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Measuring and analyzing the efficiency of expenditure on Iraqi universities using the super efficiency approach

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Abstract
The research aims to measure the efficiency of government spending on Iraqi universities using the Super Efficiency approach within the framework of the Data Envelopment Analysis (DEA) model. It analyzes the disparities in spending efficiency among Iraqi universities and identifies the institutions that achieve the highest levels of efficiency, as well as those suffering from underperformance. Furthermore, it diagnoses the factors influencing spending efficiency on universities, whether administrative, organizational, related to human resources, or infrastructure. The research problem is centered on answering the following question: To what extent is spending on Iraqi universities efficient, and what are the factors contributing to the variance in efficiency among these universities according to the Super Efficiency method?
The research concludes that the University of Fallujah ranked second in terms of scale efficiency, with a scale efficiency value of 0.999. This indicates that by using inputs at a rate of 1%, the university was able to achieve a 0.99% increase in outputs, a highly significant level compared to other universities. The recently established university managed to attain this output level due to the efficiency of its administrative leadership. The research recommends that the Ministry of Higher Education and university administrations in Iraq investigate the reasons behind the low relative efficiency of certain universities and work on addressing the root causes. Additionally, the factors that enabled other universities to achieve full efficiency should be studied and considered as practical models to be emulated by less efficient universities in order to attain full relative efficiency.

Keywords: Public expenditure, super efficiency, Iraqi universities

Introduction
Higher education has constituted one of the fundamental pillars of human and economic development, with universities serving as key drivers in capacity building, knowledge generation, and human capital development. In Iraq, the higher education sector has received increasing attention since 2003, manifested in the significant expansion in the number of universities and the rise in government expenditure allocated to them. However, this expansion has often not been accompanied by a clear assessment of the efficiency of such spending, raising questions about the extent to which universities are achieving the intended objectives of the financial allocations granted to them. Hence, there emerges a need for precise quantitative tools to measure and analyze the efficiency of this expenditure. The Super Efficiency approach is considered one of the advanced methods in this regard, as it enables differentiation among the most efficient units and classifies them based on their relative performance with higher accuracy than traditional methods.

Research significance
The significance of this research is manifested in the following points
1. The study contributes to enriching the economic and educational literature by employing the Super Efficiency method in evaluating the performance of universities—an application rarely utilized in the Iraqi context.
2. It provides an analytical tool for decision-makers in the Ministry of Higher Education and Scientific Research to allocate resources more efficiently, thereby enhancing the

quality of education and reducing financial waste.
3. It supports strategic planning for the higher education sector in alignment with the requirements of sustainable development and the labor market in Iraq.

Research problem

The research problem can be represented by the following question: To what extent is spending on Iraqi universities efficient, and what factors influence the variation in this efficiency among universities, according to the Super Efficiency approach?

Research hypothesis

The research is based on the hypothesis that there are substantial differences in spending efficiency among Iraqi universities, and that applying the Super Efficiency approach reveals that some universities achieve higher levels of performance than others, despite having equal or similar levels of financial resources allocated to them. This indicates a weakness in the allocation or management of resources in some universities.

Research objectives

The research focuses on achieving the following

1. Measuring the efficiency of government spending on Iraqi universities using the Super Efficiency approach within the framework of the Data Envelopment Analysis (DEA) model.
2. Analyzing the differences in spending efficiency among Iraqi universities and identifying those that achieve the highest levels of efficiency and those experiencing performance decline.
3. Diagnosing the factors affecting spending efficiency on universities, whether administrative, organizational, related to human resources, or infrastructure.
4. Proposing practical recommendations for decision-makers in the Ministry of Higher Education and Scientific Research to improve the efficiency of resource allocation and enhance institutional performance in universities.
5. Contributing to the development of a knowledge base that supports the evaluation of current educational policies and the assessment of the impact of public spending on the quality of higher education in Iraq.

Research methodology

To achieve the research objectives and test its hypothesis, this study employed a combination of analytical descriptive methods based on deductive reasoning within the framework of economic theory and previous studies, along with quantitative econometric methods. The Super Efficiency approach was used within the Data Envelopment Analysis (DEA) model.

Structure of the research

The research is divided into two sections, preceded by an introduction. The first section addresses the conceptual and theoretical framework for measuring spending efficiency in the higher education sector, while the second section focuses on analyzing the results of spending efficiency in Iraqi universities during the study period based on output-oriented direction.

Section One: The conceptual and theoretical framework for measuring spending efficiency in the higher education sector

First Requirement: Public expenditure

First: The concept of public expenditure

The volume of public expenditure reflects the extent of government intervention and the nature of its fiscal behavior. Public expenditure takes the form of monetary amounts spent to achieve economic, social, and political objectives. There are several definitions of public expenditure, among the most prominent: v Danladi and others (2015:142) [13] define public expenditure as “an amount of money spent by the government to satisfy public needs such as healthcare, education, security, defense, and other public services”. Al-Obaidi (2011:56) [5] defines it as “a sum of money spent by the government to fulfill public needs such as services in health, education, security, defense, and others”.

Second: Principles of public expenditure

Achieving the intended outcomes of public expenditure requires the following (Hashish, 1983:69-75) [6]:

1. **Maximizing social benefit:** To achieve this objective, the government must prioritize areas of public expenditure and make choices among them based on the social benefits they generate. This depends on two main factors: the relative income or per capita share of national income, and the method of national income distribution. In order to maximize social benefit, fiscal policy should direct public revenues toward spending in a way that increases national income and ensures equity through transfer expenditures.
2. **Cost minimization:** Enhancing the efficiency of public expenditure requires the government's ability to maximize social benefit to be linked with its capacity to achieve the lowest possible cost. This is attained through prudent management and the avoidance of waste and extravagance. The sources of financial waste and excess are numerous and often stem from weak parliamentary and administrative oversight. Therefore, achieving cost minimization depends on the level of financial discipline and the degree to which necessary public needs are observed.
3. **Ensuring the productivity of public spending:** The increase in the productivity of public expenditure is related to the fiscal policy’s capacity to define priorities in public spending directions. This principle is justified by two considerations: first, public expenditure should satisfy a public need, and a need is considered public only if its satisfaction yields a public benefit. Second, if public spending achieves a public benefit, this leads to the realization of the principle of equality among citizens in bearing public burdens. Hence, public expenditure must be directed toward activities that serve society.

