

Regional Economic Efficiency In South Sumatera, 2024-2025: A DEA Approach

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ABSTRACT

This study aims to analyze the technical efficiency and scale efficiency of regional economic performance across regencies/cities in South Sumatra Province during 2024-2025 using the Data Envelopment Analysis (DEA) method. This study applies a quantitative approach, with 17 regencies/cities treated as Decision Making Units (DMUs). The input variables include household consumption, government expenditure, investment, and net exports, while the output variable is Gross Regional Domestic Product (GRDP). The findings show that, under the CRS model, the number of efficient regions increased from five in 2024 to six in 2025. Meanwhile, the VRS results indicate that several regions were purely technically efficient but had not yet achieved scale efficiency. Muara Enim, Musi Banyuasin, PALI, Palembang, and Pagar Alam were consistently efficient. DEA projections also reveal that several regions still have potential to improve GRDP, particularly Empat Lawang, Prabumulih, Ogan Komering Ulu, Musi Rawas Utara, and OKU Timur. These findings indicate that regional economic development policies should be directed toward optimizing economic inputs, adjusting the scale of operation, and using benchmarks as a basis for evidence-based policymaking.

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Introduction

Regional economic development is a process intended to improve public welfare. It is an essential component of national development because regions play a direct role in managing economic potential, formulating development priorities, and optimizing resource allocation according to their territorial characteristics. In regional economics, development is not merely related to increasing economic output, but also to a region's capacity to manage resources, strengthen intersectoral linkages, and promote a more balanced distribution of economic activity. Regional economics positions territory as an economic space in which production, consumption, investment, resource mobility, and interregional interactions shape regional income (Richardson, 2001).

One of the main indicators used to assess regional economic performance is Gross Regional Domestic Product (GRDP). GRDP represents the value added of goods and services generated by various economic activities in a region during a given period. It can be used to measure regional economic growth, understand the direction and strength of

regional economies, and serve as a basis for regional economic policymaking (Crisandy et al., 2024). Under the expenditure approach, GRDP formation is influenced by several components, including household consumption, investment, government expenditure, and net exports. The interaction among these components shapes regional economic activity and, subsequently, the rate of regional economic growth.

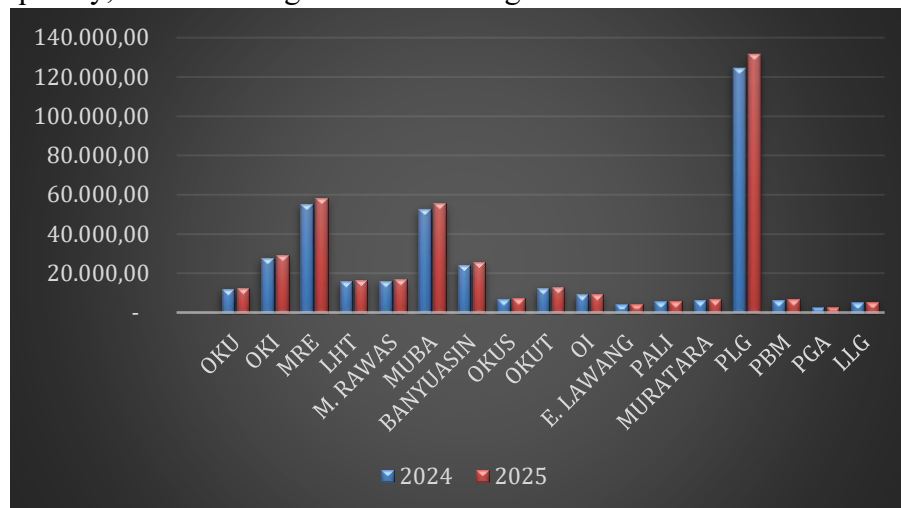


Figure 1. GRDP of Regencies/Cities in South Sumatra Province, 2024-2025

Differences in regional economic capacity in South Sumatra can be observed from the development of regency/city GRDP in 2024-2025. As shown in Figure 1, Palembang recorded the highest GRDP, followed by Muara Enim and Musi Banyuasin, while several regions such as Pagar Alam, Lubuk Linggau, PALI, and Empat Lawang recorded relatively lower GRDP values. These differences indicate substantial variation in regional economic output.

