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CASE STUDY RESEARCH PAPER

Functional evaluation of organizations with the approach of data management unit analysis via Shiplely value (Case Study: branches of Yazd city national bank)

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ABSTRACT

Performance evaluation has become one of the basic concerns of managers of organizations in today's competitive conditions. The window analysis method, by enabling the combination of observations in time and cross-sectional series, to some extent solves the problem of insufficient observations. Therefore, firstly, by using interviews with experts and reading the library and reviewing the subject literature, in order to evaluate the efficiency of bank branches, four input indicators. Up to the identified branches of Yazd city national bank, 40 bank branches were evaluated and analyzed. In the evaluation, the efficiency of 40 branches was evaluated using the cross-sectional window data overlay analysis method, of which five branches were efficient, and in order to confirm the presented model, the efficiency of the branches was evaluated first with the window CCR model and then via Shiplely value. The comparative results of the cross efficiency method and the integration algorithm were shown to be the same. Considering the efficiency of five bank branches, the cooperative game theory between efficient branches was established. Each efficient unit or branch was defined as a player and the set of efficient branches was defined as a coalition. Then, different coalitions were formed for each efficient DMU, and the income from the alliances was Each DMU was calculated and using the concept of Shiplely value, the cooperative game value was obtained between efficient branches. At the result, 17 branches were introduced as the most efficient unit in the evaluation of hyper-efficiency.

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INTRODUCTION

Efficiency and productivity are concepts that determine the input and output ratios of an economic system. Increasing efficiency in a company is a sure way to increase competitiveness and profitability. DEA data coverage analysis approach is one of the useful tools in measuring the efficiency of several companies with similar structure. Among its problems, it can be mentioned that the time factor is not involved in the obtained results, and also, when the number of decision-making units of DMUs is small, it is not able to measure the efficiency well. Therefore, by using windowed DEA, the number of decision-making unit increases and the efficiency of organizations can be measured well (Amani, 2014). Considering the competitiveness of today's world, banks are also included in this category, and considering this issue, the topic of efficiency and as a result measuring efficiency is inevitable (Shafiei, 2016). Evaluating the efficiency of organizations, especially banks, is one of the most important issues in the field of management. The data coverage analysis technique is a very powerful tool for evaluating organizations, taking into account multiple input and output indicators. Traditional models of data coverage analysis only evaluate the efficiency during a period of time and ignore the time factor as one of the most important factors affecting efficiency (Shafiei, 2018). Data coverage analysis is one of the fastest growing branches of management science and operations research, and it is used to evaluate the efficiency of private and public sector organizations (Bal et al, 2010). Data envelopment analysis creates many opportunities for collaboration between the analyst and the decision maker. Sometimes it happens that all the decision-making units are under the supervision and supervision of a central decision-maker. Many organizations such as bank branches can act in this way. This central decision-making unit expects that resource allocation and performance evaluation will be done in such a way that the decision-making units are not used separately, but as a group

and at the same time, so based on the common data coverage analysis models, it is possible It is not acceptable (Bakhtiari et al, 2016). One of the common methods of measuring the efficiency of similar units is the method of data envelopment analysis. Despite its advantages, this method is not able to measure efficiency well when the number of decision making units is small. Therefore, by using the window coverage analysis approach, the number of decision-making unit increases and the efficiency of organizations can be measured well (Borji and Nazari, 2017). The window analysis method, by enabling the combination of observations in time and cross-sectional series, to some extent solves the problem of insufficient observations in time evaluations. This technique is based on moving average and is useful for finding performance trends of a unit over time. Each unit in a different period is treated as an independent unit. In this case, the performance of a unit during a specific period is evaluated against the performance of that unit in other periods, in addition to the performance of other units. This situation increases the number of periods examined in the analysis, which is useful when studying small sample sizes. Changing the width of the window, i.e. The number of time periods, indicates the provision of a range of simultaneous analyses, which only include observations of one time period to cross-sectional analyzes that include observations from all studied periods.

