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Financial Assessment of Banks and Financial Institutes in Stock Exchange by Means of an Enhanced Two-stage DEA Model

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ABSTRACT

A stock exchange is an entity that provides ''trading'' facilities for stock brokers and traders to trade stocks and other securities. How to invest in stock exchange is one of the important issues in investment, and one of the factors that can help investors in the process of investment is the efficiency of the corporation under consideration. Data envelopment analysis is a mathematical methodology that has been widely applied to assess the performance of banks and financial institutes. The main feature of this methodology evaluating firms by considering multiple inputs and outputs. Conventional DEA models consider each firm as a black box and does not note into the inner activities. Two-stage data envelopment analysis has been applied by several authors that evaluate each firm by considering the inner operations. This paper proposes a new two-stage BAM model and further evaluates the banks and financial institutes in the Tehran stock exchange by considering the financial ratios.

1 Introduction

Financial evaluation of a market analyzes a market for checking whether the market is profitable or not before taking the market in hand. One of the biggest markets in Iran is the Tehran Stock Exchange (TSE). TSE is Iran's largest stock exchange, which first opened in 1967. The TSE is based in Tehran ([1,2,3]). As of May 2012, 339 companies with a combined market capitalization of US$104.21 billion were listed on TSE. TSE, which is a founding member of the Federation of Euro-Asian Stock Exchanges, has been one of the world's best performing stock exchanges in the years 2002 through 2013. Therefore, the importance and credibility of the Tehran Stock Exchange increase the importance and value of intense competition among companies that are on the stock exchange. In addition to constantly reviewing their performance against others, these companies must also identify their strengths and weaknesses in order to stay on course with competitors. One of the methods that is capable in this field and has many capabilities in performance evaluation is data envelopment analysis method ([4,5]).

DEA is a practical and applicable approach and it is widely employed in various fields and real-life problems such as financial markets including insurance, banking, and stock exchange (e.g. [6,7,8,9,10]). The subject of this research is to assess the financial evaluation of banks and financial institutes in Tehran Stock Exchange by means of DEA models. Mathematical formulation like Data Envelopment Analysis can be employed to measure the efficiency of DMUs ([11,12]). DEA is a non-parametric mathematical programming technique proposed by Charnes et al. Charnes, Cooper [13] for

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evaluating the relative efficiency of decision making units (DMUs). One of the problems of some traditional DEA models like CCR, is the inability to recognize the weak efficiency. This difficulty is due to the radial form of these models ([14, 15]). However, non-radial DEA models overcome this problem, and in general, they have some priorities over radial DEA models. This paper applies the Bounded-Adjusted Measure (BAM) model, a non-radial DEA based model, to the financial assessment of banks and financial institutes (BFIs) in TSE. BAM model is a non-radial DEA model with linear objective function and was proposed by Cooper et al. [16]. On the other hand, in many cases DMUs may consist of two-stage structures with intermediate measures. Kao and Hwang [17] modified the standard DEA model by taking into account the series relationship of the two stages within the overall process and modeled the overall efficiency of two-stage process as the product of the efficiencies of two individual stages. Two-stage DEA has been researched by a number of authors as ([18-22], [47,49,51]). Literature review shows that there is no published research in two-stage BAM model. Hence, this study investigates the performance of banks and financial institutes in Tehran Stock Exchange by means of the proposed two-stage BAM model.

The remaining part unfolds as follows: Section 2 provides the Literature review; The developed methodology is described in section 3; The case study is introduced in section 4; section 5 provides the findings and discussion; and, section 6 gives the conclusions.

2 Literature Review

2.1 DEA for Evaluating Financial Markets

Since 1978, DEA models have been widely used for evaluating financial markets. Avkiran [23] presented foreign bank technical, cost and profit efficiency models for particular application with data envelopment analysis. Toloo and Kresta [24] developed DEA models without explicit outputs, henceforth called DEA–WEO, to find the most efficient unit when outputs are not directly considered to evaluate a set of 139 different alternatives for long-term asset financing provided by Czech banks and leasing companies. Chang et al. [25] presented a new dynamic network DEA framework to investigate the substitutability between Passenger Facility Charge and the Airport Improvement Program funds. Esfandiar et al. [26] applied the DEA models for evaluating 18 accepted banks in Tehran Stock Exchange. Izadikhah [27] developed two DEA based bank efficiency measurement to measure the financial evaluation of 15 private bank branches in Markazi province, Iran. Goyal et al. [28] employed a directional distance function based meta-frontier DEA approach to carry out an assessment of intra-sector efficiency in the Indian banking sector based on cross-sectional data of 66 banks for the year 2015-16. Peykani et al. [29] proposed a new DEA approach for efficiency measurement and ranking of stocks using the data from Tehran stock exchange in order to analyze the performance of the proposed method. Wasiaturrahma et al. [30] applied DEA models to analyze the efficiency performance of conventional and Islamic rural banks in Indonesia. Mohsin et al. [31] employed a DEA-Like composite indicator to develop a low carbon finance index that may help out to entice foreign direct and private investment in low-carbon energy sector. Henriques et al. [32] presented a systematic review of the literature on the topic focusing on the banking industry based on two-stage Data Envelopment Analysis. Shuai and Fan [33] employed a super-efficient DEA model to measure the efficiency of China's green economy using the panel data of various regions in China from 2007 to 2018. Li et al. [34] provided a four-stage SBM-DEA to evaluate the total factor waste gas treatment efficiency of 65

Chinese iron and steel enterprises from 2005 to 2014. Wanke et al. [35] developed novel DEA and SFA dynamic network super-efficiency models to assess the 124 OECD banks during 2004–2013 in light of relevant accounting and financial indicators that reflect the banking production process and performance.

2.2 BAM-based DEA Models

Radial DEA models have some problems, such as lack of ability to distinguish some inefficiencies and deal with negative data. For removing these problems, the Bounded Adjusted Measure (BAM) was developed. Cooper et al. Cooper, Borras [16] introduced the BAM model for the additive model to improve the Range Adjusted Measure (RAM) model which was defined by Cooper et al. [36]. Pastor et al. [37] proposed an enhanced extension of Bounded Adjusted Measure by applying less restrictions on the bounds, which removed the negative effect. Rashidi and Farzipoor Saen [38] developed a BAM model based on green factors to determine the eco-efficiency of DMUs. Haghighi and Rostamy-Malkhalifeh [39] applied the BAM model for investigating the environmental efficiency of organizations. Qin et al. [40] developed a DEA-based global bounded adjusted measure to evaluate the energy efficiency by means of production efficiency and emission efficiency.

3 New two-stage model

Consider there are n decision making units (DMUs) such that DMU_j uses m different inputs $x_{ij}, (i = 1, \dots, m)$ to produce s outputs $y_{rj}, (r = 1, \dots, s)$. A two-stage DMU is a DMU consisting of two sub-DMUs (stages) working in series. The outputs of the first stage are called intermediate products and are denoted by $z_{fj}, (f = 1, \dots, F)$ and are usually used as inputs of the second stage to produce the final outputs. The proposed structure of two-stage DEA model is depicted in Fig. 1.

