakeholders. Hambrick and Jackson [15] believe that the greater the number of independent board members, the better the performance of the company. Typically, a board of directors with a higher number of non-executive managers associates a positive image of independence and accountability for shareholders and increases ensuring compliance with corporate leadership features. In the DEA technique, there is no need to express the mathematical form of the relationship between inputs and outputs, and the relationship is determined by the input and output values themselves. This classifies it as a non-parametric method. Using DEA may model new communications that have not been discovered and are hidden in other ways. It is possible to use multiple inputs and outputs simultaneously in data envelopment analysis. Types of inputs and outputs can be used in data envelopment analysis (DEA) [8,31]. Therefore, DEA is used in this article.

2 Theoretical Fundamentals

The principle of disclosure is one of the accounting principles that affects all aspects of financial reporting. The disclosure principle requires that all material facts relevant to an entity's financial events and activities be properly and fully reported. According to this principle, the fundamental financial statements must contain all relevant, timely and important information that must be presented in a full and comprehensible form to provide an informed decision-making opportunity for users. On the other hand, the quality and quantity of the information must be provided in a way not to confuse the users of financial statements. Financial disclosure is an important tool for management to effectively transfer information to extra-organizational individuals. In the existing literature, numerous hypotheses and theories have been expressed regarding disclosure, and the economic consequences of disclosure and its positive effects have been repeatedly referred to in previous studies. According to Botasan [5], more information disclosure can decrease capital costs and increase corporate value. Based on signaling theory, companies compete with each other to achieve limited resources of capital. Risk can be defined as the types of events or conditions that may prevent an organization from achieving its goals. According to the international standards organization, the risk is defined as a combination of the probability of an event and its effects. Therefore, determining all possible risks in a process and the possibility of their occurrence are the main part of risk assessment in an organization [27]. Risk disclosure can be a source of information for decision-making models. If the decision model involves a set of actions, conditions, and outcomes, output uncertainty and the outcome of the decision are constrained by the circumstances. As such, the information provided in the risk disclosure specifically predicts the probability of conditions occurring as well as the likelihood of outputs. In addition, the signaling theory deduces that managers in well-performing companies use voluntary risk disclosure to

signal risk management practices and attract more investors (by improving transparency). Therefore, risk disclosure provides beneficial information to the market and improves the perception of stakeholders of the level of risk. In addition, risk disclosure is crucial in presenting the performance of companies. Given the mentioned issues, there is a high demand rate for transparent risk disclosure in annual reports. Risk disclosure is a set of information including management estimates, judgments, and market-based accounting policies (e.g., immunization of derivatives, financial tools, and fair value). In addition, risk disclosure involves disclosing non-financial information about programs, strategies and other economic, political, financial, and management risks and the risk of internal controls. This definition is in line with another definition by authors such as Schrand and Elliott [37], which claims that risk disclosure presents all types of information related to business uncertainties. The risk and information disclosure theories include the following items [21]:

Positive Theory: Introduced by Watts and Zimmerman [35] for the first time, positive accounting theory can be used to explain management behavior regarding voluntary disclosure. The theory helps describe the decisions of managers on accounting methods. Three assumptions regarding the positive accounting theory by Watts and Zimmerman [36] include hypotheses for management compensation, debt/equity hypothesis (hypothesis related to loan contract provisions), and political costs hypothesis.

Agency Theory: In agency theory, it is assumed that managers act according to their interests and shareholders' interests are not prioritized. This view is based on the belief that there is a separation between ownership and management in the firm, which leads to costs associated with resolving differences between owner and manager. The basic premise of the agency theory is the conflict between the manager and the owner. Within companies, managers own the resources of owners and use their resources. According to the agency theory, companies disclose information to reduce conflict between managers and owners (shareholders) and increase their value by increasing disclosure. In addition, due to the conflicts of interest between the manager and owners, the latter seeks to conclude contracts to minimize these conflicts of interest. In order to monitor agency contracts, the company deals with incurred costs, which may reduce management compensation. Therefore, managers are encouraged to provide extra-organizational people with accounting information in a timely and reliable manner to minimize agency monitoring costs. As such, a greater information disclosure can lead to a decrease in costs of agency monitoring and increase cash flows belonging to shareholders, thereby increasing the corporate value spontaneously.

Stewardship Theory: In contrast, the stewardship theory declares that managers and board of directors are necessarily reliable and must be assigned the corporate sources as stewards and monitoring in this area is meaningless. As a steward, the board of directors takes more steps toward maximizing the wealth of shareholders. Davis [7] states that stewards prefer organizational goals to their interests, and achieving organizational success leads to meeting personal needs and obtaining goals of stewards. According to this theory, managers build their independence on trust, which reduces the costs of monitoring and behavioral control of managers and the board of directors.

Stakeholder Theory: This is a relatively new theory in the field of management and its existential philosophy lies in the responsibility of the company. Nicholson [30] expresses that companies and society are intrinsically interdependent and the board of directors should focus more on its social responsibilities, compared to the shareholders.

Legitimacy Theory: The legitimacy theory states that organizations can continue to exist as long as society views them as legitimate and gives them legitimacy. In other words, there is a social contract between corporations and all society members. Society, as a group of individuals, provides organizations with the legitimacy to use natural resources and workforce. On the other hand,

organizations use these sources and negatively affect the environment in addition to providing products and services to the community.