A "true" window analysis with a window width somewhere between one and all of the horizontal study periods (evaluation of a single unit over time), can be viewed as a special case of a sequential analysis. However, sequential analysis assumes that what was practiced in the past will remain practical and therefore includes all previous observations. However, the above problem is not true for window analysis, which only considers observations that are within a certain number of time periods (that is, a window) and due to which the number of observations remains constant in each analysis. With a defined window, the observations in that

window are assumed to be in an intertemporal behavior and thus analyzed as a cross-sectional intertemporal analysis. It is worth noting that since all units are measured relative to each other in a window, this method implicitly assumes that there is no technical change in any of the windows. The world is undergoing constant transformation, and along with it, changes in the environment of organizations are also accelerating. The resulting changes in the environment follow an aimless evolution, and in the meantime, organizations have two ways ahead: firstly, to be aimless like the environment and accept the disappearance in these changes, secondly, to survive by continuing the two principles of learning and adaptation. Continue purposefully. In the case of financial issues that need to be decided, ideals can be used, ideals are goals that, although they are not achievable, but moving towards them is possible and can be approached as much as possible with ideal planning. The first step that is taken for ideal planning is to identify the existing situation. After that, the most important question is modeling the problem and what method can be used to achieve a model to solve the problem (Shafiei, 2016). Budgeting is a process that includes different goals and in conflicting cases, which makes it impossible to achieve the optimal level of all the goals set in practice (Rajabi, 2009). One of the challenges in the budgeting process is prioritizing different and sometimes conflicting ideals and goals (Rahmani and Arab Manzar, 2015). In fact, at the stage of budgeting and allocating resources to various units, it is always a priority for organizations to check the ideals, but paying attention to the fact that this allocation with the approach of providing maximum efficiency can lead to the growth of the organization, is the main key to optimal resource allocation. .

In this research, with the aim of optimally allocating the construction credits of National Bank of Yazd province to different units (branches), new solutions have been tried by examining the efficiency of each of the units with the method of data overlay analysis in relation to

the allocation of these resources in budgeting and how to allocate them. And the optimal one that has the ability to be implemented should be provided. In this research, various methods have been used, such as the ideal planning method, which guide us to choose the best and lowest input and output parameters. In the current situation, higher productivity and the use of existing facilities have practically gone beyond an optional option and become an absolute necessity for organizations. The current world is full of competition, development of markets, the emergence and spread of superior technology and the expansion of business. The condition of survival and progress in this competitive arena is the efficient use of opportunities, facilities and resources that must be used for limited resources to face the challenges ahead. Profit The pressures caused by the globalization of economic competition and the increasing growth of banks and banking institutions in the past years require banks to constantly monitor and analyze their performance in order to survive and progress, so that they can improve their efficiency by knowing their weaknesses. Increase yourself. Without a comprehensive and complete evaluation of the organization's performance, it is not possible to realize its strengths and weaknesses, and as a result, the organization will decline and perish (Simar and Zelenyuk, 2011). Therefore, the allocation of construction budgets in banks as one of the important stages in the growth of banking units has always been given special attention and for this purpose, a special procedure has been considered based on the items desired by the managers in different periods. Therefore, investigating this issue by using different methods of the effectiveness of this allocation of resources can be of great help to continue this method or modify it. Therefore, it is appropriate to check the efficiency of various units and compare the allocations with the units and their efficiency, and provide a new method of resource allocation based on the ideal planning of efficient and inefficient units, to ensure the wastage of resources and their optimal allocation.

MATERIALS AND METHODS

Efficiency

Efficiency is a concept that evaluates the cost of resources spent in the process of achieving a goal. In this way, the comparison of the obtained outputs with the consumed inputs determines the level of efficiency. In order to measure the efficiency of the cost of providing human resources, the cost of using equipment, maintaining facilities, and the rate of return on investment, etc., are considered. In this interpretation of efficiency, the most efficient supervisor is the one whose unit can work with the lowest cost of materials and daily wages. Efficiency is related to the correct implementation of tasks in the organization; That is, the decisions that are made with the aim of reducing costs, increasing the amount of production and improving the quality of the product (Paradi and Schaffnit, 2004). Usually, the effective factors in productivity also have an effect on efficiency and cause its increase or decrease (Gholami et al, 2018). Effective factors in productivity are divided into two general categories: internal organizational factors (in the organization's possession and power) and external or environmental factors that are out of the organization's control in the short term:

Internal factors include:

- Hardware factors: machinery and equipment and tools, technology, raw materials, financial resources and land;
- Software factors: information, instructions, maps and formulas;
- Man-made or brain-made agents:
- Human resources: ability, expertise, experience, education, motivation, work environment and management attitudes;
- Management: management philosophy and style, access to information technologies and....