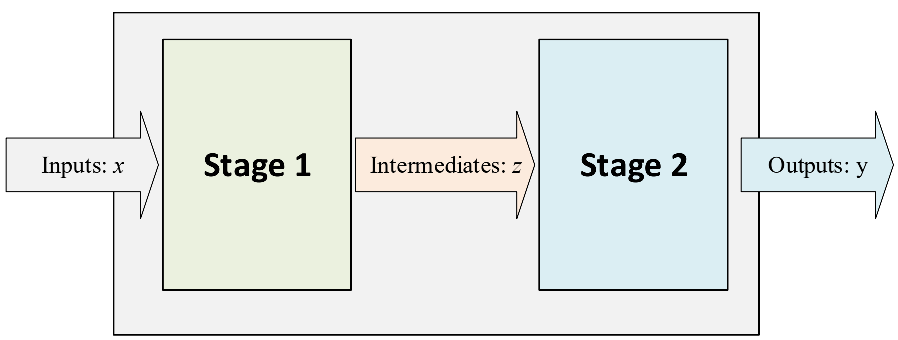

Fig. 1: A two-stage DMU

To present a model for solving the above two-stage framework, we develop the following variable return to scale two-stage BAM model for estimating overall efficiency in envelopment form:

$$\max \ \mathrm{w}_1\left\{\frac{1}{m+F}\left(\sum_{i=1}^{m}\frac{s_i^-}{L_{ip}^-}+\sum_{f=1}^{F}\frac{\ddot{s}_f^+}{H_{fp}^+}\right)\right\}+\mathrm{w}_2\left\{\frac{1}{F+s}\left(\sum_{f=1}^{F}\frac{\dot{s}_f^-}{H_{fp}^-}+\sum_{r=1}^{s}\frac{s_r^+}{L_{rp}^+}\right)\right\}$$

$$\begin{aligned}
& s.t. \\
& \sum_{j=1}^{n}\lambda_j^1 x_{ij}+s_i^- = x_{ip}, && i=1,\dots,m, \\
& \sum_{j=1}^{n}\lambda_j^1 z_{fj}-\ddot{s}_f^+ = z_{fp}, && f=1,\dots,F, \\
& \sum_{j=1}^{n}\lambda_j^2 z_{fj}+\dot{s}_f^+ = z_{fp}, && f=1,\dots,F, \\
& \sum_{j=1}^{n}\lambda_j^2 y_{rj}-s_r^+ = y_{rp}, && r=1,\dots,s, \\
& \sum_{j=1}^{n}\lambda_j^1 = 1, \\
& \sum_{j=1}^{n}\lambda_j^2 = 1, \\
& s_i^-, s_r^+, \dot{s}_f^-, \ddot{s}_f^+, \lambda_j^1, \lambda_j^2 \geq 0, && \forall i,r,f,j
\end{aligned} \tag{1}$$

Where, L_{ip}^- and L_{rp}^+ are bounded adjusted measures for inputs and outputs, respectively. Also, the H_{fp}^- and H_{fp}^+ are bounded adjusted measures for intermediate products. The bounded adjusted measures are defined as follows:

$$\begin{aligned}
& L_{ip}^- = x_{ip} - min_j\{x_{ij}\}, \quad (i=1,\dots,m) \\
& L_{rp}^+ = max_j\{y_{rj}\} - y_{rp}, \quad (r=1,\dots,s) \\
& H_{fp}^- = z_{fp} - min_j\{z_{fj}\}, \quad (f=1,\dots,F) \\
& H_{fp}^+ = max_j\{z_{fj}\} - z_{fp}, \quad (f=1,\dots,F)
\end{aligned} \tag{2}$$

In the model (1), $s_i^-, s_r^+, \dot{s}_f^-, \ddot{s}_f^+$ indicate the slacks related to the constraints and λ_j^1, λ_j^2 are intensity vectors. The proposed model (1) has some interesting properties as following theorems.

Theorem 1: The model (1) is always feasible.
Proof.
Clearly, $s_i^-, s_r^+, \dot{s}_f^-, \ddot{s}_f^+ = 0\ (\forall i,r,f)$ and $\lambda_p^1 = \lambda_p^2 = 1$; $\lambda_j^1 = \lambda_j^2 = 0, (\forall j, j \neq p)$ is a feasible solution for Model (1), that proves its feasibility. □

The *w₁* and *w₂* are weights reflecting total preference over the two stages. When stages 1 and 2 have the same importance, *w₁* and *w₂* will be equal and they add up to 1, i.e., $w_1 + w_2 = 1$. The overall efficiency and efficiency scores corresponding to stage 1 and stage 2 can be obtained as follows:

$$\Theta_p^{\text{Overall}} = 1 - \left[\mathrm{w}_1 \left\{ \frac{1}{m+F} \left(\sum_{i=1}^{m} \frac{s_i^{-*}}{L_{ip}^-} + \sum_{f=1}^{F} \frac{\ddot{s}_f^{+*}}{H_{fp}^+} \right) \right\} + \mathrm{w}_2 \left\{ \frac{1}{F+s} \left(\sum_{f=1}^{F} \frac{\dot{s}_f^{-*}}{H_{fp}^-} + \sum_{r=1}^{s} \frac{s_r^{+*}}{L_{rp}^+} \right) \right\} \right]$$

According to the optimal solution of the Model (1), the efficiency performance of each stage is defined as follows:

$$\Theta_p^{\text{Stage 1}} = 1 - \left\{ \frac{1}{m+F} \left(\sum_{i=1}^{m} \frac{s_i^{-*}}{L_{ip}^-} + \sum_{f=1}^{F} \frac{\ddot{s}_f^{+*}}{H_{fp}^+} \right) \right\}$$

$$\Theta_p^{\text{Stage 2}} = 1 - \left\{ \frac{1}{F+s} \left(\sum_{f=1}^{F} \frac{\dot{s}_f^{-*}}{H_{fp}^-} + \sum_{r=1}^{s} \frac{s_r^{+*}}{L_{rp}^+} \right) \right\}$$

where (*) represents optimal values in the model (1).

Theorem 2: In the optimal solution of the model (1), we have $0 \le \Theta_p^{\text{Overall}} \le 1$.

Proof.

From the convexity constraint $\sum_{j=1}^{n} \lambda_j^1 = 1$, we have $\min_j\{x_{ij}\} \le \sum_{j=1}^{n} \lambda_j^1 x_{ij} \le \max_j\{x_{ij}\}$. On the other hand, from the first constraint of Model (1), we have

$$s_i^- = x_{ip} - \sum_{j=1}^{n} \lambda_j^1 x_{ij} \le x_{ip} - \min_j\{x_{ij}\} = L_{ip}^-$$

Then, we have, $\frac{s_i^-}{L_{ip}^-} \le 1$. In similar manners, we conclude that all fractions in the objective functions are less than or equal to one. From this issue, we easily realize that $0 \le \Theta_p^{\text{Overall}} \le 1$. □

The values of w_1 and w_2 can be determined subjectively by decision-makers. Despite this issue, several approaches such as point allocation, paired comparisons, trade-off analysis, and regression estimates, can be used to specify the weights ([41, 42]). Alternatively, pairwise comparisons and eigenvalue theory proposed by [43] can be used to determine suitable weights for efficiency scores of the two stages.

3 Evaluating the Active Banks and Financial Institutes in TSE

One of the important activities that plays a vital role in developing countries' economy in the current century is investment. The most important investment way that can lead to the various industries and economic activities, is Stock Exchange Market [44]. A stock exchange is an entity which provides ''trading'' facilities for stock brokers and traders to trade stocks and other securities. How to invest in stock exchange is an important issue in the economy, and one of the ratios that can help investors in the process of investment is the efficiency of the corporation under consideration [45]. The Tehran Stock Exchange (TSE) is Iran's largest stock exchange, which first opened in 1967. As of June 2018, 337 active companies were listed on TSE. Comprehensive release of information creates the confidence for investors and also an environment for fair trade ([45], [46]).

3.1 Variables Definitions

In order to rank the companies listed in Tehran Stock Exchange, their performance should be evaluated comprehensively according to various criteria and indicators. Financial ratios are recognized as effective tools to measure the performance of these companies and compare their efficiencies. Financial ratios are numerical values that are extracted from a company's financial statements in order to obtain meaningful information [48]. One of the most common ways of companies' financial analysis is to calculate and examine financial ratios. These ratios are defined in several groups, and each deals with one aspect of companies' financial condition [50]. The main categories of financial ratios are Liquidity Ratios, Leverage Ratios, Activity Ratios, Profitability Ratios and Valuation Ratios. These categories are divided into two groups, inputs and outputs [52]. Additionally, this study considers some intermediate criteria that make the proposed model a two-stage one.