3 Literature Review

In a research, Didar et al. [10] evaluated the effect of the quality of corporate governance on disclosure quality while emphasizing the modifying role of product market competition in companies listed in Tehran Stock Exchange. To evaluate these relations, the information of 721 company-year (including 103 companies during 2008-2014) was assessed. Data analysis and testing the hypotheses were carried out by multivariate regression based on panel data. The results demonstrated that the quality of corporate governance had a positive, significant effect on disclosure quality, and a higher disclosure quality was the result of increased quality of corporate governance. However, product market competition had no significant effect in this regard. Rayat Azimi [33] sought to determine the effect of competition, corporate governance mechanisms, and ownership structure on the level of risk disclosure in companies listed in Tehran Stock Exchange. To this end, 91 companies active in Tehran Stock Exchange during 2011-2015 were selected as the statistical sample by the elimination method. Data analysis was performed in Eviews, and all six hypotheses were assessed by various tests. In the end, the results were indicative of a significant relationship between all hypotheses and confirmation of the hypotheses with a high degree of credibility. In another study, Khodadadi et al. [23] evaluated the effect of corporate governance criteria on timely disclosure of financial reporting in companies listed in Tehran Stock Exchange. The evaluated criteria included two internal criteria of management ownership, board independence, the board size, and the duality of responsibility of chairman of the board of directors and CEO, and two external criteria of institutional ownership and centralization of ownership. To this end, six hypotheses were defined to assess this topic, and the data related to 105 companies listed in Tehran Stock Exchange during 2005-2013 were evaluated.

According to the results, among the selected criteria for corporate governance, only the variables of centralization of ownership and duality of responsibility of chairman of the board of directors and CEO had a significant, positive effect, whereas the criteria of management ownership had a significant, negative impact on timely disclosure of financial reporting. Moreover, the results demonstrated that the variables of institutional ownership, as well as board size and independence, had no significant effect on the timely disclosure of financial reporting. An extensive and up-to-date review of the empirical risk disclosure literature was performed by Elshandidi et al. [11], where articles were divided into two main topics of incentives and risk disclosure. The results were indicative of voluntary and non-voluntary risk disclosure, manual and automatic content analysis, changes in the country in contrast to changes in risk disclosure and risk disclosure in financial and non-financial companies. In addition, they identified a number of issues that must be assessed in future studies. Specifically, they focused on two areas: first, lack of clarity and incompatibility with risk conceptualization and second, potential costs and benefits of standardization in the field of risk disclosure. In a study, Abbassi and Schmidt [1] evaluated the comprehensive approach in risk disclosure in banks, reporting that in banks exposed to risk in one type of asset, the risk affects the method of reporting the weight of legal risks for another type of asset. Specifically, when banks are at higher risk, they have less credit risk for their loan portfolio. This relationship is particularly strong for banks with legal capital restrictions. These findings mean that there needs to be a comprehensive view of the various aspects of bank risk for supervision. Ridhima et

al. [34] evaluated the effect of corporate governance components on risk disclosure. This study was conducted to evaluate the level of voluntary risk disclosure and the relationship between the qualitative level of corporate governance in the form of features of the board of directors and the effect of ownership concentration on risk disclosure in the annual report of companies. In the mentioned research, 100 non-financial Hindi companies were assessed, and the results demonstrated that the total number of positive keywords was greater than the disclosure of negative risk keywords. In other words, the main sources of corporate governance, the board size, and gender diversity had a positive effect on risk disclosure, whereas ownership concentration in the hands of the largest stakeholder significantly affected risk disclosure. Nonetheless, the identity of the largest stakeholder, who had ownership concentration, negatively affected risk disclosure. In terms of generating sentences and text and the importance and necessity of addressing this issue, Jacobsen marked that the relationship between the message and the codes for the production of language as speech is so fundamental that it can be said that the same relationship defines speech, whether spoken or written. Types of codes (phonetic, lexical and syntactic codes) provide the speaker with a set of separate units and combinatorial rules, used by writer or speaker to produce the most basic unit of speech (e.i., a sentence). In addition, the role of literary genres in the production of speech or text can be expressed in the form of poetry, fiction or essay.

This role undoubtedly refers to the same relationship between the message and the codes since literary types are tools that produce the word in the form of texts (e.g., stories and poetry). These literary genres have the same role as the generative order for single sentences. In this sense, speech codes can join phonetic, lexical and syntactic codes that determine the units of the word- i.e., sentence. In this regard, Halliday [14] believes that the command relies more on the role of linguistic elements than on the linguistic form. According to this scholar, reliance on the role is defined in three ways: in text interpretation, in system interpretation and the interpretation of linguistic elements of constructions. In addition, Halliday marks that the basis of meaning in language is the same as the characteristics of a role. All languages are organized based on three fundamental meanings, including speculative, interpersonal, and textual. Other theological approaches, all based on theoretical functional views, have been introduced in European linguistic circles in recent years. In this regard, one of the approaches is critical discourse analysis, according to which the text and its meaning are the product of the ideologies hidden behind the dominant social institutions [3]. Research related to risk disclosure in the banking network was initiated in 1998 and based on the report by the Basel Committee on Banking Supervision. After the financial crisis in 2008, identifying and understanding the risks in the banking system became an important issue internationally. These studies emphasized the role of bank risk information and clarity (which must be disclosed in the form of financial statements and associated notes). Nevertheless, the requirements of risk and disclosure became a critical issue with different financial crises (2001 and 2008) and its domino effect on international economy and economic austerity of EU Member States, the output of which has been the risk disclosure framework established to comprehensively cover, control and monitor risk in banks and financial institutions effectively. In this regard, one example is the publication of the international accounting standard No. 7 entitled “financial instruments, disclosure, and presentation” proposed in 2007 and corrected in 2009 and 2010 in response to financial crises. Critical discourse analysis, which evaluates the fundamental concepts of power, language, and ideology, is defined as transferring the concept of structure from the sentence level and grammatical relations (e.g., verb, subject, and object) to the larger text level. In addition to explaining structural units within or text, all of the attention is focused on its applied language. In his critical discourse approach (which is the basis for analysis in the present study), Norman Fairclough used the theories of several

critical-social theorists such as Foucault's Orders of Discourse and Gramsci's hegemony. According to this scholar, discourse analysis is divided into three levels: descriptive: discourse as text (including linguistic analysis in terms of vocabulary, grammar, phonetic system and consistency at a level higher than a sentence), interpretation: discourse as the interaction between the production process and the interpretation of the text (discussion of producing and consuming texts) and explanation: discourse as social contexts [25]. Data Envelopment Analysis (DEA) models are used to estimate the performance of Decision Making Units (DMUs) by measuring the relative efficiency. Farrell was the first one who used the linear programming for evaluating the relative efficiency of DMUs.