1.

Second Requirement: Efficiency of public expenditure

The pursuit of enhancing the efficiency of public expenditure has gained increasing importance in academic discussions and society at large due to several factors related to macroeconomic policy discipline, fiscal discipline, and the emergence of new laws that reinforce public financial transparency. As a result, pressures on the public sector to improve the quality of public administration are intensifying.

First: The concept of efficiency

The concept of efficiency is fundamentally based on analyzing the relationship between inputs and outputs. Efficiency is represented by achieving the optimal combination between the best use of inputs and the selection of the most effective production methods to maximize outputs. In other words, efficiency is the ability to perform tasks correctly while minimizing the input-to-output ratio to achieve optimal resource utilization. The economist Farrell was the first to use the concept of efficiency. He defined it as the ability of a production unit to obtain the maximum possible outputs given the available inputs. Efficiency is a measure that reflects the extent to which an economic unit can optimally utilize its available resources to maximize outputs and minimize costs. In essence, it expresses how successfully an economic unit transforms available inputs into outputs with minimal effort and cost by reducing waste. If the efficiency score equals one, it indicates the achievement of optimal efficiency, meaning that actual outputs match the maximum possible outputs for a given level of inputs implying optimal resource utilization. However, if the efficiency score is less than one, it reflects inefficiency in resource utilization (Farrell, 1957: 254) [12]. From the preceding definitions, we conclude that efficiency reflects how production units use their resources in relation to their outputs, through the optimal combination of production factors and methods to maximize outputs.

Second: Types of efficiency

There are several notable types of efficiency, including

1. **Relative Efficiency:** This refers to the ratio of the weighted sum of outputs to the weighted sum of inputs. It is measured through linear programming and is considered one of the best weighting methods for decision-making units.(Al-Azzaz, 2000: 26) [7].
2. **Economic efficiency:** This refers to the production of a certain level of output using the lowest possible level of production costs. (Al-Ukaili, 2001: 100) [8].
3. **Productive efficiency:** Productive efficiency means achieving the maximum amount of output with the minimum amount of inputs and at the lowest possible cost. It requires knowledge of technical factors to arrive at a production method characterized by speed, skill, and reduced waste in production elements. (Najm, 2010: 212) [9].
4. **Allocative or distributive employment efficiency:** This type of efficiency refers to the condition in which a production institution achieves the optimal mix of available inputs or resources, based on the relative prices and costs of these resources. It reflects the production unit's ability to use the optimal combination of inputs, taking into account technical inputs and production methods, to achieve the highest possible level of output. If the maximum technically feasible output is achieved alongside the best possible input allocation, economic efficiency is attained. However, the concept of economic efficiency differs when applied to the economy as a whole, where individuals are the final decision-makers, bearing the costs and reaping the benefits of economic activities. (Cubbin, 1998: 39) [11].
5. **Technical efficiency:** Technical efficiency refers to the unit's ability to obtain the maximum possible outputs using the available amounts of inputs by making trade-offs between produced goods i.e., increasing the production of one good at the expense of another to maximize total output under given resource constraints.
6. **Scale efficiency:** This type of efficiency measures the extent to which a unit can expand based on the scale of its operations. It reflects the degree of change in output resulting from a simultaneous change in input levels. A unit may operate under increasing, decreasing, or constant returns to scale.

Third: Requirements for efficiency

The concept of efficiency is the result of an accumulation of several elements, which include the following (Asiya, 2011: 9).

1. **Data:** These are sets of objective facts that are not yet interconnected. They are classified, analyzed, and then presented within a clear framework, transforming them into useful and understandable information.
2. **Information:** This refers to data characterized by credibility. Information is developed to serve a specific purpose or to be used in discussions or dialogues.
3. **Knowledge:** As defined by Drucker, knowledge is the translation of information into performance to accomplish a specific task or job. This ability is characteristic of individuals with intellectual skills.
4. **Expertise:** This refers to the highest level of efficiency, acquired through extensive mastery of knowledge.

Section Two: Analysis of spending efficiency results for Iraqi universities during the study period based on output orientation using Data Envelopment Analysis (DEA)

First Requirement: Theoretical framework of the data envelopment analysis model

First: The concept and emergence of data envelopment analysis

Data Envelopment Analysis (DEA) is a mathematical method used to measure technical efficiency by determining the optimal combination of a set of input and output elements for institutions with similar activities and objectives. The term "Data Envelopment Analysis" originates from the fact that the productively efficient units lie at the frontier, enveloping the less efficient institutions. This method is based on Pareto optimality, which states that any business entity or combination of entities should be capable of producing greater quantities of output using the same or fewer inputs without increasing any other resource (Al-Mahdi and Salahuddin, 2013: 296).

The study by Farrell (1957) [12] laid the foundation for DEA; however, it was limited to measuring technical efficiency with only one input and one output, which does not align with modern studies that require multiple inputs to generate a single output. DEA, in contrast, allows for simultaneous handling of multiple inputs and outputs. Additionally, DEA contributes to identifying key indicators when assessing the performance of various productive and service institutions, as follows (Battal, 2006: 96):

1. **Identifying the reference institution:** DEA identifies the best-performing peer institutions in terms of efficiency and practices, which have achieved full efficiency levels. These are then used as benchmarks to

compare with inefficient institutions. Thus, universities that achieve 100% efficiency serve as references for those with partial technical efficiency.