Input group:

- Leverage ratios measure the amount of resources received from debt. In fact, leverage ratios are used to assess a firm's short- and long-term debt levels. From this group, we consider: Solvency Ratio –I (SRI), Solvency Ratio –II (SRII), Assets to Equity Ratio (AER).
- Activity ratios compare the company's sales volume with investments in various assets and evaluate the effective use of company resources and the efficiency of its operations during the period of operations. For instance, by means of this ratio, we find out when the company returns its sales revenue to the operating cycle. From this group we consider: Asset Turnover (AT), Inventory Turnover (IT), Receivables Turnover (RT).

Intermediate products:

- Deposits ratios (DR) that representing the ratio of short-term and long-term deposits;
- Loans ratios (LR) that standing for the ratio of customer and business loans;
- Services ratios (SR) which represent the ratio of diversity of the bank services.

Output group:

- Liquidity ratios provide information about companies' ability to repay short-term debts or meet their short-term liabilities. The higher these amounts, the higher the company's ability to repay its short-term debts. From this group e consider: Debt to Equity Ratio (DER), Quick Ratio (QR), Current Ratio (CR).
- Profitability ratios measure a firm's ability to generate revenue related to performance and dividends, balance sheet assets, operating expenses and shares. From this group we consider: Return on Assets (ROA), Earnings Per Share (EPS), Net Profit Margin (NPM), Return on Equity (ROE).
- Valuation ratios reflect the attitudes of shareholders and capital market analysts about past performance and forecast future trends. Price to Earnings Ratio (PER), Price to Book Ratio (PBR)

Each BFI consists of two stages: Stage 1 represents the *Operations* while Stage 2 represents *Profitability*. Fig. 2 provides a graphic of the two-stage structure proposed to analyze the BFIs listed in TSE.

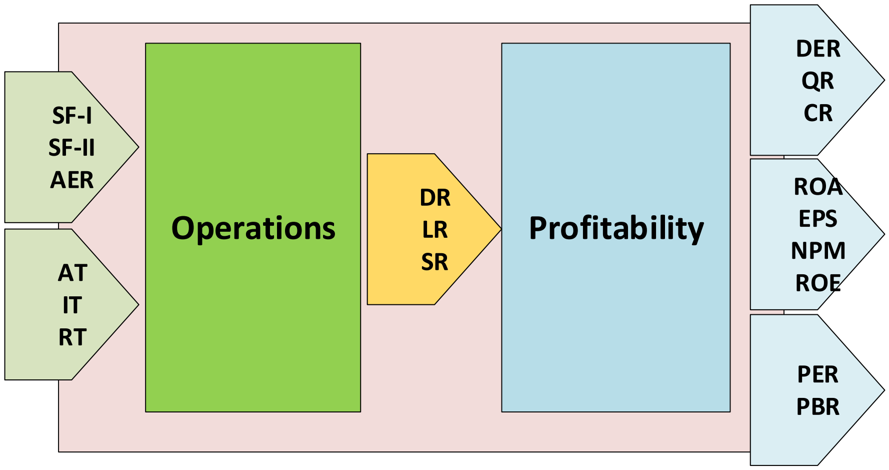

Fig. 2: Proposed two-stage structure of a branch of the PNB system

3.2 Data Set

The current study considers 36 active banks and financial institutes (BFIs) listed in TSE. Their related data[1] according to financial ratios are summarized as inputs, intermediates and outputs data in Tables 1 and 2. It must be noted that we just considered BFIs that their financial statement audit for the year 2018 have been reported[2].

Table 1: Inputs and Intermediates

No.	BFI Name	Inputs						Intermediates		
		Leverage Ratios			Activity Ratios			DR	LR	SR
		SF-I	SF-II	AEF	AT	IT	RT			
BFI01	BMI	0.86572	6.44734	7.44734	0.47402	5.89268	0.71499	0.02746	0.00619	0.01551
BFI02	MSI	0.52878	1.12216	2.12216	1.53393	7.77329	5.92488	0.02484	0.00658	0.02530
BFI03	BTSI	0.57069	1.32931	2.32931	0.80612	5.77346	13.78896	0.01673	0.01676	0.01885
BFI04	BSM	0.95242	20.01932	21.01932	1.17945	9.07975	1.51227	0.04934	0.01467	0.04238
BFI05	AB	0.52090	1.08723	2.08723	0.42130	4.96730	2.83607	0.05468	0.03004	0.04939
BFI06	MB	0.35005	0.53859	1.53859	1.10678	11.32056	2.71454	0.02418	0.01376	0.03341
BFI07	PBI	0.45166	0.82369	1.82369	1.26672	24.61496	4.61429	0.01990	0.01712	0.02477
BFI08	BTT	0.81549	4.41985	5.41985	0.00003	0.00076	0.00068	0.01844	0.01139	0.03071
BFI09	BEN	0.18782	0.23126	1.23126	0.00034	0.00131	0.00008	0.03616	0.08276	0.04457
BFI10	BPR	0.53965	1.17227	2.17227	1.36853	5.41222	6.81961	0.01862	0.01047	0.03091
BFI11	BPD	0.67501	2.07705	3.07705	0.34760	7.75359	2.81115	0.03838	0.02044	0.03125
BFI12	BKA	0.53093	1.13186	2.13186	0.88826	4.55328	8.81038	0.02050	0.01108	0.02491

[1] The name has been changed to protect the anonymity of the company.
[2] Securities and Exchange Organization web site: www.codal.ir

Table 1: Continue

No.	BFI Name	Inputs						Intermediates		
		Leverage Ratios			Activity Ratios			DR	LR	SR
		SF-I	SF-II	AEF	AT	IT	RT			
BFI13	BSA	0.74728	2.95703	3.95703	1.12713	2.61606	5.07935	0.02162	0.02726	0.02462
BFI14	BSI	0.01190	0.01205	1.01205	0.00021	0.00027	0.00022	0.01446	0.01239	0.02216
BFI15	BSR	0.46072	0.85431	1.85431	0.90327	8.18310	2.86579	0.00880	0.01969	0.01257
BFI16	BSH	0.11819	0.13404	1.13404	0.00017	0.00033	0.00024	0.03083	0.04227	0.02401
BFI17	BDI	0.85733	6.00919	7.00919	0.00027	0.00042	0.00053	0.03591	0.02335	0.03097
BFI18	BSA	1.93486	2.06968	0.16968	0.95859	2.84439	134.60067	0.02052	0.04004	0.03728
BFI19	BME	0.38239	0.61914	1.61914	0.99920	2.13210	80.47538	0.03422	0.02310	0.02814
BFI20	BTJ	1.00058	0.00171	0.00171	0.12034	0.69671	0.26769	0.01013	0.05432	0.03150
BFI21	BRF	0.67745	2.10027	3.10027	1.37303	3.81207	5.06589	0.04573	0.01901	0.01371
BFI22	BHI	0.30918	0.44756	1.44756	0.65852	1.95457	7.58777	0.04195	0.02720	0.01520
BFI23	BGS	1.16123	0.20234	0.20234	0.35828	1.53644	3.35812	0.03605	0.03069	0.01352
BFI24	BIZ	0.74209	2.87731	3.87731	2.04550	12.8935	4.80091	0.02337	0.02734	0.01526
BFI25	BGN	0.76735	3.29838	4.29838	1.42195	11.7374	3.76888	0.03380	0.04660	0.02192
BFI26	BAN	0.66365	1.97306	2.97306	1.19343	2.91998	5.14654	0.00985	0.02781	0.03280
BFI27	BKH	0.43389	0.76644	1.76644	0.22083	37.5615	1.00949	0.03259	0.03731	0.02608
BFI28	BMV	0.10066	0.11192	1.11192	0.00041	0.00038	0.00072	0.00947	0.03995	0.01519
BFI29	BAY	0.50696	1.02824	2.02824	0.58832	4.01651	2.77957	0.04862	0.04206	0.03120
BFI30	MIT	0.74241	2.88221	3.88221	0.00039	0.00102	0.00009	0.02436	0.01586	0.03848
BFI31	MIK	0.21673	0.27670	1.27670	0.66814	4.61777	3.71051	0.00804	0.03362	0.02139
BFI32	MIM	0.56889	1.31957	2.31957	0.74263	3.95335	5.80980	0.04736	0.04515	0.01848
BFI33	MIN	0.50203	1.00816	2.00816	1.58387	8.46779	3.33946	0.02234	0.03771	0.04751
BFI34	MIC	0.07797	0.08456	1.08456	0.00029	0.00032	0.00071	0.03464	0.04702	0.03435
BFI35	BGM	0.34317	0.52247	1.52247	0.87264	4.79201	20.64771	0.01674	0.02990	0.03704
BFI36	BGR	0.41579	0.71172	1.71172	0.63844	2.51069	2.66559	0.03938	0.00912	0.03468