For using DEA models, inputs and outputs must be defined (For example risk can be considered as input and return as output). The majority of DEA models cannot be used for a case in which DMUs include both negative and positive inputs/outputs. CCR model (Charnes, Cooper, Rhodes) and BCC model (Banker, Charnes, Cooper) are examples of such sorts. Portela et al. represented a DEA model which can be used in cases where input/output data take positive and negative values [29]. Hwang and Kao, the performance of the first stage, the marketing capability, and secondly, the ability to profit, independently measured using the conventional DEA And the conclusions suggest that rather than the performance of an insurance company just in general, and once the measure is better than the performance of an insurance company in two steps, measure, and this will cause performance to better manage the show data, and will help insurance companies understand their particular advantages and disadvantages of the series. Yang [38] in their study of a two-stage DEA model to evaluate the efficiency of systems and Health Canada, offers the life insurance industry [32]. The present research focuses on a topic that has not been explained in domestic articles and studies. Now that the use of international standards for financial disclosure has been particularly emphasized by the stock exchange organization, audit organization and other related institutions, this research can provide the knowledge needed to apply IFRS in banks.

4 Research Methodology

This descriptive, analytical research was performed on all banks listed on the Tehran Stock Exchange. Consistent with the Fairclough model in critical discourse analysis, we first focused on the lexicology of financial reporting texts. Fairclough recognizes three main features for critical discourse analysis, including relational, dialectical and interdisciplinary. In this regard, critical discourse analysis is a "relational" type of research, meaning that its main emphasis is on social relations rather than creatures or people. In general, social relations are very complicated and layered, meaning that they comprise relations between relations. For instance, discourse can be seen as a type of creature or object. Discourse can be internalized in power and vice versa. According to Fairclough, the critical discourse analysis is not a critical discourse per se, but an analysis of dialectical relationships between discourse and other objects, elements or times, as well as the analysis of the internal relations of discourse. Given the fact that such an analysis transcends the conventional boundaries between disciplines (linguistics, politics, and sociology), Fairclough considers critical discourse analysis an interdisciplinary or transdisciplinary type of analysis [20]. Critical discourse analysis evaluates a text at three levels: The first level (description level) of that aspect of experimental values which is most emphasized in the work of Fairclough is that how ideological differences between texts in different representations of the world are encoded in vocabulary, which shows the experimental values of words. In general,

experimental values of words include semantic relationships such as synonymy, semantic inclusion, and semantic conflict. The data envelopment analysis (DEA) of mathematical programming formulation is based on a technique that develops efficient frontiers with the efficiency related to each decision-making unit (DMU) in a DEA problem set on the concept of evaluating the performance of decision-making options based on the performance of outputs created through input consumption. The key DEA models are classified into two categories of CCR and BCC, each can be assessed in two input-based and output-based methods [4]. However, these methods are different in terms of constant or variable returns to scale.

In the CCR method, the constant return to scale is assumed, whereas the variable return to scale is considered in the BCC model. In this regard, the constant return to scale means that outputs will change as much as the inputs change. For instance, if inputs are doubled, the outputs will be doubled. However, variable return to scale means that outputs are not changed relative to inputs [25]. The assumption of constant return to scale is applicable when firms operate at an optimal scale. Nonetheless, different issues such as competitive effects and limitations lead to firms' failure to operate at an optimal scale. Using the assumption of constant return to scale will result in the impairment of the values calculated to technical efficiency when all firms do not operate at optimal scale [12]. In this study, the assumption of a variable return to scale was considered, which seems logical since commercial units do not usually operate at optimal scale [22]. Whether we consider the problem as an input or output depends on the implementation goal, which can be either maximizing output or minimizing input [26]. Given the fact that our goal was maximizing the output (increasing the level of risk disclosure), the BCC model of DEA with an output nature was selected to estimate the efficiency score of DMUs. The CCR model is the first data envelopment analysis model which takes its name from the initials of its creators (Charans, Cooper, Rhodes). In this model, to determine the highest efficiency ratio and to involve the amount of inputs and outputs of other decision-making units in determining the optimal weights for the unit under study, the following basic model was proposed:

$$\begin{aligned} \text{Max: } & \frac{\sum_{r=1}^s u_r y_{ro}}{\sum_{i=1}^m v_i x_{io}} \\ \text{s. t. : } & \frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, \\ & j = 1, 2, \dots, n, \quad u_r \geq 0 \quad v_i \geq 0 \end{aligned}$$

This model is named using the initials of its creators, Bunker, Charans, and Cooper. Unlike the CCR model, which assumes a constant return to scale ratio, the BCC model assumes a variable return to scale ratio. To scale, by calculating technical efficiency in terms of scale efficiency and management efficiency, a very detailed analysis is provided. To build input-oriented and output-oriented models in the main BCC model, the same principles of the CCR model are used in the model. Input-oriented efficiency increases with decreasing inputs, but in the output-oriented model, efficiency increases with increasing inputs. The BCC multiplicative model with the input-oriented form is as follows:

$$\begin{aligned}
 & \text{Min } \sum_{i=1}^m v_i x_{io} \\
 & \text{s. t. : } \sum_{r=1}^s u_r y_{ro} = 1 \\
 & \sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} \leq 0 \quad j = 1, 2, \dots, n \quad v_i \geq 0 \quad u_r \geq 0
 \end{aligned}$$

In this part, we elaborated on research findings after assessing the performance of banks active in the banking industry of Iran based on a quantitative criterion (i.e., DEA), applying the output-based BCC model with a variable return to scale in order to rank the banks. The following model was designed after assessing the mechanisms of corporate governance in banks and extracting data related to risk disclosure in the text of financial reporting:

Inputs included: major shareholder, board independence, the duality of CEO duties. Outputs included: positive risk disclosure words, negative risk disclosure words, capital adequacy ratio. In the present study, the variable assessed was risk disclosure. First, financial reportings were evaluated for the first level of critical discourse analysis based on Norman Fairclough's model, followed by assessing the text in terms of disclosure of positive or negative risk words.