However, a high GRDP does not necessarily indicate that a region operates efficiently. A region with a high GRDP may use a large amount of economic input, whereas a region with a lower GRDP may be considered efficient if it produces output proportionally to the inputs used. Therefore, regional economic performance should be assessed not only by output magnitude but also by the ability to optimize household consumption, government expenditure, investment, and net exports.

In the context of decentralization and regional autonomy, efficiency is a critical issue because local governments are responsible for managing public resources effectively. Efficient use of regional government resources plays an important role in regional development, particularly because local governments have the authority to formulate policies and allocate budgets based on local needs. Efficiency also reflects the extent to which public resources generate optimal development benefits for society (Paidri et al., 2025).

Studies on local government efficiency have been widely conducted, particularly concerning public expenditure efficiency and regional fiscal performance. Rambe found that the efficiency of regional government expenditure in Indonesia varies, thus requiring a measurement approach that can compare relative performance and identify regions that may serve as references for less efficient regions (Rambe, 2020). Wulan Sari found that

government spending, household consumption, the Human Development Index, and exports have positive and significant effects on GRDP. These findings suggest that improved regional economic performance is closely related to the effective use of the components that form GRDP. Therefore, efficiency analysis is needed to evaluate the extent to which economic inputs, such as household consumption, government expenditure, investment, and net exports, can generate regional output optimally (Sari et al., 2025).

Data Envelopment Analysis (DEA) is relevant for regional efficiency studies because it can measure the relative efficiency of decision-making units with multiple inputs and outputs. Yanti and Kustiani explain that DEA is appropriate for measuring government entity efficiency because the public sector generally has a multi-input and multi-output character in public service provision (Yanti & Kustianti, 2016).

In a previous study in South Sumatra Province, regional economic performance efficiency was measured using consumption, government expenditure, investment, and net exports as inputs, and GRDP as output. The results showed that five regions achieved perfect efficiency: Muara Enim Regency, Musi Banyuasin Regency, Penukal Abab Lematang Ilir Regency, Palembang City, and Pagar Alam City, while other regions demonstrated lower levels of efficiency (Desmanita et al., 2025).

Table 1. Initial Overview of Regional Economic Performance Efficiency Scores of Regencies/Cities in South Sumatra Province Based on the CRS DEA Model in 2024

Regency/City	Efficiency Score	Category
Lahat	0,844	Inefficient
OKU Timur	0,835	Inefficient
Ogan Komering Ulu	0,802	Inefficient
Muara Enim	1,000	Efficient
Musi Banyuasin	1,000	Efficient
Penukal Abab Lematang Ilir	1,000	Efficient
Palembang	1,000	Efficient
Pagar Alam	1,000	Efficient

The table shows differences in economic performance efficiency across regencies/cities in South Sumatra Province. Regions such as Muara Enim, Musi Banyuasin, Penukal Abab Lematang Ilir, Palembang, and Pagar Alam achieved an efficiency score of 1.000, whereas Lahat, OKU Timur, and Ogan Komering Ulu remained in the inefficient category. This condition indicates that the ability of regions to optimize economic inputs into GRDP output is uneven. Therefore, further analysis is required to examine whether inefficiency is caused by technical weaknesses in input management or by inappropriate regional economic scale.

The limitation of the previous study lies in its use of the Constant Returns to Scale model, which does not fully distinguish whether regional inefficiency is caused by technical weaknesses in input management or by scale mismatch. Aji and Letizia show that an input-oriented Variable Returns to Scale model is relevant at the regency/city level

because regions have different capacities, socioeconomic conditions, and operational scales (Aji & Letizia, 2025).

Regional economic development is not only determined by the availability of resources, but also by the efficiency with which regions transform economic inputs into development outputs. Differences in fiscal capacity, infrastructure, human resources, and economic structure often create disparities in regional economic performance. In this context, efficiency analysis becomes important because high economic growth does not always reflect the optimal use of regional resources. Regions with similar resource capacities may produce different development outcomes due to differences in technical capability, scale of operation, and policy management. Therefore, measuring regional economic efficiency is essential to evaluate how effectively local governments utilize available resources to achieve development objectives.