Table 2: Outputs data

No.	BFI Name	Liquidity Ratios			Profitability Ratios				Valuation Ratios	
		DEF	QF	CF	ROA	EPS	NPM	ROE	PEF	PBF
BFI01	BMI	0.33126	0.99910	1.09705	0.02762	879.69333	0.05826	0.20566	3.94886	0.81240
BFI02	MSI	0.22190	0.82581	1.29099	0.20199	228.61889	0.13168	0.42866	6.80681	2.91891
BFI03	BTSI	0.09703	0.73289	0.99681	0.13206	492.73750	0.16382	0.30760	19.29750	1.50713
BFI04	BSM	1.60092	0.92839	1.07663	0.02197	1306.9860	0.01863	0.46177	0.00021	0.00009
BFI05	AB	0.07253	0.48467	0.65913	0.24342	72.48067	0.57779	0.50808	9.32224	4.73513
BFI06	MB	0.01679	1.36640	1.65468	0.36484	197.94625	0.32964	0.56134	11.63352	3.26526
BFI07	PBI	0.01127	1.64562	1.76113	0.38319	0.35125	0.30251	0.69882	2.73161	1.90910
BFI08	BTT	0.00443	0.04249	0.04249	0.00277	0.15552	0.00007	0.01500	1.66312	2.56661

Table 2: Continue

No.	BFI Name	Liquidity Ratios			Profitability Ratios				Valuation Ratios	
		DEF	QF	CF	ROA	EPS	NPM	ROE	PEF	PBF
BFI09	BEN	0.00656	2.48165	2.48165	0.18167	978.59320	0.00055	0.22368	12.17301	1.36005
BFI10	BPR	0.10944	0.67958	1.19639	0.21180	384.73500	0.15476	0.46009	12.63564	1.93740
BFI11	BPD	0.81907	0.34196	0.45162	0.11771	0.00410	0.33863	0.36220	9.25538	1.67646
BFI12	BKA	0.12658	0.43832	0.85202	0.03185	2.16923	0.03586	0.06791	0.00033	0.00103
BFI13	BSA	0.24853	0.56140	1.19085	0.05319	0.00324	0.04719	0.21048	0.53062	3.72812
BFI14	BSI	0.00014	65.85458	65.85458	0.03996	99.77321	0.00008	0.04044	52.66914	0.87419
BFI15	BSR	0.01106	1.38935	1.63208	0.37579	159.79895	0.41604	0.69684	3.44700	2.40211
BFI16	BSH	0.00031	2.71664	2.71664	0.00833	8.78788	0.00032	0.00945	#####	1.06169
BFI17	BDI	0.07794	0.00118	0.00118	0.00026	1.73920	0.00046	0.00184	0.06256	1.25984
BFI18	BSA	0.27011	0.22066	0.48407	0.23027	0.00226	0.24022	0.24632	0.14009	0.98762
BFI19	BME	0.08830	0.51546	1.94490	0.14198	318.55714	0.14210	0.22989	10.29154	2.36925
BFI20	BTJ	0.09120	0.82223	1.00457	0.06608	0.00697	0.54912	#####	0.48780	1.68344
BFI21	BRF	0.25717	0.50957	1.11543	0.02277	0.05572	0.01658	0.07058	24.38000	1.71592
BFI22	BHI	0.04762	1.20982	2.42927	0.07124	211.91489	0.10819	0.10313	5.59322	0.57704
BFI23	BGS	0.13495	1.10078	1.80036	0.18747	0.00141	0.52325	1.16276	0.34041	0.72114
BFI24	BIZ	0.18106	0.79034	1.01847	0.03648	0.17582	0.01783	0.14143	74.57959	10.53426
BFI25	BGN	0.95005	0.80864	1.03039	0.05209	354.63750	0.03663	0.22389	51.49919	11.54189
BFI26	BAN	0.03063	0.68789	1.31346	0.01622	24.38000	0.01359	0.04823	0.00081	0.00075
BFI27	BKH	0.00126	1.63874	1.65231	0.24805	400.06573	1.12328	0.43817	7.51214	3.29142
BFI28	BMV	0.00091	0.09526	0.09526	0.01411	14.90553	0.00006	0.01568	#####	1.45730
BFI29	BAY	0.25631	0.71559	1.10046	0.28979	71.83441	0.49258	0.58777	4.78298	2.81160
BFI30	MIT	2.22929	0.06653	0.06867	0.00059	0.20930	0.00039	0.00230	0.04550	0.94712
BFI31	MIK	0.00833	3.03591	3.72424	0.33074	560.98136	0.49501	0.42225	3.46212	1.46190
BFI32	MIM	0.09722	0.77863	1.13509	0.04306	78.60400	0.05798	0.09988	15.36681	1.53748
BFI33	MIN	0.03725	1.28484	1.67171	0.31096	344.66857	0.19633	0.62446	7.39187	4.61673
BFI34	MIC	0.00013	8.16226	8.37280	0.55057	1852.4305	0.00045	0.59712	0.00068	0.00009
BFI35	BGM	0.05961	1.22804	1.82703	0.42682	72.32857	0.48911	0.64982	6.12017	3.97636
BFI36	BGR	0.04422	0.97702	1.62911	0.15212	390.24994	0.23826	0.26038	0.00004	0.00205

3.3 General Financial Analysis

The results of general financial efficiencies are depicted in Table 3. Table 3 also shows the results of overall, stage 1 (operations stage) and stage 2 (profitability stage) financial efficiencies for all BFIs. The current study assumes that the weights of the operations stage and the profitability stage are 0.4 and 0.6, respectively. According to the obtained results, seven BFIs are operated efficiently in overall financial evaluations. The worst performance is recorded by BFI26, i.e., “BAN”, with the overall financial efficiency score of 0.5053.

Table 3: General Financial Efficiencies

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI01	BMI	0.6,547	0.1367	1.0000	BFI19	BME	0.5876	0.3044	0.7763
BFI02	MSI	0.6865	0.2162	1.0000	BFI20	BTJ	1.0000	1.0000	1.0000
BFI03	BTSI	0.6739	0.1847	1.0000	BFI21	BRF	0.7776	0.4441	1.0000
BFI04	BSM	1.0000	1.0000	1.0000	BFI22	BHI	0.8430	1.0000	0.7383
BFI05	AB	0.9073	1.0000	0.8455	BFI23	BGS	1.0000	1.0000	1.0000
BFI06	MB	0.7181	0.2952	1.0000	BFI24	BIZ	0.6609	0.1523	1.0000
BFI07	PBI	0.6926	0.2314	1.0000	BFI25	BGN	0.6734	0.1835	1.0000
BFI08	BTT	1.0000	1.0000	1.0000	BFI26	BAN	0.5053	0.1671	0.7308
BFI09	BEN	0.8527	1.0000	0.7544	BFI27	BKH	0.7094	0.2734	1.0000
BFI10	BPR	0.6831	0.2079	1.0000	BFI28	BMV	0.8689	0.6722	1.0000
BFI11	BPD	0.6467	0.2887	0.8854	BFI29	BAY	0.7772	0.7158	0.8181
BFI12	BKA	0.5564	0.2065	0.7898	BFI30	MIT	1.0000	1.0000	1.0000
BFI13	BSA	0.5285	0.1537	0.7784	BFI31	MIK	0.7408	0.3520	1.0000
BFI14	BSI	1.0000	1.0000	1.0000	BFI32	MIM	0.6652	0.5896	0.7156
BFI15	BSR	0.6827	0.2066	1.0000	BFI33	MIN	0.7532	0.5965	0.8576
BFI16	BSH	0.8821	1.0000	0.8035	BFI34	MIC	1.0000	1.0000	1.0000
BFI17	BDI	0.7882	1.0000	0.6470	BFI35	BGM	0.7182	0.2955	1.0000
BFI18	BSA	0.8494	1.0000	0.7489	BFI36	BGR	0.7759	0.4397	1.0000

The summarized information of the results is given in Table 4. According to these results, we can see the average of all obtained financial efficiencies and the number of efficient BFIs in stage 2 are better than the average of overall and stage 1 financial efficiencies. This issue proves that the BFIs in stage 2 are performed better than in stage 1 and the overall. Although, in stage 1 more BFIs than in overall performance are recognized as efficient ones, the average of overall financial efficiency is bigger than the stage 1 efficiency.