Fig 1: Data Envelopment Analysis Model

TRD: total risk disclosure words including keywords (positive, negative)

In this section, we analyzed the content of the “corporate risk analysis report” to evaluate the level of risk disclosure. Similar to the work by Ridhima et al. [34], we first determined risk keywords and their types (based on the list below). The definition of risk applied in the present study indicates events that affect achieving organizational goals and encompasses positive (opportunities) and negative (risk, damage, threat or loss) aspects of risk that exert an impact on the firm and management of the risks in the past, present, or future [24]. The quantification of risk disclosure to be used in the DEA model involved considering the number of disclosed risks as total risk disclosure (TRD) based on the list below (the number one is assigned to each disclosed case, and the numbers are summed up at the end).

Negative Words: Negative words are: against (in contradiction), challenge, decrease, decline, disclosure, smaller (less), loss (damage), lower, deviation, INTEREST-free potential, risk, decrease, uncertainty, delay, slow, reverse, and bankruptcy.

Positive Words: Positive words include: changes, distinctiveness, difference, variation, fluctuation, growth, eminent (excellent), increase, opportunity, higher (exceeding), competent (sufficient), benefits, variability, expected, future, earnings (profits) and top [34].

Board independence: is the level of the board's independence to decide about matters. To measure this variable, we use the ratio of the number of independent board members (non-executive) to the total number of board members. The data required was extracted from the board report or change of board composition.

Capital adequacy ratio: a credit institution's capital adequacy ratio is the ratio of regulatory capital to total risk-weighted assets that must be at least eight percent (guidelines for calculating regulatory capital and credit institution capital adequacy).

Major shareholder: the largest shareholder of the company is the major shareholder if they own more than 5%. The data required is extracted from the board report in the section of shareholders' information or explanatory notes attached to the financial statements of the capital section.

The duality of CEO duties: the duality of CEO duties occurs when the chairman or vice-chairman of the board of directors is the corporate CEO as well, which is assigned number one. Otherwise, it is assigned number zero. This item is broken down at the beginning of the annual activity report of the board of directors or the report of the change of composition of the board of directors.

5 Analysis and Results

Data and output description of 20 year-bank units is observed in Table 1 using the main statistical parameters. In the evaluated period, the mean percentage of shareholder ownership was 20.48% with a maximum and minimum of 63.10 and 2.40, respectively. In addition, variance and standard deviation were evaluated as dispersion indices, which indicate the distance in the data distribution.

Table 1: Descriptive Statistics of Input and Outputs

	Variable	Mean	Maximum	Min	S.deviation	Variance
Data	Major shareholder	20.48	63.10	2.40	18.0090	324.32
	Board independence	0.55	1.00	0.00	0.2736	0.07
	Duality of CEO duties	0.35	1.00	0.00	0.4769	0.22
Outputs	Risk disclosure words (positive)	2.80	7.00	0.00	2.3579	5.56
	Risk disclosure words (negative)	5.60	13.00	2.00	3.2619	0.64
	Capital adequacy ratio	-0.82	14.00	-72.00	15.1140	228.43

Moreover, board independence had a mean of 55%, which showed low dispersion based on standard deviation and variance, meaning that the evaluated members were averagely in a limited range of board independence ratio. On the other hand, the duality of CEO duties had a mean of 0.35, and this low mean was indicative of banks' preference not to create a duality of CEO duties. According to the data related to positive and negative risk disclosure words, it could be concluded that a higher number of negative words were used in the text of financial reporting to disclosure risk, compared to positive words, which might be due to the traditional view toward risk definition. Therefore, the higher disclosure of negative risk words is justified by understanding that in the traditional view, risk is considered only from a negative and decreasing aspect. On the other hand, capital adequacy ratio, which is considered as an important variable by bank shareholders and depositors, had a highly dispersed distribution, and there is a huge distance between the maximum and minimum of this ratio. On the other hand, its standard deviation and variance confirmed high dispersion. In the case of using an output-based model, the goal is to bring an inefficient unit to the efficiency frontier by keeping the input constant and increasing the output. The Max function type is applied in this situation. Given the nature of the current research and

the combination of inputs and outputs, the increase of performance efficiency of banks through the increase of capital adequacy ratio and positive and negative risk disclosure words in the text of reports, when inputs are kept constant, occurred preceding the use of the output-based model and Max function. The level of efficiency obtained from the DEA model (by considering all data and outputs) is shown in the table below. In fact, Table 2 presents the efficiency of companies active in the banking industry of Iran. In this regard, the corporations assigned the number one were efficient, whereas the other companies were inefficient (lack of full efficiency). According to Table 2, seven year-bank units were considered efficient and allocated number one, and the remaining 13 year-bank units were regarded as inefficient with a number below one. In addition, the highest efficiency rate (i.e., one) was allocated to credit institutions of Melal, Hekmat Iranian, and Dey during 2016-2017 and Melat Bank in 2016. On the other hand, the lowest level of efficiency (i.e., 0.15) was related to Sarmayeh Bank during 2016-2017.

Table 2: Banks' Efficiency Level in Output-Based Dea Model

Decision-making unit	Year-bank	Level of efficiency	Type of efficiency
DMU1	EghtesadNovin Bank (2016)	0.55	Inefficient
DMU 2	Eghtesad Novin Bank (2017)	0.80	Inefficient
DMU 3	Ansar Bank (2016)	0.54	Inefficient
DMU 4	Ansar Bank (2017)	0.86	Inefficient
DMU 5	Tejarat Bank (2016)	0.87	Inefficient
DMU 6	Tejarat Bank (2017)	0.87	Inefficient
DMU 7	Hekmat Iranian Bank (2016)	1	Strong efficiency
DMU 8	Hekmat Iranian Bank (2017)	1	Strong efficiency
DMU 9	Dey Bank (2016)	1	Strong efficiency
DMU 10	Dey Bank (2017)	1	Strong efficiency
DMU11	Sarmayeh Bank (2016)	0.15	Inefficient
DMU12	Sarmayeh Bank (2017)	0.15	Inefficient
DMU13	Sina Bank (2016)	0.66	Inefficient
DMU14	Sina Bank (2017)	0.72	Inefficient
DMU15	Saderat Bank (2016)	0.36	Inefficient
DMU16	Saderat Bank (2017)	0.39	Inefficient
DMU17	Melat Bank (2016)	0.91	Inefficient
DMU18	Melat Bank (2017)	1	Strong efficiency
DMU19	Melal Credit Institution (2016)	1	Poor efficiency
DMU 20	Melal Credit Institution (2017)	1	Strong efficiency