2. **Identifying fully efficient institutions:** This model provides a comprehensive analysis of peer institutions based on efficiency levels. It highlights the institutions that have achieved full technical efficiency (100%), while ranking the remaining institutions according to their efficiency levels.
3. **Determining the requirements for achieving full efficiency:** One of the key advantages of DEA is its ability to specify the required adjustments for each inefficient institution—either in terms of inputs or outputs to attain full technical efficiency (Bahramz, 1996: 25) [1].
4. **Setting planning objectives:** Decision-makers often aim to set various goals to enhance efficiency by increasing outputs or reducing inputs, with the ultimate goal of improving the level of technical efficiency of institutions.

Data Envelopment Analysis (DEA) is a non-parametric mathematical method based on linear programming that provides a realistic evaluation of efficiency for a large number of similar institutions. The efficiency score is derived from a set of institutions that collectively form the performance frontier, which envelops all observations. Institutions located on the frontier are considered efficient in producing their outputs and allocating their inputs, while those positioned outside the frontier are deemed inefficient. This method operates on the principle that each institution is evaluated relative to the best-performing institutions, also referred to as the best-practice frontier (Al-Azzaz, 2000: 32) [7].

Regarding the origin and development of DEA, its foundational concepts date back to Farrell's 1957 [12] study titled *"The Measurement of Productive Efficiency."* In this work, Farrell sought optimal approaches and models for evaluating efficiency and productivity, noting that earlier studies had numerous shortcomings—particularly their failure to consolidate multiple input measures into a single acceptable metric for assessing efficiency. As a solution, Farrell proposed a new approach for analyzing institutional activities that he believed was better suited to addressing these challenges. The measures he introduced were more applicable across different productive institutions for evaluating their efficiency.

DEA has undergone continuous refinement since the late 1980s, demonstrating its flexibility and effectiveness in handling the complex relationship between multiple inputs and outputs. In the Arab world, DEA was first applied in 1996 by Bahramz, who used it to measure the relative efficiency of administrative units. The method was later employed again by Bahramz (1996: 35) [1], and a series of subsequent Arab studies have since utilized DEA to assess performance and measure efficiency across various administrative fields.

Second: Models of the data envelopment analysis method

1. **Constant returns to scale model:** The initial steps of this model trace back to the work of Charnes, Cooper, and Rhodes in 1978, who introduced it to measure the efficiency of decision-making units. This foundational model served as the basis for subsequent mathematical formulations. The DEA model under the assumption of constant returns to scale is built on the idea that any proportional change in inputs leads to an equivalent proportional change in outputs—a property known as constant returns to scale.

This model, under output orientation, takes the following mathematical form:

$$\text{Min}\ (\rho \cdot X_i')$$

Subject to

$$(\rho \cdot X_i') - (\theta \cdot Y_i') > 0, \quad j = 1, \dots, n$$

$$(\theta \cdot Y_i') = 1$$

$$\rho, \theta > 0$$

By applying the dual linear programming formulation, the above problem can be rewritten as:

$$\text{Max}\ \Phi$$

Subject to

$$\sum_j x_i \lambda < x_i, \quad j = 1, \dots, n$$

$$\sum_j y_i \lambda - y_i \Phi > 0$$

$$\lambda > 0$$

Here, λ represents the weights of the units, and Φ represents the efficiency score under the output-oriented model. The objective of this output-oriented linear programming problem is to maximize the outputs of the institution while maintaining the same level of inputs.

Variable returns to scale model: This model was developed by Charnes, Banker, and Cooper in 1984. It distinguishes between two types of efficiency: scale efficiency and technical efficiency. The model was introduced to modify the constant returns to scale model in linear programming by adding a separate variable ε, which allows the identification of the scale characteristics of the institution. The output-oriented linear programming model can be written as follows:

$$\text{Min}\ (\rho \cdot X_i') + \varepsilon$$

Subject to:

$$(\rho \cdot X_i') - (\theta \cdot Y_i') + \varepsilon > 0, \quad j = 1, \dots, n$$

$$(\theta \cdot Y_i') = 1$$

$$\rho, \theta, \varepsilon > 0$$

Using the corresponding dual linear programming form, the problem can be rewritten as:

Max Φ

Subject to:

$$\sum_j x_i y_i < x_i, \quad j = 1, \ldots, n$$

$$\sum_j y_i y - y_i \Phi > 0$$

$$y > 0$$

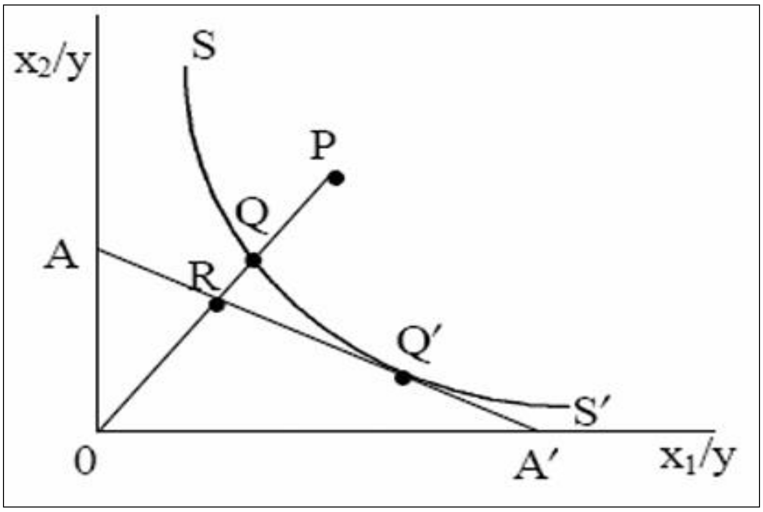
This model accounts for variable returns to scale by incorporating the adjustment variable ε, thus improving the realism and flexibility of the analysis, particularly when institutions do not operate under constant scale conditions.