External factors are factors that are very effective in producing, but companies are not able to control them; Such as: government policies, national and international laws and regulations, work environment, access to financial resources, electricity, water, transportation, communications and raw materials, etc.

Effectiveness

Effectiveness is the degree and amount of achieving the set goals. In other words, effectiveness shows to what extent the desired results have been achieved. This term is widely used in defining and measuring productivity (Gholami et al, 2018)

Difference between efficiency and effectiveness

Efficiency and effectiveness are common management terms. Although both start with the same sound and letter (Effectiveness & Efficiency), they have different meanings. Efficiency refers to doing things in the right way. Scientifically, it is defined as output relative to input and obtaining maximum output with minimum resources. On the other hand, effectiveness refers to doing the right things. Usually, the actual output is opposite to the desired output (Coelli et al, 2005). Because efficiency is all about focusing on the important process, which means getting things done while reaching the end goal set. Efficiency is concerned with the current situation or status quo. Thinking ahead and adding or removing resources disrupts the efficient flow. Effectiveness, on the other hand, believes that the goal at the end of each session should be considered. And any other variables may change in the future. For this purpose, a lot of order and precision is needed in efficiency. This can cause inflexibility in the system. Effectiveness, on the other hand, keeps the long-term strategy in mind, so it is more in line with changes in the environment (Birafane and Abdi, 2019). Efficiency focuses on the process while effectiveness focuses on the end. Efficiency is limited to the present, while effectiveness involves thinking long term. Organizations must adjust both effectiveness and efficiency to achieve success.

Data envelopment analysis

Evaluation of the performance of organizations plays a fundamental role in guiding their future decisions. In this regard, the level of efficiency and productivity of organizations should be calculated so that the economic growth process can be monitored in future decision-making. In

today's era, achieving economic growth through improving productivity is one of the most important economic goals of countries. Improving productivity is achieved by optimal use of production factors and plays an important role in achieving continuous economic growth and sustainable production (Zhou et al., 2020). Today, competition in the field of production and global trade has found other dimensions due to the fading of economic borders, and efforts to improve product based on economic rationality should always be emphasized and paid attention to. But improving productivity requires operationalizing the potential. Therefore, this movement needs a stimulating tool and the most appropriate stimulus is "competition" in the domestic scene and foreign markets (Zhou et al., 2020). Improving productivity leads to progress and development, and most of the developed and developing countries have made a lot of investments in order to spread the attitude towards the category of productivity and generalize the use of techniques and methods to improve it. Examining the performance of countries that have had significant economic growth in the last few decades indicates that most of these countries have achieved growth through improving productivity. One of the appropriate and efficient tools in this field is data envelopment analysis, which is used as a non-parametric method to calculate the efficiency of decision-making units. Nowadays, the use of data envelopment analysis technique is expanding rapidly and is used in the evaluation of various organizations and industries such as the banking industry, post office, hospitals, educational centers, power plants, refineries, etc. (Chen and Yeh, 2000). There have been many developments in theoretical and practical aspects in data coverage analysis models, which makes it indispensable to know its various aspects for more precise application. The use of data coverage analysis models, in addition to determining the relative efficiency, determines the weak points of the organization in various indicators, and by providing their optimal level,

it determines the organization's policy towards improving efficiency and productivity. Also, the efficient models based on which the evaluation of the inefficient units has been performed are introduced to the inefficient units. Efficient patterns are units that have produced more outputs with the same inputs as the inefficient unit or the same outputs using fewer inputs. It is this wide variation in the results that has caused the use of this technique to expand at an increasing rate. This has caused this technique to grow increasingly from the theoretical aspect and become one of the active branches of the science of operations research (Dar et al, 2021).

The word DEA stands for Data Envelopment Analysis, which means data envelopment analysis, a mathematical programming model to measure and evaluate the efficiency of decision-making units (DMU) that have several inputs and several outputs. Efficiency measurement has always been the focus of researchers due to its importance in evaluating the performance of a company or organization. In 1957, Farrell measured efficiency for a production unit using a method similar to efficiency measurement in engineering topics. Case which Farrell considered to measure efficiency included an input and an output (Zhou et al, 2020).