We evaluated 20 year-bank units listed in the Tehran Stock Exchange during 2016-2017 through implementation of the output-based BCC model of DEA. Among the year-bank units, seven cases were determined to be efficient. The banks are ranked in the table below based on their efficiency. In this regard, efficient banks were ranked first while the other banks were ranked based on their level of efficiency. Meanwhile, Saderat and Sarmayeh banks were ranked lowest. Efficiency was determined when proper output was presented proportionally to the value of input received. In any DEA linear programming, the solution method seeks to maximize the efficiency of the target unit. This search procedure stops when the efficiency of the target unit or at least one of the units equals one. Therefore, for each inefficient unit, there is at least one other unit that has the efficiency of one with the same unit weight of the target obtained from solving the model.

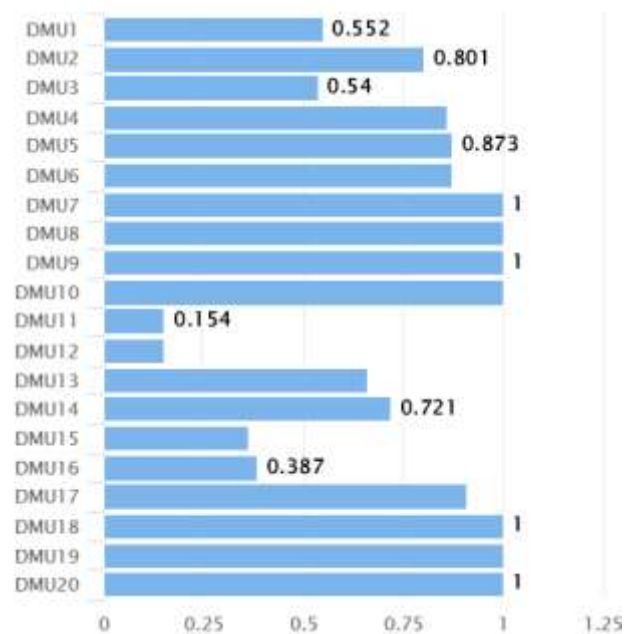


Fig 2: Level of Efficiency of Units (Year-Bank)

Table 3: Ranking of Banks Based on the Level of Efficiency Estimated by Output-Based Dea Model

Decision-making unit	Year-bank	Level of efficiency	Type of efficiency
DMU1	Melal Credit Institution (2017)	1	Strong efficiency
DMU 2	Hekmat Iranian Bank (2016)	1	Strong efficiency
DMU 3	Melat Bank (2017)	1	Strong efficiency
DMU 4	Dey Bank (2017)	1	Strong efficiency
DMU 5	Dey Bank (2016)	1	Strong efficiency
DMU 6	Hekmat Iranian Bank (2017)	1	Strong efficiency
DMU 7	Melal Credit Institution (2016)	1	Poor efficiency
DMU 8	Melat Bank (2016)	2	Inefficient
DMU 9	Tejarat Bank (2016)	3	Inefficient
DMU 10	Tejarat Bank (2017)	3	Inefficient
DMU11	Ansar Bank (2017)	4	Inefficient
DMU12	Eghtesad Novin Bank (2017)	5	Inefficient
DMU13	Sina Bank (2017)	6	Inefficient
DMU14	Sina Bank (2016)	7	Inefficient
DMU15	Eghtesad Novin Bank (2016)	8	Inefficient
DMU16	Ansar Bank (2016)	9	Inefficient
DMU17	Saderat Bank (2017)	10	Inefficient
DMU18	Saderat Bank (2016)	11	Inefficient
DMU19	Sarmayeh Bank (2016)	12	Inefficient
DMU 20	Sarmayeh Bank (2017)	12	Inefficient

These efficient units are referred to as the inefficient unit reference group [12]. The reference groups are presented in the table below:

Table 4: Reference Units

Decision-making unit	Year-bank	Reference 1	Reference 2	Reference 3	Reference 4
DMU1	Eghtesade Novin (2016)	DMU8	DMU12	DMU18	DMU20
DMU2	Eghtesade Novin (2017)	DMU8	DMU12	DMU18	DMU20
DMU3	Ansar Bank (2016)	DMU7	DMU8	DMU18	DMU20
DMU4	Ansar Bank (2017)	DMU8	DMU12	DMU18	DMU20
DMU5	Tejarat Bank (2016)	DMU5	-	-	-
DMU6	Tejarat Bank (2017)	DMU6	-	-	-
DMU7	Hekmat Iranian Bank (2016)	DMU7	-	-	-
DMU8	Hekmat Iranian Bank (2017)	DMU8	-	-	-
DMU9	Dey Bank (2016)	DMU9	DMU12	-	-
DMU10	Dey Bank (2017)	DMU9	-	-	-
DMU11	Sarmayeh Bank (2016)	DMU11	-	-	-
DMU12	Sarmayeh Bank (2017)	DMU12	-	-	-
DMU13	Sina Bank (2016)	DMU8	DMU12	-	-
DMU14	Sina Bank (2017)	DMU8	DMU12	-	-
DMU15	Saderat Bank (2016)	DMU15	-	-	-
DMU16	Saderat Bank (2017)	DMU16	-	-	-
DMU17	Melat Bank (2016)	DMU17	-	-	-
DMU18	Melat Bank (2017)	DMU18	-	-	-
DMU19	Melal Credit Institution (2016)	DMU20	-	-	-
DMU20	Melal Credit Institution (2017)	DMU20	-	-	-

The following table shows the number of repetitions for each reference unit.