Third: Efficiency measurement indicators

There are two methods for calculating efficiency indicators. The first method is known as input-oriented efficiency, and the second is known as output-oriented efficiency**.**

1. Input-oriented efficiency: This type of efficiency involves a number of production units that produce a single output (Y) using multiple inputs (x1,x2,...,xn)(x_1, x_2, ..., x_n), under relatively stable conditions, as illustrated in Figure (1).

In this orientation, the focus is on minimizing the quantity of inputs used while maintaining the same level of output. The objective is to determine the extent to which input usage can be proportionally reduced without affecting the output level, thereby enhancing the unit's technical efficiency.



***Source*:** Alex Manzoni and Sardar Islam (2009) [14] Performance Measurement in Corporate Governance: DEA Modelling and Implications for Organisational Behaviour and Supply Chain Management, Springer Science + Business Media, Physica-Verlag Heidelberg, Germany. P.91.

Fig 1: Input-oriented efficiency

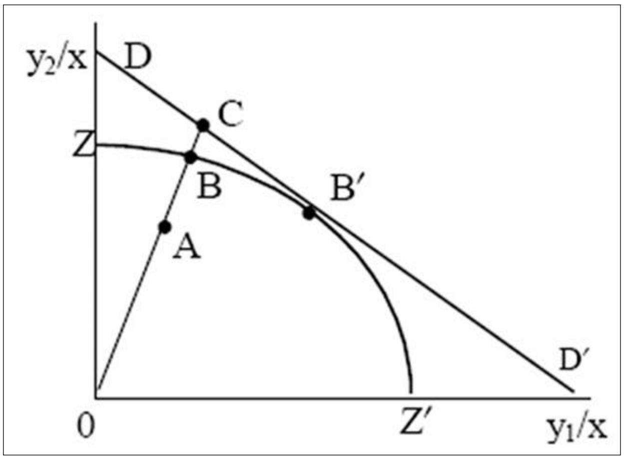
The curve (SS) represents the production of one unit of output (Y) using inputs (X_1, X_2) at the highest possible efficiency. The curve (AA) represents the iso-cost curve, and point Q indicates the lowest level of production cost. When the marginal rate of technical substitution between the input elements equals the ratio of their prices, institution P is considered less efficient than institution Q in producing one unit of output.

The distance PQ represents the degree of reduction in technical efficiency. It indicates the quantity by which inputs can be reduced without decreasing the final output. The technical efficiency index for the institution producing at point P along the ray OP can be calculated using the following formula:'

$$\text{Efficiency Index} = \frac{OQ}{OP}$$

Its value ranges between 0 and 1, and when the index reaches a value of 1, this indicates that the institution is operating with full technical efficiency.

2. Output-oriented efficiency: Efficiency from the output perspective is defined as the proportion by which outputs can be increased without reducing the quantity of inputs. Figures (2–3) illustrate the technical relationship of the outputs for a number of production units that produce two types of products (Y_1, Y_2) using a single input (X_1) under stable and constant conditions, as shown in Figure (2).



Source: Alex Manzoni and Sardar Islam (2009) [14] Performance Measurement in
Corporate Governance: DEA Modeling and Implications for Organizational
Behavior and Supply Chain Management, Springer Science + Business Media, Physica-Verlag Heidelberg, Germany. P92

Fig 2: Output-oriented efficiency

The curve (ZZ) represents the production possibilities frontier, while the line (DD) represents the iso-revenue line. Point (A) indicates that the institution is inefficient, as it can only produce outputs (Y_1, Y_2) at that level. However, it is capable of reaching point (B) without increasing the amount of inputs. Therefore, the technical efficiency of the institution can be calculated using the following formula:

$$TE_o = \frac{OA}{OB}$$

The efficiency index takes values between 0 and 1, with 1 indicating full technical efficiency. The slope of line (DD) represents the relative price of outputs. Additionally, the allocative efficiency index, which reflects the institution's ability to achieve point B′ on ray OC, can be calculated using the formula:

$$AE_o = \frac{OB}{OC}$$

Fourth: The mathematical formula for the data envelopment analysis method

According to the basic concept of the Data Envelopment Analysis (DEA) method, the efficiency score for a number of productive institutions can be calculated under the single input–single output model (Batal, 2012: 100) [3] using the following formula:

$$\text{Efficiency} = \frac{\text{Actual output of institution } j}{\text{Actual input of institution } j}$$

To make the equation more realistic and applicable in practice, it has been developed to measure the efficiency of institutions with multiple inputs and multiple outputs. The mathematical representation is as follows:

$$x_j = \begin{bmatrix} x_1^j \\ \\ x_m^j \end{bmatrix}, \quad y_j = \begin{bmatrix} y_1^j \\ \\ y_s^j \end{bmatrix}, \quad j = 1,2,\ldots,n$$

Where x_j and y_j represent the quantities of inputs and outputs used by institution j. With the assumption of relative weights for outputs and inputs ($\pi_1, \pi_2, \ldots, \pi\_m1$ and $\sigma_1, \sigma_2, \ldots, \sigma\_m2$), the efficiency index for institution j is calculated using the formula (Batal, 2012: 101) [3]:

$$E = \frac{\sigma_1 y_1^j + \sigma_2 y_2^j + \cdots + \sigma_{m2} y_{m2}^j}{\pi_1 x_1^j + \pi_2 x_2^j + \cdots + \pi_{m1} x_{m1}^j}$$

As for the linear programming method for determining the efficiency score mathematically (Bahauddin, 2006: 95) [4]:

$$\max = \frac{(\sigma \cdot y_i')}{\pi \cdot x_i'}$$

Subject to:

$$\frac{\left(\sigma \cdot y_j'\right)}{\pi \cdot x_j'} \le 1, \quad j = 1,2,\ldots,n$$

This model is in fractional form, and it can be converted into a linear programming model using the following equivalent formulation:

$$\max\,(\sigma \cdot y_i')$$

Subject to:

$$(\pi \cdot x_i') = 1$$

$$(\sigma \cdot y_j') - (\pi \cdot x_j') \le 0, \quad j = 1,2,\ldots,n$$

This model is referred to as the input-oriented model under the assumption of constant returns to scale.