The theory of overlay analysis of window network data

Game theory is a branch of applied mathematics that has been used in social sciences, especially in economics, biology, engineering, political science, international relations, computer science, and philosophy. Game theory is trying to mathematically obtain behavior in strategic situations or games, in which one's success in choosing depends on the choices of others. (Coelli et al, 2005) A game consists of a set of players, a set of moves or strategies, and a specific outcome for each combination of strategies. Winning in every game is not only a function of luck, but also has its own principles and rules, and every player tries to get closer to winning by applying those principles during the game. The competi-

tion of two countries to obtain nuclear energy, the mechanism governing the relations between two countries in solving an international dispute, the competition of two commercial companies in the stock market are examples of games (Ayres et al, 2002). Game theory tries to model the mathematical behavior governing a strategic situation (conflict of interest). This situation arises when a person's success depends on the choices others make. The ultimate goal of this knowledge is to find the optimal strategy for the players. (Coelli et al, 2005)

Ideal planning structure

Optimistic programming tries to combine the logic of optimization in mathematical programming with the decision maker's desire to satisfy multiple goals. Until the mid-70s, there were relatively few users of ideal planning, but since then, fundamental works have been done in this category. The general model of ideal planning is a linear mathematical model that searches for the optimal achievement of goals in the given decision-making environment. In other words, ideal planning shows the way to move towards several goals at the same time. The basis of the work is that for each of the goals, a certain number is determined as the ideal and the corresponding goal function is formulated, then an answer is sought that is the sum (weight) of the deviation of each goal compared to the ideal that is determined for the same goal. minimize it (Tavana et al, 2018). The ideal planning model consists of four components as follows:

- Decision variables: are the variables that the decision maker tries to determine their value. For example, in a production mix problem, the amount of production of each product is a decision variable.
- System limitations: These limitations are the same as the limitations of the linear programming model, that is, it is not possible to violate such limitations, and the solution to the problem (the value of the decision variables) must apply to it. In problem solving, system constraints should be considered before any kind of ideal constraints.

- Aspirational Limits: These limits represent the desired levels of each objective.

Objective function: The objective function in this model is prepared in such a way as to minimize the weighted sum of undesirable deviations. Therefore, the structure of the objective function depends on the weighting of ideals, for which the following situations can be imagined:

- 1- The problem with an ideal
- 2- Multi-objective problem, combined ranking
- 3- The problem with multiple objectives, using the main scale
- 4- The problem with multiple objectives, using ordinal and original ranking (Tone and Tsutsui, 2014).

METHODOLOGY

The current research is descriptive-mathematical from the point of view of the applied goal and from the point of view of the execution method, and the window data coverage analysis method and the ideal planning method are used to evaluate the financial efficiency of banks in the field of bank construction budgets. The method of carrying out this research can be divided into several basic steps. In the first stage, with the background check and studies related to the research, the financial institutions and institutions that are effective on the evaluation of banks are identified. In the next step, with the help of collective opinions from experts and using decision-making techniques, several criteria are weighted and among them the final entities and variables are selected to enter the data coverage analysis models. After selecting the final inputs and outputs, the required raw data is collected through the existing databases and in the form of the data coverage analysis model, the initial model is developed and it is solved. In solving these problems, various softwares are used according to the case, among which DEA Solver / WINQSB / Lingo and MATLAB softwares can be mentioned.

DISSCUSION AND CONCLUSION

Bank branches is an Iranian banking and financial services company that operates with 1456 branches throughout Iran. In this research, National Bank of Yazd Province has been selected as a case study and currently it is one of the largest banks in the country with a capital of 5,000 billion Tomans. The most important strategies of National Bank are development of information and communication technology, management of customer relations, improvement of service quality, development of human resources and improvement of performance indicators in construction projects. In order to achieve these

strategies, goals such as the growth and productivity of the bank, profitability and providing suitable services to customers, recognizing the needs and categorization of customers and processes related to profit, strategy-oriented trainings, modern banking technology and alignment of individual, departmental and organizational goals have been drawn. National Bank has 1455 branches all over Iran and also has branches in different cities of the world.