Table 5: Number of References

Decision-making units	N
DMU5	1
DMU6	1
DMU7	2
DMU8	7
DMU9	2
DMU11	1
DMU12	7
DMU15	1
DMU16	1
DMU17	1
DMU18	5
DMU20	6

Data envelopment analysis for each of the inefficient observations determines reference group or template with the aim of increasing performance. The number of reference times is shown in Table 5. Higher number of reference banks means that the DUM can be a more appropriate criterion for all units and become a relative benchmark of other units. By benchmarking that bank, other inefficient units can reach efficiency level 1. DUM has been referenced more times, so the combination of inputs and outputs

of this bank can be a benchmark for other banks.

Table 6: Weight of Inputs

Year-bank		Input1	Input2	Input3
Eghtesade Novin Bank (2016)	DMU1	0	1.236	0.158
Eghtesade Novin Bank (2017)	DMU2	0.092	2.359	0.157
Ansar Bank (2016)	DMU3	0.13	3.54	0
Ansar Bank (2017)	DMU4	0.081	2.221	0
Tejarat Bank (2016)	DMU5	0	0.417	0
Tejarat Bank (2017)	DMU6	0	0.417	0
Hekmat Iranian Bank (2016)	DMU7	0.34	0	0
Hekmat Iranian Bank (2017)	DMU8	0.037	0.85	0.004
Dey Bank (2016)	DMU9	2.717	0	0
Dey Bank (2017)	DMU10	0.834	2.04	0.342
Sarmayeh Bank (2016)	DMU11	0	3.333	0
Sarmayeh Bank (2017)	DMU12	0	0.333	0
Sina Bank (2016)	DMU13	0	0	0.108
Sina Bank (2017)	DMU14	0	0	0.099
Saderat Bank (2016)	DMU15	0	1.667	0
Saderat Bank (2017)	DMU16	0	1.667	0
Melat Bank (2016)	DMU17	0	0.5	0
Melat Bank (2017)	DMU18	0	0.5	0
Melal Credit Institution (2016)	DMU19	1.214	0	0.067
Melal Credit Institution (2017)	DMU20	0	0.741	0

Table 7: Weight of Outputs

Year-bank		Output1	Output2	Output3
Eghtesade Novin Bank (2016)	DMU1	0	0	0.158
Eghtesade Novin Bank (2017)	DMU2	0	0	0.147
Ansar Bank (2016)	DMU3	0	0	0.199
Ansar Bank (2017)	DMU4	0	0	0.125
Tejarat Bank (2016)	DMU5	0.167	0	0
Tejarat Bank (2017)	DMU6	0.167	0	0
Hekmat Iranian Bank (2016)	DMU7	0	0	0.071
Hekmat Iranian Bank (2017)	DMU8	0.143	0	0
Dey Bank (2016)	DMU9	0	0.25	0
Dey Bank (2017)	DMU10	0	0	0.25
Sarmayeh Bank (2016)	DMU11	0	0.5	0
Sarmayeh Bank (2017)	DMU12	0	0.5	0
Sina Bank (2016)	DMU13	0	0	0.108
Sina Bank (2017)	DMU14	0	0	0.099
Saderat Bank (2016)	DMU15	0	0.25	0
Saderat Bank (2017)	DMU16	0	0.25	0
Melat Bank (2016)	DMU17	0.2	0	0
Melat Bank (2017)	DMU18	0.2	0	0
Melal Credit Institution (2016)	DMU19	0.24	0	0.094
Melal Credit Institution (2017)	DMU20	0	0.111	0

Table 8: Surplus Inputs

Year-bank		Input1	Input2	Input3
Eghtesade Novin Bank (2016)	DMU1	0	0	0
Eghtesade Novin Bank (2017)	DMU2	0	0	0
Ansar Bank (2016)	DMU3	0	0	0.992
Ansar Bank (2017)	DMU4	0	0	1
Tejarat Bank (2016)	DMU5	0	0	0
Tejarat Bank (2017)	DMU6	0	0	0
Hekmat Iranian Bank (2016)	DMU7	0	0	0
Hekmat Iranian Bank (2017)	DMU8	0	0	0
Dey Bank (2016)	DMU9	0	0	0
Dey Bank (2017)	DMU10	0	0	0
Sarmayeh Bank (2016)	DMU11	0	0	0
Sarmayeh Bank (2017)	DMU12	0	0	0
Sina Bank (2016)	DMU13	55.395	0.03	1
Sina Bank (2017)	DMU14	55.162	0.03	1
Saderat Bank (2016)	DMU15	0	0	0
Saderat Bank (2017)	DMU16	0	0	0
Melat Bank (2016)	DMU17	0	0	0
Melat Bank (2017)	DMU18	0	0	0
Melal Credit Institution (2016)	DMU19	0	0.2	1
Melal Credit Institution (2017)	DMU20	0	0	0

Table 9: Output Shortage

Year-bank		Output1	Output2	Output3
Eghtesade Novin Bank (2016)	DMU1	0	1.786	-32.592
Eghtesade Novin Bank (2017)	DMU2	0	2.143	-32.285
Ansar Bank (2016)	DMU3	0	6.013	-0.481
Ansar Bank (2017)	DMU4	0	4.64	-23.285
Tejarat Bank (2016)	DMU5	0	0	0
Tejarat Bank (2017)	DMU6	0	0	0
Hekmat Iranian Bank (2016)	DMU7	0	0	0
Hekmat Iranian Bank (2017)	DMU8	0	0	0
Dey Bank (2016)	DMU9	0	0	0
Dey Bank (2017)	DMU10	0	0	-6
Sarmayeh Bank (2016)	DMU11	0	0	0
Sarmayeh Bank (2017)	DMU12	0	0	0
Sina Bank (2016)	DMU13	2.97	0	-31.66
Sina Bank (2017)	DMU14	2.634	0	-37.188
Saderat Bank (2016)	DMU15	0	0	0
Saderat Bank (2017)	DMU16	0	0	0
Melat Bank (2016)	DMU17	0	0	0
Melat Bank (2017)	DMU18	0	0	0
Melal Credit Institution (2016)	DMU19	0	0	-0.72
Melal Credit Institution (2017)	DMU20	0	0	0