Second Requirement: Analysis of spending efficiency indicators for Iraqi universities according to output orientation

First: Analysis of spending efficiency indicators for the university of Baghdad according to output orientation

Table (1) shows that the University of Baghdad achieved the highest results among the Iraqi universities in the study sample. This is evident from the results related to constant and variable efficiency, followed by the scale returns of the university. In terms of constant returns to scale efficiency, the University of Baghdad recorded values below one during the period 2018–2021. In contrast, the variable returns to scale efficiency remained at one throughout the entire study period. This indicates that the total scale returns for the University of Baghdad were decreasing during the years 2018–2021, as it had exceeded the optimal efficiency threshold (i.e., constant efficiency).

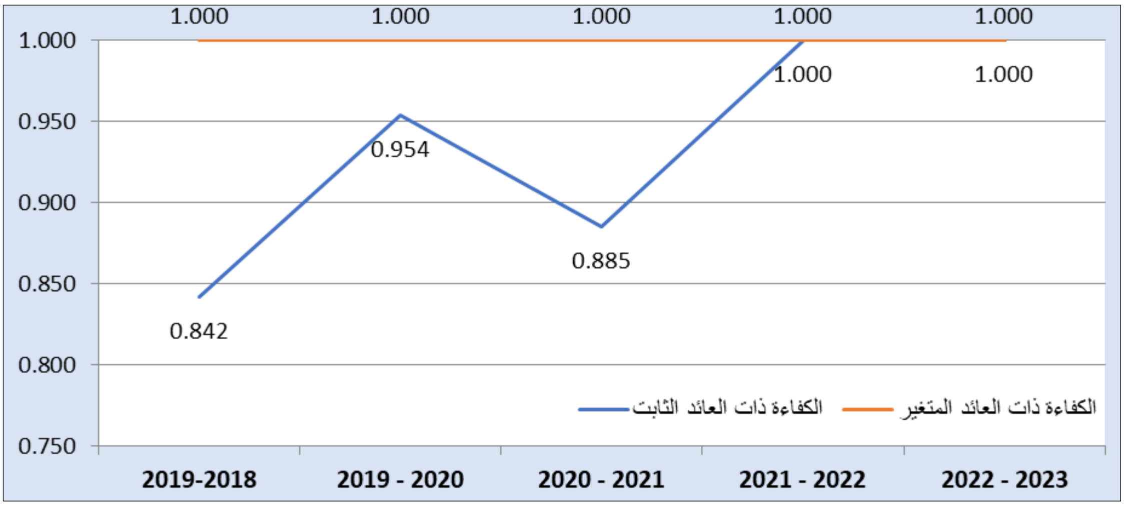
However, in the last two years (2022–2023), the university's performance improved in terms of constant returns to scale efficiency. This improvement was due to the university's ability to control its outputs in alignment with the state's policy and orientation towards output-based input utilization. As a result, the efficiency under constant returns to scale reached the optimal value of one, which in turn led to a stabilization of scale returns at the optimal efficiency level (i.e., constant efficiency). This means that the increase in inputs corresponded proportionally to the increase in outputs.

Table 1: Output of the data envelopment analysis model for the university of Baghdad during the period 2018–2023

University	Year	Constant Returns Efficiency	Variable Returns Efficiency	Scale Efficiency	Returns to Scale
Baghdad	2018–2019	0.842	1.000	0.842	Decreasing
Baghdad	2019–2020	0.954	1.000	0.954	Decreasing
Baghdad	2020–2021	0.885	1.000	0.885	Decreasing
Baghdad	2021–2022	1.000	1.000	1.000	Constant
Baghdad	2022–2023	1.000	1.000	1.000	Constant
Average	—	0.936	1.000	—	—

***Source*:** Prepared by the researcher based on the results of the DEAP ver. 2 software for Data Envelopment Analysis.

Figure (3) illustrates the development of both variable and constant returns to scale efficiency for the University of Baghdad over the study period. It is evident that the university consistently achieved optimal variable returns to scale efficiency, indicating that it managed the inputs imposed by the Ministry of Higher Education and Scientific Research such as the number of students, staff, faculty members, and financial expenditures through a rational and effective policy. This approach yielded results in the form of optimal performance under variable returns to scale. Consequently, this prudent policy contributed to enhancing the university's overall performance, leading it to attain the highest levels of constant returns to scale efficiency during the last two years of the study.



***Source*:** Prepared by the researcher based on the results of SPSS version 25

Fig 3: Variable and constant returns to scale efficiency for the university of Baghdad

Second: Analysis of Spending Efficiency Indicators for Al-Nahrain University According to Output Orientation