Table 4: Summarized information

	Overall	Stage 1	Stage 2
Average	0.7739	0.5643	0.9136
Min	0.5053	0.1367	0.6470
Max	1.0000	1.0000	1.0000
Efficient	7	13	22

This issue can be seen from Fig. 3, too. One reason is related to the ranges of efficiency scores that are [0.5053, 1] and [0.1367, 1] for the overall and stage 1 efficiency scores.

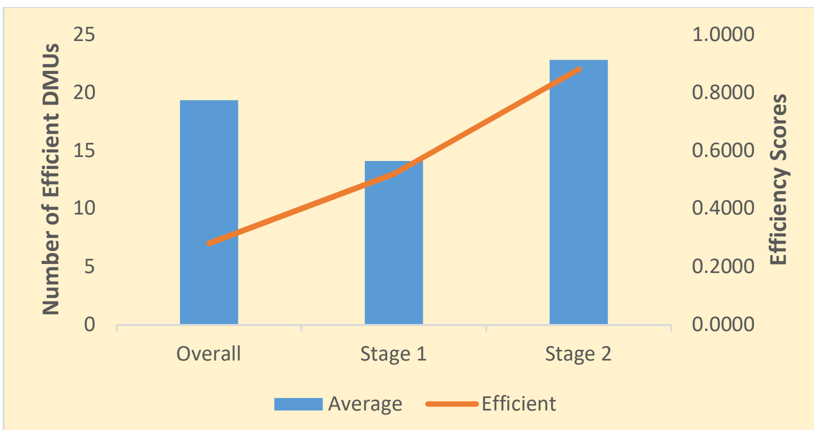

Fig. 3: Comparison between Efficiency Scores and Number of Efficient BFIs

3.4 Categories Analysis

For the purpose of category analysis, we first compared the BFIs of each category with each other. Table 5, depicted the obtained efficiency results of BFIs on the category 1. Eight BFIs are in category 1. Results indicate that four out of eight BFIs are operated efficiently in the overall financial aspect. According to the results, four BFIs are operated efficiently in all overall, stage 1 and stage 2 aspects, respectively. Out of these four BFIs, BFI04 and BFI08 were operated efficiently in general overall financial aspect, too.

Table 5: Category 1 Evaluation

No.	BFI Name	Overall	Stage 1	Stage 2
BFI01	BMI	0.8317	0.5793	1.0000
BFI02	MSI	0.7879	0.4698	1.0000
BFI03	BTSI	0.7667	0.4167	1.0000
BFI04	BSM	1.0000	1.0000	1.0000
BFI05	AB	1.0000	1.0000	1.0000
BFI06	MB	1.0000	1.0000	1.0000
BFI07	PBI	0.8273	0.5683	1.0000
BFI08	BTT	1.0000	1.0000	1.0000
Average		0.9017	0.7543	1.0000
Min		0.7667	0.4167	1.0000
Max		1.0000	1.0000	1.0000
Efficient		4	4	8

Table 6, depicted the obtained efficiency results of BFIs on the category 2. 21 BFIs are considered in category 2. Results indicate that six out of 21 BFIs are operated efficiently in the overall financial aspect. According to the results, six BFIs are operated efficiently in all overall, stage 1 and stage 2 aspects, respectively. Out of these six BFIs, BFI14, BFI20 and BFI23 were operated efficiently in general overall financial aspect, too.

Table 6: Category 2 Evaluation

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI09	BEN	1.0000	1.0000	1.0000	BFI20	BTJ	1.0000	1.0000	1.0000
BFI10	BPR	0.6672	0.1680	1.0000	BFI21	BRF	0.8220	0.5549	1.0000
BFI11	BPD	0.7263	0.3158	1.0000	BFI22	BHI	0.8679	1.0000	0.7798
BFI12	BKA	0.6694	0.1736	1.0000	BFI23	BGS	1.0000	1.0000	1.0000
BFI13	BSA	0.5062	0.1211	0.7629	BFI24	BIZ	0.6503	0.1257	1.0000
BFI14	BSI	1.0000	1.0000	1.0000	BFI25	BGN	0.6635	0.1588	1.0000
BFI15	BSR	0.6728	0.1820	1.0000	BFI26	BAN	0.4647	0.1247	0.6915
BFI16	BSH	0.8793	1.0000	0.7989	BFI27	BKH	0.6974	0.2435	1.0000

Table 6: Continue

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI17	BDI	0.7790	1.0000	0.6316	BFI28	BMV	1.0000	1.0000	1.0000
BFI18	BSA	0.8510	1.0000	0.7517	BFI29	BAY	1.0000	1.0000	1.0000
BFI19	BME	0.6009	0.2747	0.8184					

	Overall	Stage 1	Stage 2
Average	0.7866	0.5925	0.9159
Min	0.4647	0.1211	0.6316
Max	1.0000	1.0000	1.0000
Efficient	6	10	14

Table 7, depicted the obtained efficiency results of BFIs on the category 3. Five BFIs belong to category 3. Results indicate that four out of five BFIs are operated efficiently in the overall financial aspect. According to the results, four BFIs are operated efficiently in all overall, stage 1 and stage 2 aspects, respectively. Out of these four BFIs, BFI30 and BFI34 were operated efficiently in general overall financial aspect, too.

Table 7: Category 3 Evaluation

No.	BFI Name	Overall	Stage 1	Stage 2
BFI30	MIT	1.0000	1.0000	1.0000
BFI31	MIK	0.6368	0.0919	1.0000
BFI32	MIM	1.0000	1.0000	1.0000
BFI33	MIN	1.0000	1.0000	1.0000
BFI34	MIC	1.0000	1.0000	1.0000
Average		0.9274	0.8184	1.0000
Min		0.6368	0.0919	1.0000
Max		1.0000	1.0000	1.0000
Efficient		4	4	5

Table 8, depicted the obtained efficiency results of BFIs on the category 4. Two BFIs are in the category 4. Results indicate that all of these BFIs are operated efficiently in the overall financial aspect and also, they are operated efficiently in all overall, stage 1 and stage 2 aspects, respectively. However, none of them were operated efficiently in the general overall financial aspect.

Table 8: Category 4 Evaluation

No.	BFI Name	Overall	Stage 1	Stage 2
BFI35	BGM	1.0000	1.0000	1.0000
BFI36	BGR	1.0000	1.0000	1.0000
Average		1.0000	1.0000	1.0000
Min		1.0000	1.0000	1.0000
Max		1.0000	1.0000	1.0000
Efficient		2	2	2

In order to provide an integrated efficiency analysis, we calculated the average of data in each category. Hence, four new BFIs are obtained in which each of them is regarded as representative of each category. The results of this analysis are depicted in Table 9.

Table 9: Analysis of the average of each category

	Overall	Stage 1	Stage 2
Category 1	1.0000	1.0000	1.0000
Category 2	0.7309	0.3271	1.0000
Category 3	1.0000	1.0000	1.0000
Category 4	1.0000	1.0000	1.0000
Average	0.9327	0.8318	1.0000
Min	0.7309	0.3271	1.0000
Max	1.0000	1.0000	1.0000
Efficient	3	3	4

According to the obtained results, except category 2, all other categories performed efficiently in all cases. Fig. 4 illustrated the overall efficiency of each category. However, category 2 was performed efficiently in stage 2. This issue is meaningful due to its low amount of efficiency in stage 1.