Table 10: Actual Value of Inputs

Year-bank		Input1	Input2	Input3
Eghtesade Novin Bank (2016)	DMU1	9.49	0.6	0
Eghtesade Novin Bank (2017)	DMU2	9.49	0.4	0
Ansar Bank (2016)	DMU3	10	0.4	1
Ansar Bank (2017)	DMU4	10	0.4	1
Tejarat Bank (2016)	DMU5	40	0.75	0
Tejarat Bank (2017)	DMU6	40	0.75	0
Hekmat Iranian Bank (2016)	DMU7	6.3	0.8	1
Hekmat Iranian Bank (2017)	DMU8	6.41	0.8	0
Dey Bank (2016)	DMU9	4.2	0.6	0
Dey Bank (2017)	DMU10	4.2	0.6	0
Sarmayeh Bank (2016)	DMU11	10	0.8	0
Sarmayeh Bank (2017)	DMU12	10	0.8	0
Sina Bank (2016)	DMU13	63.1	0.83	1
Sina Bank (2017)	DMU14	63.1	0.83	1
Saderat Bank (2016)	DMU15	40	0.5	0
Saderat Bank (2017)	DMU16	40	0.4	0
Melat Bank (2016)	DMU17	17	0.2	1
Melat Bank (2017)	DMU18	17	0	0
Melal Credit Institution (2016)	DMU19	4.66	0.4	1
Melal Credit Institution (2017)	DMU20	4.66	0.2	0

Table 11: Target Value of Inputs

Year-bank		Input1	Input2	Input3
Eghtesade Novin Bank (2016)	DMU1	9.49	0.6	0
Eghtesade Novin Bank (2017)	DMU2	0.49	0.4	0
Ansar Bank (2016)	DMU3	10	0.4	0.008
Ansar Bank (2017)	DMU4	10	0.4	0
Tejarat Bank (2016)	DMU5	40	0.75	0
Tejarat Bank (2017)	DMU6	40	0.75	0
Hekmat Iranian Bank (2016)	DMU7	6.3	0.8	1
Hekmat Iranian Bank (2017)	DMU8	6.41	0.8	0
Dey Bank (2016)	DMU9	4.2	0.6	0
Dey Bank (2017)	DMU10	4.2	0.6	0
Sarmayeh Bank (2016)	DMU11	10	0.8	0
Sarmayeh Bank (2017)	DMU12	10	0.8	0
Sina Bank (2016)	DMU13	7.705	0.8	0
Sina Bank (2017)	DMU14	7.938	0.8	0
Saderat Bank (2016)	DMU15	40	0.5	0
Saderat Bank (2017)	DMU16	40	0.4	0
Melat Bank (2016)	DMU17	17	0.2	1
Melat Bank (2017)	DMU18	17	0	0
Melal Credit Institution (2016)	DMU19	4.66	0.2	0
Melal Credit Institution (2017)	DMU20	4.66	0.2	0

If the value of the inputs or outputs changes to the point at which the unit under investigation is on the efficiency frontier (in other words, efficiency is equal to one), the assumed unit on the efficiency frontier is called the virtual unit. Tables 8 and 9 present the λ values as well as the values of the initial model variables, which are v_i (input coefficients) and u_r (output coefficients). Tables 8 and 9 present the input and output surplus values for each unit in order. A reduction in surplus production factors does

not reduce production, but means that the unit, whether efficient or inefficient, will maintain the same level of efficiency as it loses the calculated surplus. Therefore, the factors of surplus production in a bank can be directed to other sectors. Given that the model used is output-oriented in nature, by changing inputs, favorable outputs can be achieved which, in turn, will help achieve 100% efficiency. The favorable values are, in fact, the optimal values of inputs and outputs. The following tables show the actual values of the inputs and their optimal (target) values, respectively. By changing the values of input variables according to Table 11, inefficient banks become efficient. For example, in 2016, Bank Eghtesad-e-Novin can become an efficient unit by changing the first input variable to 9.49 and the second input to 0.6. The actual and optimal values of outputs are presented in the tables below in order:

Table 12: Actual Value of Outputs

Year-bank		Output1	Output2	Output3
Eghtesade Novin Bank (2016)	DMU1	2	3	6.31
Eghtesade Novin Bank (2017)	DMU2	2	3	6.81
Ansar Bank (2016)	DMU3	3	2	5.02
Ansar Bank (2017)	DMU4	3	2	8
Tejarat Bank (2016)	DMU5	6	7	3
Tejarat Bank (2017)	DMU6	6	7	-5.9
Hekmat Iranian Bank (2016)	DMU7	7	13	14
Hekmat Iranian Bank (2017)	DMU8	7	13	13
Dey Bank (2016)	DMU9	0	4	-2
Dey Bank (2017)	DMU10	0	4	4
Sarmayeh Bank (2016)	DMU11	0	2	-32
Sarmayeh Bank (2017)	DMU12	0	2	-72
Sina Bank (2016)	DMU13	1	6	9.3
Sina Bank (2017)	DMU14	1	6	10.1
Saderat Bank (2016)	DMU15	1	4	-0.61
Saderat Bank (2017)	DMU16	1	4	-2.44
Melat Bank (2016)	DMU17	5	6	7.02
Melat Bank (2017)	DMU18	5	6	6.76
Melal Credit Institution (2016)	DMU19	3	9	2.99
Melal Credit Institution (2017)	DMU20	3	9	2.27

The table of target values of outputs for each variable shows the value that, if acquired, that variable will make the bank efficient. The table above shows the ranking of banks based on their efficiency score obtained by DEA. According to the results, Hekmat Iranian and Melat banks and Melal Credit Institution were ranked first in 2017 and 2016. Finally, it can be concluded that using this technique, the efficiency score assigned to each of the decision units includes all the financial aspects of a decision unit, and based on it, the decision units can be easily put together. Decision units can readily be compared with each other, or a decision unit can be evaluated over several financial periods. All of this indicates the high ability of the DEA mathematical model to determine efficient companies and rank based on their financial reporting information. Output tables of data envelopment analysis provide a way to improve the efficiency of banks so that they can obtain optimal outputs by modifying the structure of inputs. As a result, they achieve efficiency. The purpose of this study is to structurally critique banks to improve efficiency.