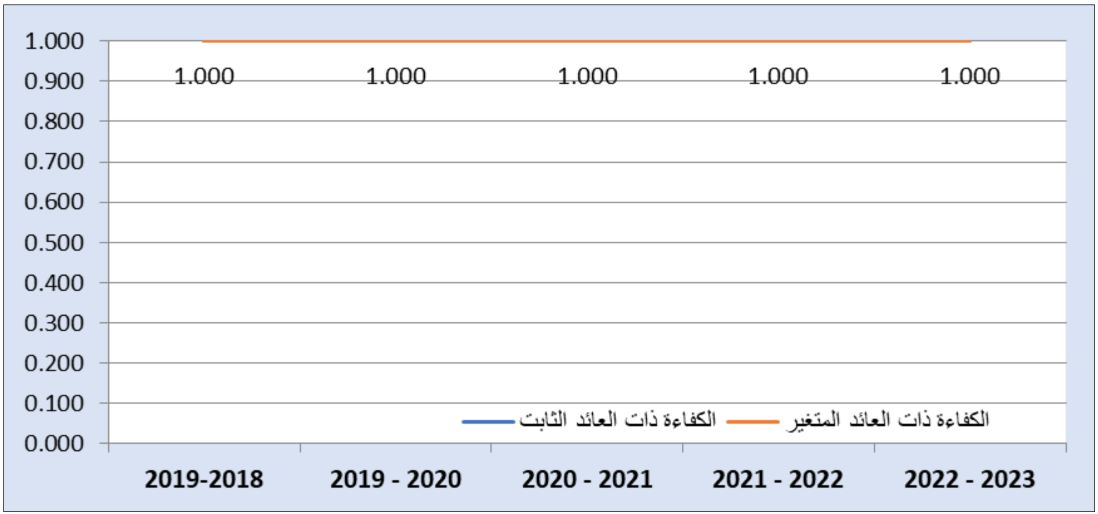
Table (2) presents the results of the Data Envelopment Analysis model for Al-Nahrain University during the period 2018–2023. The table shows that both variable and constant returns to scale efficiency scores reached a perfect value of one in all years of the study. This indicates that Al-Nahrain University achieved optimal efficiency levels by aligning its outputs with its inputs. In other words, the proportionate increase in outputs was exactly equal to the increase in inputs, resulting in constant returns to scale throughout the entire study period. This means that Al-Nahrain University was the only university among the study sample to achieve perfect technical efficiency in all the years observed. Therefore, it is recommended that other universities refer to the output-oriented policy adopted by Al-Nahrain University and learn from its procedures in output control to reach the optimal level of technical efficiency.

Table 2: Outputs of the data envelopment analysis model for Al-Nahrain university during the Period 2018–2023

University	Year	Constant Returns Efficiency	Variable Returns Efficiency	Scale Efficiency	Returns to Scale
Al-Nahrain	2018–2019	1.000	1.000	1.000	Constant
Al-Nahrain	2019–2020	1.000	1.000	1.000	Constant
Al-Nahrain	2020–2021	1.000	1.000	1.000	Constant
Al-Nahrain	2021–2022	1.000	1.000	1.000	Constant
Al-Nahrain	2022–2023	1.000	1.000	1.000	Constant
Average	—	1.000	1.000	1.000	—

***Source*:** Prepared by the researcher based on the results of the DEAP ver. 2 software for Data Envelopment Analysis.

Figure (4) illustrates the development path of both variable and constant returns to scale efficiency for Al-Nahrain University during the study period. It is evident that the university consistently recorded the optimal level of efficiency throughout the entire duration of the study. The increase in inputs at Al-Nahrain University was proportionate to the increase in its outputs, leading to a consistent trend of constant returns to scale.



Source: Prepared by the researcher based on the results of SPSS version 25

Fig 4: Variable and constant returns to scale efficiency for Al-Nahrain university

Third: Analysis of spending efficiency indicators for the university of kufa according to output orientation

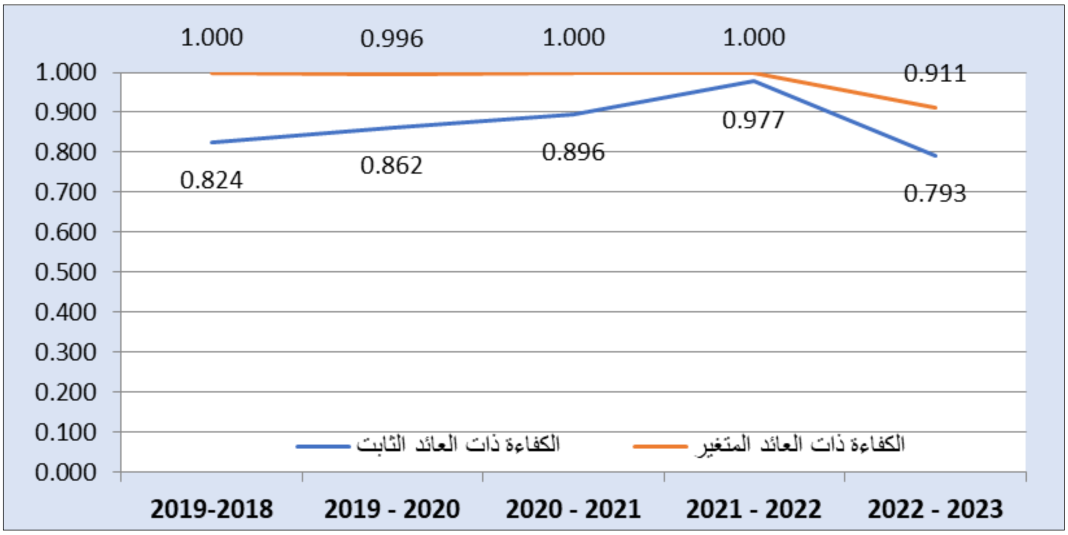
The results presented in Table (3) reflect the technical efficiency of the University of Kufa. These results indicate that the university achieved perfect variable returns to scale efficiency (a value of 1) in some years and came very close to it in others. This suggests that the university utilized its inputs efficiently during certain periods, while in others, it experienced decreasing returns to scale. This means that the University of Kufa did not optimally and precisely utilize the financial resources allocated by the Ministry of Higher Education and Scientific Research. Consequently, the proportionate increase in the university's outputs was lower than the increase in its inputs. As a result, the scale returns for all years of the study were classified as decreasing, since the constant returns to scale efficiency scores remained below one. When constant efficiency scores are divided by variable efficiency scores, the resulting value represents the scale efficiency or returns to scale, which in this case appeared to be decreasing. Therefore, the university is advised to reconsider its output policies, particularly in terms of regulating the number of graduates in both undergraduate and postgraduate programs, as well as the number of published scientific research papers. These adjustments would help improve the constant returns to scale efficiency and raise overall technical efficiency to optimal levels.