Collecting information on the input and output variables affecting the efficiency of National Bank of Yazd city

Table 1: information of input variables

	Annual personnel costs (million riyals)	Administrative expenses (million riyals)	Deposit interest charges (million riyals)	Other overhead costs (million riyals)
DMU1	570	70	3501	96
DMU2	700	95	2403	120
DMU3	850	128	2010	210
DMU4	510	800	1500	1050
DMU5	900	90	1709	120
DMU6	600	97	1200	150
DMU7	1200	3100	1870	4200
DMU8	850	65	3000	95
DMU9	980	110	3500	150
DMU10	780	78	870	110
DMU11	1150	700	4250	1120
DMU12	1000	750	4330	1200
DMU13	600	55	975	85
DMU14	620	78	670	105
DMU15	790	117	3760	220
DMU16	820	120	2760	250
DMU17	510	56	680	78
DMU18	710	95	3540	130
DMU19	830	220	2570	300
DMU20	890	90	3490	140
DMU21	910	180	1680	370
DMU22	654	97	1350	160
DMU23	450	45	755	68
DMU24	1250	150	3980	320

	Annual personnel costs (million riyals)	Administrative expenses (million riyals)	Deposit interest charges (million riyals)	Other overhead costs (million riyals)
DMU25	783	520	1130	650
DMU26	594	88	877	171
DMU27	664	150	1360	210
DMU28	725	190	985	260
DMU29	1950	3000	3555	5100
DMU30	840	150	1980	260
DMU31	836	900	1655	1350
DMU32	550	780	2433	960
DMU33	840	150	2310	210
DMU34	452	220	2840	320
DMU35	865	145	3120	180
DMU36	1275	590	3110	880
DMU37	657	700	2380	850
DMU38	856	450	1604	620
DMU39	654	670	1308	960
DMU40	1002	225	3650	420

Indicators for evaluating the efficiency of bank branches

- In this section, according to the information collected in the previous chapter, the efficiency of bank branches is evaluated and analyzed, and the steps are as follows:
 - Evaluating the efficiency of branches based on the standard CCR model (data coverage analysis)
 - Evaluation and ranking of bank branches using the AP (super efficiency) model approach
 - Evaluating and ranking the efficiency of branches using the approach of cross-data coverage analysis and cross-dea planning.
 - Forming cooperative alliances between the effective branches
 - Evaluation and ranking of efficient units after cooperation in different coalitions by obtaining the Shipley value

Evaluation of bank branches individually (Date management unit)

In this section, according to the collection of information regarding the evaluation of the banking efficiency of the branches, the evaluation of the standard CCR method (Dugan) and and cross-efficiency will be discussed, and the results of the model are as follows:

Table 2: evaluating the efficiency of decision-making units

	Cross-functionality	CCR	Super-efficiency
DMU1	1.022	1	1.022
DMU2	0.532	0.532	0.532
DMU3	0.682	0.682	0.682
DMU4	0.565	0.565	0.565
DMU5	0.546	0.546	0.546
DMU6	0.726	0.726	0.726
DMU7	0.424	0.424	0.424
DMU8	0.985	0.985	0.985
DMU9	0.480	0.480	0.480
DMU10	0.580	0.580	0.580
DMU11	0.794	0.794	0.794
DMU12	1.292	1	1.292
DMU13	0.632	0.632	0.632
DMU14	0.767	0.767	0.767
DMU15	0.596	0.596	0.596
DMU16	0.645	0.645	0.645
DMU17	2.554	1	2.554
DMU18	0.748	0.748	0.748
DMU19	0.699	0.699	0.699
DMU20	0.622	0.622	0.622

	Cross-functionality	CCR	Super-efficiency
DMU21	0.524	0.524	0.524
DMU22	0.333	0.333	0.333
DMU23	1.556	1	1.556
DMU24	0.450	0.450	0.450
DMU25	0.651	0.651	0.651
DMU26	0.730	0.730	0.730
DMU27	0.709	0.709	0.709
DMU28	0.650	0.650	0.650
DMU29	0.522	0.522	0.522
DMU30	0.583	0.583	0.583
DMU31	0.675	0.675	0.675
DMU32	0.606	0.606	0.606
DMU33	0.431	0.431	0.431
DMU34	1.254	1	1.254
DMU35	0.611	0.611	0.611
DMU36	0.482	0.482	0.482
DMU37	0.596	0.596	0.596
DMU38	0.424	0.424	0.424
DMU39	0.703	0.703	0.703
DMU40	0.669	0.669	0.669

According to the evaluation of the two methods, it was shown that out of 40 bank branches, only 5 branches are known to be effective.