Table 13: Target Values of Outputs

Year-bank		Output1	Output2	Output3
Eghtesade Novin Bank (2016)	DMU1	3.626	7.255	-21.152
Eghtesade Novin Bank (2017)	DMU2	2.496	5.886	-23.787
Ansar Bank (2016)	DMU3	5.56	9.72	8.824
Ansar Bank (2017)	DMU4	3.489	6.967	-13.98
Tejarat Bank (2016)	DMU5	6.875	8.021	3.437
Tejarat Bank (2017)	DMU6	6.875	8.021	-6.76
Hekmat Iranian Bank (2016)	DMU7	7	13	14
Hekmat Iranian Bank (2017)	DMU8	7	13	13
Dey Bank (2016)	DMU9	0	4	-2
Dey Bank (2017)	DMU10	0	4	-2
Sarmayeh Bank (2016)	DMU11	0	13	-208
Sarmayeh Bank (2017)	DMU12	0	13	-468
Sina Bank (2016)	DMU13	4.475	9.032	-17.66
Sina Bank (2017)	DMU14	4.02	8.317	-23.188
Saderat Bank (2016)	DMU15	2.75	11	-1.677
Saderat Bank (2017)	DMU16	2.583	10.333	-6.303
Melat Bank (2016)	DMU17	5.5	6.6	7.722
Melat Bank (2017)	DMU18	5	6	6.76
Melal Credit Institution (2016)	DMU19	3	9	2.27
Melal Credit Institution (2017)	DMU20	3	9	2.27

6 Conclusion

Generally, DEA is a powerful management tool used to evaluate the performance of DMUs. Measuring the efficiency and ranking of the banks listed in the Stock Exchange is not only important to researchers but also has attracted the attention of managers and investors. One of the features of this mathematical method is using diverse and heterogeneous input and outputs indexes and determining the strengths and weaknesses of each DMU and its distance to efficiency frontier. In the present study, the results of implementing the model showed that applying more inputs in the banks obtaining an efficiency score of one resulted in a higher level of output generation. In addition, data assessment demonstrated that in the board report, the positive and negative risk disclosure words along with capital adequacy ratio could present a model for corporate governance mechanism analysis in risk disclosure. According to agency theory, the presence of non-executive managers in the board of directors of companies and their supervisory performance as independent individuals greatly help reduce the conflicts of interest of managers and stakeholders. Therefore, the level of risk disclosure increases with increased independence of non-executive board members.

Typically, investors have a positive attitude toward the independence and accountability of a board of directors, the non-executive members of which are more than other members, which increases ensuring the adherence to corporate governance features. As such, non-executive members better support investors and are better representatives for them. Accordingly, independent non-executive members control the agency issue, which decreases information asymmetry between the manager and investors through timely and high-quality risk disclosure. According to the results of the present study, the higher the ratio of non-executive managers, the higher the tendency to voluntary risk disclosure. According to agency theory, independent non-executive managers and risk disclosure are both able to reduce the costs caused by the distance between ownership and control. In this regard, Abraham and Cox [2] analyzed the reliability of risk information and its relationship to corporate and ownership

governance system in British firms using the linear regression model. In the end, the results were indicative of a reverse association between risk disclosure and share ownership in old companies, which led to investors' preference to invest in companies with a lower risk disclosure level. In addition, a direct relationship was found between the corporate governance system and risk information, and companies listed in the US Stock Exchange had a higher disposition toward risk disclosure. The duality of CEO duties occurs when a person is both the CEO and board chairman of a company, which potentially increased the CEO's autonomy and could lead to a higher level of risk disclosure. In a research in Iran, Dianati Deylami and Malek Mohammadi [9] evaluated the effect of features of the corporate governance system and financial information quality, reporting that among the seven variables of the corporate governance system, four variables of centralization of ownership, CEO influence, board independence, and CEO tenure had a positive, significant effect on financial information quality, which is somehow congruent with our findings. It could be justified that the profits of centralized companies have less information content in Iranian banks. Therefore, the centralization of ownership could cause agency problems and information asymmetry. It seems that companies with dispersed ownership had a higher level of voluntary information disclosure. This is mainly due to the fact that corporates with ownership diversity had a higher tendency to disclose information voluntarily in annual reports to show performance in line with the benefits of shareholders. In addition, they demand a decrease in monitoring costs through more disclosure. As observed, increased centralization of ownership strengthens risk disclosure.

The results obtained in this study are in line with the documentation mentioned in the theoretical framework of financial research and literature. Therefore, as a general conclusion, and while considering the references cited in the literature of the study subject, it could be justified that corporate governance components affected risk disclosure in banks listed in the Tehran Stock Exchange. Accordingly, it could be expressed that the company's strategic bylaws have been somewhat successful and have had a significant impact on reducing information asymmetry, increasing voluntary disclosure of risk and thus enhancing firm performance. Ultimately, it could be concluded that lawfully exercising corporate governance features in banks and disclosing them to the community through financial statements and board of directors' reports will increase information reliability. In other words, investors can rely on the information disclosed by the mentioned companies and react properly to this type of risk disclosure, which would be reflected in the stock market price of the above banks.

Therefore, linguistic analysis tools for financial reporting along with corporate governance supervisory techniques must be provided to investors and capital market activists to protect the rights of minority shareholders, increase risk disclosure reliability and help capital market growth and development. It is recommended that linguistic techniques be used by the market supervisor in the ranking of banks in terms of risk disclosure level and the results of this analysis be provided to capital market activists at specific intervals. The results of the present study were obtained by the effective use of the DEA method to estimate the efficiency score of banks and determine their distance from an efficient unit. Our findings can be used to improve the understanding of qualitative financial reporting literature. It is expected that qualitative analysis along with quantitative analysis in the area of financial reporting be able to provide a clearer picture of the current and future business situation of the entity. In order to have a higher level of risk disclosure, it is suggested that the elements of the corporate governance system be strengthened. In addition, the presence of women in the board of directors and

increasing board independence can be effective in risk disclosure from the perspective of critical discourse analysis.

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