Table 3: Outputs of the data envelopment analysis model for the University of Kufa during the period 2018–2023

University	Year	Constant Returns Efficiency	Variable Returns Efficiency	Scale Efficiency	Returns to Scale
Kufa	2018–2019	0.824	1.000	0.824	Decreasing
Kufa	2019–2020	0.862	0.996	0.866	Decreasing
Kufa	2020–2021	0.896	1.000	0.896	Decreasing
Kufa	2021–2022	0.977	1.000	0.977	Decreasing
Kufa	2022–2023	0.793	0.911	0.870	Decreasing
Average	—	0.870	0.981	0.887	—

Source: Prepared by the researcher based on the results of the DEAP ver. 2 software for Data Envelopment Analysis.

Figure (5) illustrates the development path of variable and constant returns to scale efficiency for the University of Kufa throughout the study period. It is evident that the university achieved full variable returns to scale efficiency in most of the study years, indicating that the increase in its outputs was proportionate to the increase in its inputs. As a result, the general trend in scale returns appeared to be stable. However, a decline in efficiency was observed in the final year. Therefore, if the University of Kufa aims to achieve constant returns to scale, it must address and revise its output-oriented policies and better manage its outputs. This includes regulating the number of graduates in both undergraduate and postgraduate programs, enhancing the university's societal contributions through community services and advisory roles, and focusing on the quality and quantity of research output and research centers in alignment with international academic standards. Such measures would enable the university to regain constant returns to scale and reach optimal technical efficiency.



***Source*: Prepared by the researcher based on the results of SPSS version 25

Fig 5: Variable and Constant Returns to Scale Efficiency for the University of Kufa

Fourth: Analysis of spending efficiency indicators for the university of Fallujah according to output orientation

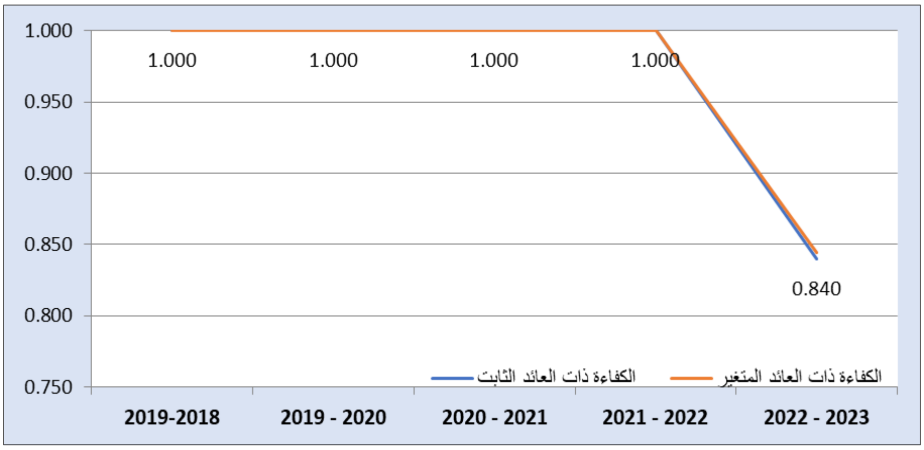
Table (4) presents the results of the Data Envelopment Analysis model for the University of Fallujah during the period 2018–2023. The results indicate that both variable and constant returns to scale efficiencies reached the perfect score of one in most years of the study, with the exception of the academic year 2022–2023, during which a decrease was observed. This implies that the University of Fallujah achieved optimal efficiency levels by aligning its outputs with its inputs, meaning that the rate of increase in outputs matched the rate of increase in inputs. As a result, scale returns were constant throughout most of the study period. However, the overall average scale efficiency across all study years was (0.999), indicating a slightly decreasing trend in returns to scale. This suggests that the rate of output growth was marginally lower than the rate of input growth at the University of Fallujah.

Table 4: Outputs of the Data Envelopment Analysis Model for the University of Fallujah During the Period 2018–2023

University	Year	Constant Returns Efficiency	Variable Returns Efficiency	Scale Efficiency	Returns to Scale
Fallujah	2018–2019	1.000	1.000	1.000	Constant
Fallujah	2019–2020	1.000	1.000	1.000	Constant
Fallujah	2020–2021	1.000	1.000	1.000	Constant
Fallujah	2021–2022	1.000	1.000	1.000	Constant
Fallujah	2022–2023	0.840	0.844	0.995	Decreasing
Average	—	0.968	0.969	0.999	—

***Source*: Prepared by the researcher based on the results of the DEAP ver. 2 software for Data Envelopment Analysis.

Figure (6) illustrates the development path of variable and constant returns to scale efficiency for the University of Fallujah during the study period. It is evident that the university achieved optimal efficiency levels in most of the study years, as the increase in inputs corresponded proportionally to the increase in outputs. Consequently, the general trend of scale returns remained constant. However, in the academic year 2022–2023, a decline was observed, indicating decreasing returns to scale during that year.



***Source*: Prepared by the researcher based on the results of SPSS version 25

Fig 6: Variable and constant returns to scale efficiency for the university of Fallujah

Fifth: Analysis of spending efficiency indicators for the university of Anbar according to output orientation