The First step: Forming coalitions

The second step: calculating the amount of profit obtained from the formed coalitions

In this section, according to the calculation of the efficiency and ECP of the efficient units in the coalition, the profits from the coalitions will be evaluated and analyzed:

Evaluation of coalition A

Table 4: evaluation of DMU A coalition

S	C(S)	C(S/[K])
A	0.022	0
(A,B)	1.314	0.310
(A,C)	1.213	0.532
(A,D)	1.432	0.523
(A,E)	1.324	0.631
(A,B,C)	1.432	0.540
(A,B,D)	1.895	0.435
(A,B,E)	2.102	0.983
(A,C,D)	2.314	1.029
(A,C,E)	2.404	1.421
(A,D,E)	2.513	1.546
(A,B,C,D)	3.519	2.149
(A,B,C,E)	3.241	2.414
(A,B,D,E)	3.541	2.564
(A,C,D,E)	4.201	2.140
(A,B,C,D,E)	4.653	3.201

Table 3: formation of coalitions for each DMU

P=1	P=2	P=3	P=4	P=5
A	(A,E), (A,D), (A,C), (A,B)	(A,B,C), (A,B,D), (A,B,E), (A,C,D), (A,C,E), (A,D,E)	(A,B,C,D), (A,B,C,E), (A,C,D,E), (A,B,D,E)	(A,B,C,D,E)
B	(B,E), (B,D), (B,C), (B,A)	(B,A,C), (B,A,D), (B,A,E), (B,C,E), (B,C,D), (B,D,E)	(B,A,C,D), (B,A,C,E), (B,C,D,E), (B,A,D,E)	(B,A,C,D,E)
C	(C,E), (C,D), (C,B), (C,A)	(C,B,D), (C,B,A), (C,A,D), (C,B,E), (C,D,E), (C,A,E)	(C,B,A,D), (C,B,D,E), (C,A,D,E), (C,B,A,E)	(C,B,A,D,E)
D	(D,E), (D,C), (D,B), (D,A)	(D,C,B), (D,C,A), (D,C,E), (D,B,A), (D,B,E), (D,A,E)	(D,C,B,A), (D,C,A,E), (D,B,A,E), (D,B,C,E)	(D,C,B,A,E)
E	(E,D), (E,C), (E,B), (E,A)	(E,D,C), (E,D,B), (E,D,A), (E,C,B), (E,C,A), (E,B,A)	(E,D,C,B), (E,D,C,A), (E,C,B,A), (E,B,A,D)	(E,D,C,B,A)

Evaluation of coalition B

Table 5: evaluation of DMU B coalition

S	C(S)	C(S/[K])
B	0.432	0
(B,A)	0.564	0.013
(B,C)	0.651	0.123
(B,D)	0.784	0.321
(B,E)	0.459	0.234
(B,A,C)	1.032	0.854
(B,A,D)	1.237	0.945
(B,A,E)	1.431	1.002
(B,C,E)	1.563	1.054
(B,C,D)	1.567	1.203
(B,D,E)	1.546	1.230
(B,A,C,D)	2.591	1.659
(B,C,D,E)	2.768	1.659
(B,A,D,E)	2.450	1.231
(B,A,C,E)	2.431	1.467
(B,A,C,D,E)	3.278	2.109

Evaluation of coalition D

Table 7: evaluation of DMU D coalition

S	C(S)	C(S/[K])
D	0.894	0
(D,E)	0.983	0.438
(D,A)	0.934	0.641
(D,B)	0.955	0.341
(D,C)	0.954	0.454
(D,C,B)	1.324	0.980
(D,A,E)	1.548	1.003
(D,B,E)	1.658	1.013
(D,B,A)	1.769	1.321
(D,C,E)	1.984	1.435
(D,C,A)	1.669	1.314
(D,C,B,A)	2.449	1.682
(D,B,A,E)	2.659	1.752
(D,B,C,E)	2.669	1.761
(D,C,A,E)	2.980	1.931
(D,C,B,A,E)	3.416	2.946