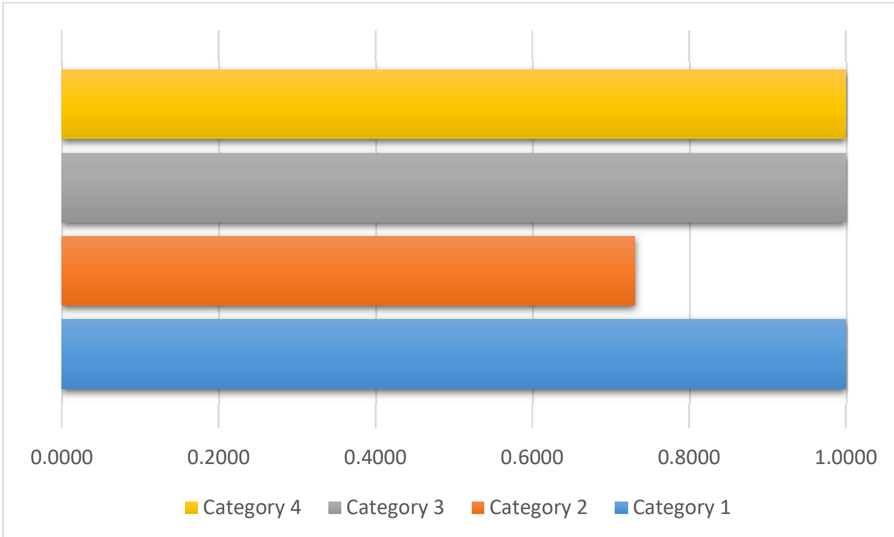

Fig. 4: Overall Financial Efficiency of each Category

3.5 Variables Efficiencies

The current study contains two groups of inputs, i.e., Leverage ratios and Activity ratios. On the other side, it has three groups of outputs, i.e., Liquidity ratios, Profitability ratios and Valuation ratios. To measure the influence of each group (inputs or outputs) on financial efficiency, we have designed more analysis based on considering each group, individually. Hence, we provide five new efficiency analysis. We start with the Leverage efficiency. In this case, we consider the Leverage group as the only inputs data and the intermediate and outputs are the same as the general evaluation. Table 10 shows the results. Results indicate that the average and the number of efficient BFIs in the overall efficiency become worse than the general case. According to the results, four BFIs are recognized as efficient in the overall aspect. These four BFIs, i.e., BFI14, BFI20, BFI23 and BFI34 were efficient in the general overall financial efficiency aspect.

Table 10: Leverage Efficiency

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI01	BMI	0.6820	0.2049	1.0000	BFI19	BME	0.6484	0.4565	0.7763
BFI02	MSI	0.7297	0.3243	1.0000	BFI20	BTJ	1.0000	1.0000	1.0000
BFI03	BTSI	0.7108	0.2769	1.0000	BFI21	BRF	0.7855	0.4637	1.0000
BFI04	BSM	0.6979	0.2448	1.0000	BFI22	BHI	0.8430	1.0000	0.7383
BFI05	AB	0.9073	1.0000	0.8455	BFI23	BGS	1.0000	1.0000	1.0000

Table 10: Continue

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI06	MB	0.7771	0.4428	1.0000	BFI24	BIZ	0.6914	0.2285	1.0000
BFI07	PBI	0.7388	0.3471	1.0000	BFI25	BGN	0.7101	0.2751	1.0000
BFI08	BTT	0.6845	0.2111	1.0000	BFI26	BAN	0.5387	0.2506	0.7308
BFI09	BEN	0.8527	1.0000	0.7544	BFI27	BKH	0.7639	0.4098	1.0000
BFI10	BPR	0.7247	0.3117	1.0000	BFI28	BMV	0.8793	0.6982	1.0000
BFI11	BPD	0.6815	0.3757	0.8854	BFI29	BAY	0.7863	0.7387	0.8181
BFI12	BKA	0.5977	0.3096	0.7898	BFI30	MIT	0.7127	0.2817	1.0000
BFI13	BSA	0.5592	0.2304	0.7784	BFI31	MIK	0.8111	0.5279	1.0000
BFI14	BSI	1.0000	1.0000	1.0000	BFI32	MIM	0.6899	0.6513	0.7156
BFI15	BSR	0.7239	0.3099	1.0000	BFI33	MIN	0.8031	0.7214	0.8576
BFI16	BSH	0.7834	0.7533	0.8035	BFI34	MIC	1.0000	1.0000	1.0000
BFI17	BDI	0.4995	0.2784	0.6470	BFI35	BGM	0.7772	0.4431	1.0000
BFI18	BSA	0.8494	1.0000	0.7489	BFI36	BGR	0.8209	0.5522	1.0000

	Overall	Stage 1	Stage 2
Average	0.7628	0.5366	0.9136
Min	0.4995	0.2049	0.6470
Max	1.0000	1.0000	1.0000
Efficient	4	8	22

The three other general overall efficient BFIs, i.e., BFI04, BFI08 and BFI30 are operated inefficiently in the Leverage efficiency case. This issue indicates that these BFIs couldn't apply efficiently their leverage levels. At the next stage, we calculate the Activity efficiency. In this case, we consider the Activity group as the only inputs data and the intermediate and outputs are the same as the general evaluation. Table 11 shows the results. Results indicate that the average and the number of efficient BFIs in the overall efficiency become worse than the general case. According to the results, five BFIs are recognized as efficient in the overall aspect. These five BFIs, i.e., BFI04, BFI08, BFI14, BFI30 and BFI34 were efficient in the general overall financial efficiency aspect.

Table 11: Activity Efficiency

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI01	BMI	0.6549	0.1372	1.0000	BFI19	BME	0.5413	0.1888	0.7763
BFI02	MSI	0.6547	0.1368	1.0000	BFI20	BTJ	0.6459	0.1148	1.0000
BFI03	BTSI	0.6431	0.1077	1.0000	BFI21	BRF	0.7743	0.4357	1.0000
BFI04	BSM	1.0000	1.0000	1.0000	BFI22	BHI	0.6100	0.4176	0.7383
BFI05	AB	0.9073	1.0000	0.8455	BFI23	BGS	0.6753	0.1883	1.0000
BFI06	MB	0.6606	0.1515	1.0000	BFI24	BIZ	0.6489	0.1222	1.0000
BFI07	PBI	0.6486	0.1214	1.0000	BFI25	BGN	0.6708	0.1771	1.0000
BFI08	BTT	1.0000	1.0000	1.0000	BFI26	BAN	0.4854	0.1173	0.7308
BFI09	BEN	0.8527	1.0000	0.7544	BFI27	BKH	0.6698	0.1744	1.0000
BFI10	BPR	0.6517	0.1291	1.0000	BFI28	BMV	0.8253	0.5632	1.0000
BFI11	BPD	0.6432	0.2799	0.8854	BFI29	BAY	0.7548	0.6598	0.8181
BFI12	BKA	0.5231	0.1232	0.7898	BFI30	MIT	1.0000	1.0000	1.0000
BFI13	BSA	0.5174	0.1259	0.7784	BFI31	MIK	0.6380	0.0949	1.0000
BFI14	BSI	1.0000	1.0000	1.0000	BFI32	MIM	0.6499	0.5513	0.7156
BFI15	BSR	0.6357	0.0891	1.0000	BFI33	MIN	0.7086	0.4851	0.8576
BFI16	BSH	0.8821	1.0000	0.8035	BFI34	MIC	1.0000	1.0000	1.0000
BFI17	BDI	0.7882	1.0000	0.6470	BFI35	BGM	0.6586	0.1465	1.0000
BFI18	BSA	0.5121	0.1568	0.7489	BFI36	BGR	0.7360	0.3399	1.0000

	Overall	Stage 1	Stage 2
Average	0.7186	0.4260	0.9136
Min	0.4854	0.0891	0.6470
Max	1.0000	1.0000	1.0000
Efficient	5	9	22

The two other general overall efficient BFIs, i.e., BFI20 and BFI23 are operated inefficiently in the Activity efficiency case. This issue indicates that these BFIs couldn't apply their activity levels efficiently. On the other side, two BFIs, i.e., BFI14 and BFI34, are performed efficiently in their overall aspect in all general, leverage and activity financial efficiency cases. The above two cases measured the impact of two groups of inputs. In all of two cases, like the general case, in stage 2 all the BFIs were performed better than stage 1. In order to measure the outputs impact, we start with the Liquidity efficiency. In this case, we consider the Liquidity group as the only outputs data and the inputs and intermediates are the same as the general evaluation. Table 12 shows the results. Results indicate that the average and the number of efficient BFIs in the overall efficiency become worse than the general case. According to the results, two BFIs are recognized as efficient in the overall aspect. These two BFIs, i.e., BFI14 and BFI30 were efficient in the general overall financial efficiency aspect. Another notable issue is the number of efficient BFIs in stage 1 and stage 2. In this case, the number of efficient BFIs in the stage 1 is more than in the stage 2.