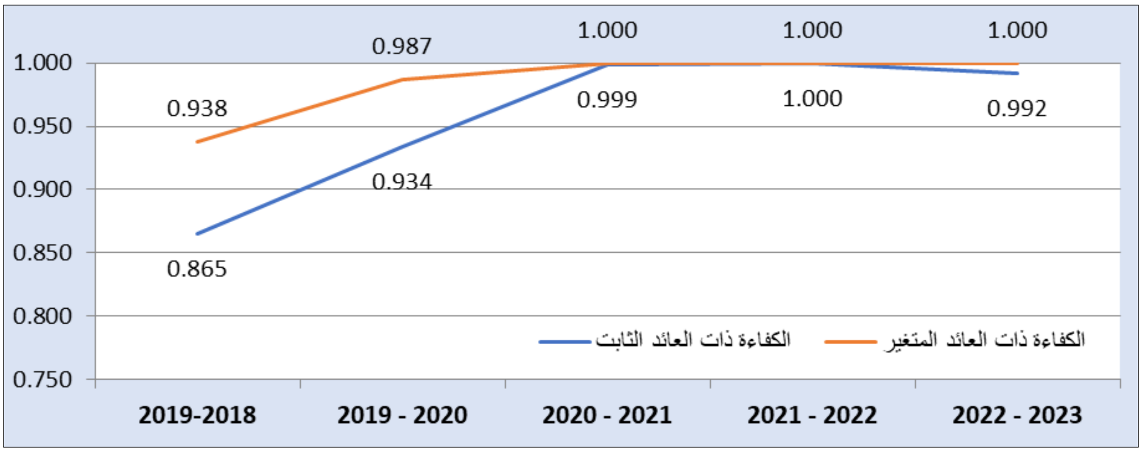
Table (4) presents the technical efficiency results for the University of Anbar during the period 2018–2023, showing both constant and variable returns to scale efficiency scores. The results indicate that constant returns to scale efficiency remained below one throughout the study period, except in the year 2021–2022, when it reached a perfect score of one. This suggests that, in most years, the increase in the university's outputs was less than the increase in its constant inputs, while in 2021–2022 the growth in inputs and outputs was proportionate. Regarding variable returns to scale efficiency, the scores were consistently close to one, and in some years even equaled one, implying that the university was able to utilize its inputs efficiently in certain periods. However, in general, the input growth exceeded the corresponding output growth. Table (4) shows that the optimal efficiency level for the University of Anbar was achieved in the academic year 2021–2022, when both constant and variable efficiency scores equaled one. The overall average scale efficiency during the study period was (0.972), meaning that a 1% increase in inputs led to only a 0.97% increase in outputs. Therefore, the university is advised to reassess its output policies in order to reach optimal scale efficiency and achieve constant returns to scale.

Table 5: Outputs of the data envelopment analysis model for the university of Anbar during the period 2018–2023

University	Year	Constant Returns Efficiency	Variable Returns Efficiency	Scale Efficiency	Returns to Scale
Anbar	2018–2019	0.865	0.938	0.923	Decreasing
Anbar	2019–2020	0.934	0.987	0.947	Decreasing
Anbar	2020–2021	0.999	1.000	0.999	Decreasing
Anbar	2021–2022	1.000	1.000	1.000	Constant
Anbar	2022–2023	0.992	1.000	0.992	Decreasing
Average	—	0.958	0.985	0.972	—

***Source*:** Prepared by the researcher based on the results of the DEAP ver. 2 software for Data Envelopment Analysis.

Figure (7) illustrates the development path of variable and constant returns to scale efficiency for the University of Anbar during the study period. It is evident that the university achieved full efficiency under variable returns to scale during the academic years 2020–2021, 2021–2022, and 2022–2023. This indicates that the increase in inputs at the University of Anbar was proportionate to the increase in its outputs, leading to a general trend of constant returns to scale during these years.



***Source*:** Prepared by the researcher based on the results of SPSS version 25

Fig 7: Variable and constant returns to scale efficiency for the University of anbar

Conclusions and Recommendations

First: Conclusions

1. The study confirmed the validity of the hypothesis indicating a positive impact of government spending on efficiency levels in terms of the optimal utilization of available resources by the selected sample of Iraqi universities.
2. The concept of efficiency is closely tied to the core economic problem of how to allocate limited resources to satisfy the diverse and evolving needs of individuals. Rational public spending is realized through maximizing utility and minimizing costs, meaning that the state's ability to expand public spending should be directly linked to its productive capacity.
3. In most developing countries, including Iraq, public spending does not adhere to the objective conditions required for efficiency. These include: first, ensuring that public expenditure generates benefits that outweigh costs and increases social welfare without diminishing the welfare of others; and second, achieving optimal allocation of public expenditure through intertemporal allocation (between consumption and investment), sectoral allocation (between activities and sectors), and geographical allocation (between regions). The lack of these allocations explains the high levels of waste and poor resource management in these countries.
4. Al-Nahrain University recorded the highest efficiency levels during the study period, with a constant output efficiency score of 1. This indicates that the university could increase its outputs by 1% in response to a 1% increase in inputs, a result attributed to effective

administration and optimal utilization of available inputs to maximize outputs.
5. The University of Fallujah ranked second in scale efficiency, with a value of (0.999). This means that with a 1% increase in inputs, the university achieved a 0.99% increase in outputs. This is a significant level, especially for a newly established institution, and reflects the competence of its administrative leadership.

Second: Recommendations

Based on the application of the Data Envelopment Analysis (DEA) method in measuring the relative efficiency of Iraqi universities, the study offers the following recommendations:

1. It is essential to allocate sufficient funds to meet the needs of higher education by diversifying sources of public revenue through tax system reform and reducing the dependence of education spending on oil revenues.
2. Enhancing spending efficiency in the education sector requires:

a) Increasing the share of education in the general budget by promoting investment spending.
b) Ensuring equity in education spending.
c) Adopting new policies for resource allocation such as infrastructure and teaching staff to achieve equity across provinces and for the most disadvantaged groups.

3. The Ministry of Higher Education and university administrations should investigate the causes of low relative efficiency in some universities and work to address the underlying reasons behind such inefficiencies. Additionally, they should examine the factors that enabled other universities to achieve full efficiency and use them as applicable models for less efficient universities to follow in order to reach full relative efficiency.
4. The application of the DEA method provides a clear picture of university performance and its ability to achieve efficiency. It supports government agencies in assessing the status of universities, monitoring their performance, and identifying efficient institutions that can serve as benchmarks.
5. Universities that have not achieved full output efficiency can consider Al-Nahrain University as a reference model and learn from its input management strategies in order to attain full output efficiency.

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