Evaluation of coalition C

Table 6: evaluation of DMU C coalition

S	C(S)	C(S/[K])
C	0.481	0
(C,A)	0.849	0.341
(C,B)	0.943	0.430
(C,D)	0.954	0.545
(C,E)	0.966	0.892
(C,B,D)	1.239	0.993
(C,B,A)	1.329	1.032
(C,A,D)	1.548	1.012
(C,B,E)	1.449	1.003
(C,D,E)	1.674	1.052
(C,A,E)	1.980	1.435
(C,B,A,D)	2.436	1.569
(C,B,D,E)	2.456	1.638
(C,B,A,E)	2.561	1.206
(C,A,D,E)	2.895	1.831
(C,B,A,D,E)	3.895	2.313

Evaluation of coalition E

Table 8: evaluation of DMU E coalition

S	C(S)	C(S/[K])
E	0.254	0
(E,D)	0.498	0.123
(E,A)	0.786	0.334
(E,B)	0.991	0.467
(E,C)	1.843	1.034
(E,D,C)	1.943	1.320
(E,B,A)	2.461	1.547
(E,C,A)	2.546	1.341
(E,C,B)	2.789	1.241
(E,D,A)	2.783	1.342
(E,D,B)	2.672	1.352
(E,D,C,B)	3.104	1.798
(E,C,B,A)	3.529	1.894
(E,B,A,D)	2.143	1.306
(E,D,C,A)	4.241	3.251
(E,D,C,B,A)	4.638	3.596

Third step: Calculation of Shipley value

According to the evaluation of the value of coalitions, in the next section, the value of DMUs in each coalition will be evaluated and calculated, so according to the Shipley value formula, we have:

FINDING AND RESULTS

Therefore, according to the Shipley value obtained in the above table, the comparison and evaluation of the Shipley value of each DMU obtained in different coalitions with cross-efficiency and hyper-efficiency method is shown in the table below and we have:

As can be seen, the efficiency rating of DMU 17, 23 and 1 in the evaluation of super efficiency and coalition has been the same, and the changes are related to DMU 12 and 34. This case shows that the efficiency score of each DMU in the hyper-efficiency method does not necessarily keep its rank after the cooperation phase. Although in this research, the 17th branch with the highest efficiency also has the most effect in the coalition and its rank remains unchanged, but the efficiency score Branch 34 is less than branch 12, but its influence in the coalition is greater,

therefore the score of branch 34 in the Shipley value method has increased and the rank of this branch has improved compared to the ranking in the super efficiency method. Also, the rank of branch 12, which is higher in the super efficiency method From the 34th branch, the Shipley value method has decreased.(Fig. 1)

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Table 9: Calculation table of Shipley value and cross efficiency

DMU	P=1	P=2	P=3	P=4	P=5	Shipley's value
A	0.024	0.129	0.143	0.268	0.413	0.977
B	0.043	0.113	0.132	0.339	0.358	0.985
C	0.063	0.162	0.173	0.564	0.661	1.623
D	0.061	0.115	0.152	0.451	0.548	1.327
E	0.048	0.161	0.199	0.449	0.338	1.195

Table 10: ranking of DMUs based on Shipley value weight and cross efficiency

DMU	Super-efficiency	Cross-functionality	Rating	Shipley's value	Ranking	Rank changes
A(1)	1.022	1.022	5	0.977	5	0
B(12)	1.292	1.292	3	0.985	4	1-
C(17)	2.554	2.554	1	1.623	1	0
D(23)	1.556	1.556	2	1.327	2	0
E(34)	1.254	1.254	4	1.195	3	1+

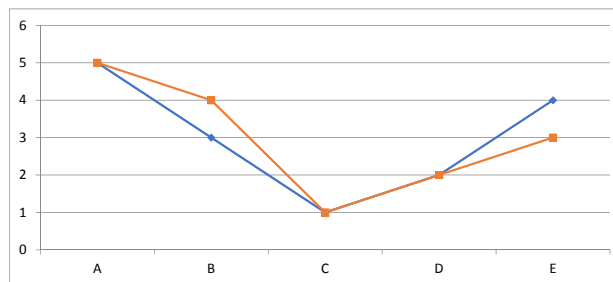


Figure 1: The value of DMUs in Shipley indices (Orange line) and cross efficiency (Blue line)

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