Table 12: Liquidity Efficiency

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI01	BMI	0.6547	0.1367	1.0000	BFI19	BME	0.3590	0.3044	0.3954
BFI02	MSI	0.6865	0.2162	1.0000	BFI20	BTJ	0.7943	1.0000	0.6571
BFI03	BTSI	0.5048	0.1847	0.7182	BFI21	BRF	0.7776	0.4441	1.0000
BFI04	BSM	0.8552	1.0000	0.7586	BFI22	BHI	0.7810	1.0000	0.6351
BFI05	AB	0.5749	1.0000	0.2916	BFI23	BGS	0.8882	1.0000	0.8136
BFI06	MB	0.3887	0.2952	0.4510	BFI24	BIZ	0.5084	0.1523	0.7458
BFI07	PBI	0.3843	0.2314	0.4862	BFI25	BGN	0.6734	0.1835	1.0000
BFI08	BTT	0.7584	1.0000	0.5973	BFI26	BAN	0.4780	0.1671	0.6852
BFI09	BEN	0.5617	1.0000	0.2695	BFI27	BKH	0.3266	0.2734	0.3620
BFI10	BPR	0.4863	0.2079	0.6719	BFI28	BMV	0.6569	0.6722	0.6467
BFI11	BPD	0.4583	0.2887	0.5714	BFI29	BAY	0.5082	0.7158	0.3697
BFI12	BKA	0.4774	0.2065	0.6580	BFI30	MIT	1.0000	1.0000	1.0000
BFI13	BSA	0.3653	0.1537	0.5064	BFI31	MIK	0.7408	0.3520	1.0000
BFI14	BSI	1.0000	1.0000	1.0000	BFI32	MIM	0.5678	0.5896	0.5532
BFI15	BSR	0.6827	0.2066	1.0000	BFI33	MIN	0.4361	0.5965	0.3292
BFI16	BSH	0.6292	1.0000	0.3820	BFI34	MIC	0.5834	1.0000	0.3056
BFI17	BDI	0.6233	1.0000	0.3721	BFI35	BGM	0.3680	0.2955	0.4163
BFI18	BSA	0.6517	1.0000	0.4196	BFI36	BGR	0.5389	0.4397	0.6051

	Overall	Stage 1	Stage 2
Average	0.6036	0.5643	0.6298
Min	0.3266	0.1367	0.2695
Max	1.0000	1.0000	1.0000
Efficient	2	13	8

The five other general overall efficient BFIs, i.e. BFI04, BFI08, BFI20, BFI23 and BFI34 are operated inefficiently in the Liquidity efficiency case. This issue indicates that these BFIs couldn't reach efficiently to their Liquidity levels. On the other side, the BFI14 is performed efficiently in their overall aspect in all general, leverage, activity and Liquidity financial efficiency cases. At the next stage, we calculate the Profitability efficiency. In this case, we consider the Profitability group as the only outputs data and the inputs and intermediates are same as the general evaluation. Table 13 shows the results. Results indicate that the average and the number of efficient BFIs in the overall efficiency become worse than the general case. According to the results, five BFIs are recognized as efficient in the overall aspect. These five BFIs, i.e., BFI04, BFI14, BFI20, BFI23 and BFI34 were efficient in the general overall financial efficiency aspect, too.

Table 13: Profitability Efficiency

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI01	BMI	0.6547	0.1367	1.0000	BFI19	BME	0.4872	0.3044	0.6091
BFI02	MSI	0.6865	0.2162	1.0000	BFI20	BTJ	1.0000	1.0000	1.0000
BFI03	BTSI	0.5686	0.1847	0.8246	BFI21	BRF	0.5276	0.4441	0.5833
BFI04	BSM	1.0000	1.0000	1.0000	BFI22	BHI	0.7317	1.0000	0.5529
BFI05	AB	0.7887	1.0000	0.6478	BFI23	BGS	1.0000	1.0000	1.0000
BFI06	MB	0.7181	0.2952	1.0000	BFI24	BIZ	0.3675	0.1523	0.5109
BFI07	PBI	0.6926	0.2314	1.0000	BFI25	BGN	0.4013	0.1835	0.5466
BFI08	BTT	0.8950	1.0000	0.8251	BFI26	BAN	0.4033	0.1671	0.5608
BFI09	BEN	0.7563	1.0000	0.5938	BFI27	BKH	0.7094	0.2734	1.0000
BFI10	BPR	0.6831	0.2079	1.0000	BFI28	BMV	0.5944	0.6722	0.5426
BFI11	BPD	0.4744	0.2887	0.5983	BFI29	BAY	0.6505	0.7158	0.6069
BFI12	BKA	0.5543	0.2065	0.7863	BFI30	MIT	0.7787	1.0000	0.6312
BFI13	BSA	0.3713	0.1537	0.5163	BFI31	MIK	0.7408	0.3520	1.0000
BFI14	BSI	1.0000	1.0000	1.0000	BFI32	MIM	0.5207	0.5896	0.4747
BFI15	BSR	0.6827	0.2066	1.0000	BFI33	MIN	0.6074	0.5965	0.6147
BFI16	BSH	0.6803	1.0000	0.4672	BFI34	MIC	1.0000	1.0000	1.0000
BFI17	BDI	0.7145	1.0000	0.5242	BFI35	BGM	0.7182	0.2955	1.0000
BFI18	BSA	0.7185	1.0000	0.5309	BFI36	BGR	0.7759	0.4397	1.0000

	Overall	Stage 1	Stage 2
Average	0.6848	0.5643	0.7652
Min	0.3675	0.1367	0.4672
Max	1.0000	1.0000	1.0000
Efficient	5	13	15

The other two general overall efficient BFIs, i.e., BFI08 and BFI30 are operated inefficiently in the Profitability efficiency case. This issue indicates that these BFIs couldn't reach efficiently to their Profitability levels. On the other side, the BFI14 is performed efficiently in their overall aspect in all general, leverage, activity, Liquidity and Profitability financial efficiency cases. At the final stage, we measure the Valuation efficiency. In this case, we consider the Valuation group as the only outputs data and the inputs and intermediates are the same as the general evaluation. Table 14 shows the results. Results indicate that the average and the number of efficient BFIs in the overall efficiency become worse than the general case. According to the results, two BFIs are recognized as efficient in the overall aspect. These to BFIs, i.e., BFI08 and BFI14 were efficient in the general overall financial efficiency aspect, too. Another notable issue is the number of efficient BFIs in stage 1 and stage 2. In this case, the number of efficient BFIs in the stage 1 is more than in the stage 2.

Table 14: Valuation Efficiency

No.	BFI Name	Overall	Stage 1	Stage 2	No.	BFI Name	Overall	Stage 1	Stage 2
BFI01	BMI	0.6547	0.1367	1.0000	BFI19	BME	0.4383	0.3044	0.5276
BFI02	MSI	0.6865	0.2162	1.0000	BFI20	BTJ	0.7055	1.0000	0.5091
BFI03	BTSI	0.5379	0.1847	0.7733	BFI21	BRF	0.7776	0.4441	1.0000
BFI04	BSM	0.6958	1.0000	0.4930	BFI22	BHI	0.7033	1.0000	0.5055
BFI05	AB	0.6185	1.0000	0.3642	BFI23	BGS	0.6875	1.0000	0.4792
BFI06	MB	0.5723	0.2952	0.7570	BFI24	BIZ	0.6609	0.1523	1.0000
BFI07	PBI	0.4956	0.2314	0.6717	BFI25	BGN	0.6734	0.1835	1.0000
BFI08	BTT	1.0000	1.0000	1.0000	BFI26	BAN	0.4032	0.1671	0.5606
BFI09	BEN	0.5679	1.0000	0.2799	BFI27	BKH	0.3497	0.2734	0.4006
BFI10	BPR	0.6112	0.2079	0.8801	BFI28	BMV	0.8689	0.6722	1.0000
BFI11	BPD	0.4416	0.2887	0.5436	BFI29	BAY	0.4779	0.7158	0.3193
BFI12	BKA	0.5473	0.2065	0.7744	BFI30	MIT	0.7552	1.0000	0.5921
BFI13	BSA	0.4023	0.1537	0.5681	BFI31	MIK	0.7408	0.3520	1.0000
BFI14	BSI	1.0000	1.0000	1.0000	BFI32	MIM	0.4634	0.5896	0.3794
BFI15	BSR	0.6827	0.2066	1.0000	BFI33	MIN	0.5230	0.5965	0.4740
BFI16	BSH	0.6626	1.0000	0.4377	BFI34	MIC	0.5991	1.0000	0.3318
BFI17	BDI	0.6957	1.0000	0.4928	BFI35	BGM	0.4737	0.2955	0.5926
BFI18	BSA	0.6608	1.0000	0.4347	BFI36	BGR	0.4937	0.4397	0.5296

	Overall	Stage 1	Stage 2
Average	0.6202	0.5643	0.6575
Min	0.3497	0.1367	0.2799
Max	1.0000	1.0000	1.0000
Efficient	2	13	10

The other five general overall efficient BFIs, i.e., BFI04, BFI20, BFI23, BFI30 and BFI34 are operated inefficiently in the Valuation efficiency case. This issue indicates that these BFIs couldn't reach efficiently to their Valuation levels. On the other side, the BFI14 is performed efficiently in their overall aspect in all general, leverage, activity, Liquidity, Profitability and Valuation financial efficiency cases.

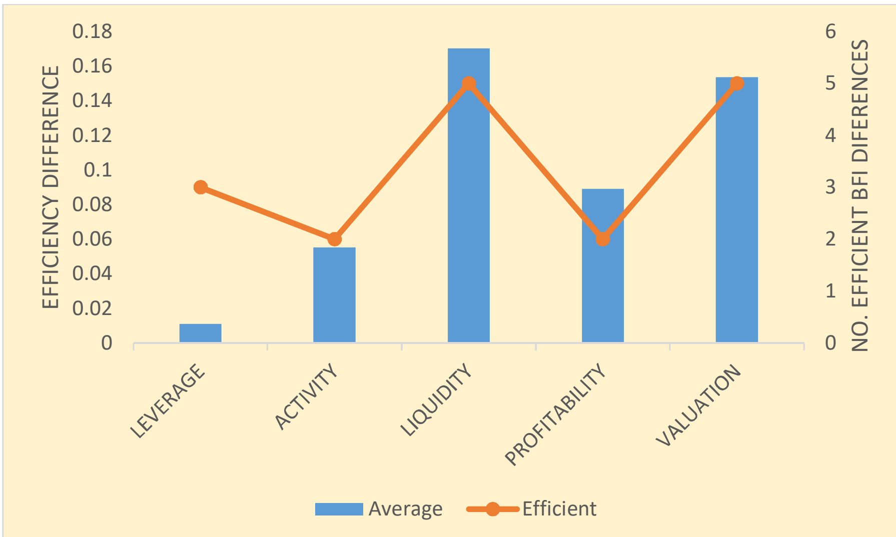

Fig. 5: The Differences

Fig. 5 compares the differences of overall efficiency scores and the number of efficient BFIs between the five above mentioned cases with the general case. This figure compares the impacts of each groups of inputs and outputs on the overall financial efficiency score. According to the results, the Liquidity ratios has the highest impact on the overall efficiency. because this group of variables make the most changes on the overall efficiency score and the number of efficient BFIs.

4 Conclusion

A stock exchange, securities exchange, or bourse is a facility where stockbrokers and traders can buy and sell securities, such as shares of stock, bonds, and other financial instruments. There are a huge amount of data and information in the stock market that because investors may not make the right decision. Therefore, there is a strong need for patterns that combine and use these data and transform them into valuable information to be used for investment decisions. Data envelopment analysis can be regarded as a suitable tool in financial efficiency which includes multiple inputs and outputs and can be very useful for managers engaged in the industry of financial services and investors active in stock exchanges. The conventional DEA models interpret DMUs as black-boxes that consume a set of inputs to produce a set of outputs without taking into consideration the intermediate performance measures that characterize a DMU. That is, traditional studies in DEA view a system as a sole block and ignore the performance of the internal processes in calculating the relative efficiency of a set of production systems. As a result, intermediate measures are lost in the process of changing the inputs to outputs and it becomes difficult, if not impossible, to provide individual DMU managers with specific information on what part(s) of a DMU is responsible for the overall inefficiency.

To answer these kinds of questions, it is necessary to break down the overall efficiency into components so that the sources of inefficiency can be identified. One way to proceed with such a decomposition is focusing on the internal structure of DMUs through DEA models. In this paper, we considered a novel two-stage BAM model, where each DMU is composed of two stages in series. The proposed two-stage BAM model allows for important applications to several management areas. We have considered an application for evaluating the active banks and financial institutes in Tehran Stock Exchange (TSE). In the case study section, the proposed model has been applied to evaluate the efficiency of 36 active banks and financial institutes in TSE. The analysis used three groups of data, inputs, intermediates and outputs. The inputs data are consisted of two categories: i) Leverage ratios that included three variables, Solvency Ratio–I (SRI), Solvency Ratio–II (SRII) and Assets to Equity Ratio (AER); ii) Activity ratios that included three variables, Asset Turnover (AT), Inventory Turnover (IT) and Receivables Turnover (RT). The intermediate group consisted of three variables: Deposits ratios (DR), Loans ratios (LR), Services ratios (SR). The outputs group consisted of three categories: i) Liquidity ratios that included three variables, Debt to Equity Ratio (DER), Quick Ratio (QR), Current Ratio (CR), ii) Profitability ratios that included four variables, return on Assets (ROA), Earnings Per Share (EPS), Net Profit Margin (NPM), Return on Equity (ROE), iii) Valuation ratios that included two variables, Price to Earnings Ratio (PER), Price to Book Ratio (PBR). Based on the proposed to-stage BAM model, the general financial analysis, categories analysis and variables efficiencies were performed. According to results general financial analysis, the average of all obtained financial efficiencies and the number of efficient BFIs in profitability stage were better than the average of overall and operations stage financial efficiencies. The results of categories analysis showed that the BFIs in category 2 were performed less efficient than other categories. According to the results of variables efficiencies, we concluded that the Liquidity ratios had the most impact on the overall efficiency because this group of the variables made the most alteration on the overall efficiency score and the number of efficient BFIs. Among all DMUs, the BFI14 was performed efficiently in their overall aspect of variables efficiencies.

We conclude with a few possible research directions towards which to extend the results of this study. The proposed analyses were only based on the proposed two-stage BAM model. It would be interesting to integrate the statistical methods with the proposed model to reach more financial insights. We also suggest applying the developed model in this research in measuring the efficiencies in other fields such as regional R&D processing, evaluating non-life insurance companies, and so on. Besides, our approach could be extended to model general series systems with multi-stage DMUs and dynamic setting.

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