Data Envelopment Analysis (DEA) has been widely used to evaluate regional efficiency because it enables the assessment of multiple input and output variables simultaneously. Fauzi (2019) explains that DEA is relevant for evaluating public-sector and regional performance through an input-output approach that measures the relative efficiency of decision-making units. However, many previous DEA studies on regional economies tend to focus only on static technical efficiency measurements within a single period and often emphasize efficiency rankings without examining the structural sources of inefficiency. Consequently, existing studies still provide limited explanations regarding whether inefficiency originates from technical managerial problems or from inappropriate scales of regional economic operation.

In addition, previous regional DEA studies generally assume that regions operate independently from one another. In reality, regional economies are interconnected through spatial interactions, economic linkages, labor mobility, infrastructure networks, and unequal development capacities. Olejnik et al. (2021) argue that the assumption of isolated decision-making units in regional efficiency analysis is often unrealistic because interregional relationships influence economic performance and efficiency outcomes. This indicates the need for a broader analytical perspective that places regional efficiency within the context of territorial heterogeneity and interregional interaction.

Another limitation in previous DEA studies is the tendency to interpret benchmarking as a direct replication process from efficient regions to inefficient ones. Such an approach often overlooks differences in local economic structures, institutional capacity, and regional potential. In practice, regional development policies cannot simply duplicate strategies from other regions because each territory has unique socioeconomic characteristics. As a result, efficiency studies require a more contextual policy interpretation in which benchmarking is understood as an adaptive policy-learning process rather than mere imitation.

Based on these gaps, this study develops a more comprehensive regional efficiency analysis by integrating technical efficiency, scale efficiency, intertemporal comparison,

and benchmarking analysis within a single analytical framework. This study compares the efficiency performance of regencies/cities in South Sumatra Province during 2024–2025 using the Data Envelopment Analysis approach. Technical efficiency is measured using the Variable Returns to Scale (VRS) model, while scale efficiency is calculated through a comparison between the Constant Returns to Scale (CRS) and VRS models. Through this approach, the study is able to distinguish regions that are technically and scale efficient, regions that are technically efficient but scale inefficient, and regions that experience inefficiency in both dimensions.

The novelty of this study lies in three main aspects. First, this research integrates technical efficiency and scale efficiency analysis with intertemporal comparison to identify changes and consistency in regional economic performance across years. Second, this study extends DEA analysis beyond efficiency measurement by incorporating territorial and interregional perspectives in interpreting regional economic performance. Third, this study redefines benchmarking in regional policy analysis as an adaptive process based on local economic characteristics, territorial capacity, and regional development potential rather than a direct replication mechanism.

Theoretically, this study contributes to the development of regional economic efficiency literature by strengthening the relevance of DEA within the context of territorial heterogeneity and interregional interaction. This study also broadens the interpretation of efficiency from merely maximizing outputs relative to inputs into evaluating the capacity of local governments to optimize development strategies according to regional characteristics. From a policy perspective, the findings are expected to provide evidence-based references for regional governments in improving resource allocation, strengthening regional competitiveness, and reducing interregional disparities in South Sumatra Province.

Therefore, this study aims to analyze the technical efficiency and scale efficiency of regional economic performance across regencies/cities in South Sumatra Province during 2024–2025 using Data Envelopment Analysis. Specifically, this study measures technical efficiency based on the VRS model, calculates scale efficiency through CRS–VRS comparison, examines efficiency changes across years, and identifies benchmark regions that can serve as adaptive policy references for less efficient regions.

Method

This study uses a quantitative approach with a descriptive-comparative design. The quantitative approach is used because the study measures regional economic performance efficiency scores based on numerical input and output variables. The descriptive design is used to describe the efficiency position of each regency/city in South Sumatra Province, while the comparative design is used to compare efficiency scores across regions and changes in efficiency between 2024 and 2025.

The selection of the 2024–2025 period is based on several considerations. First, the period represents the most recent regional economic data available after the post-pandemic

economic recovery phase, allowing the study to capture the latest dynamics of regional economic performance in South Sumatra Province. Second, the 2024–2025 period reflects a transitional phase of regional development policy in which local governments are increasingly focused on improving fiscal effectiveness, regional competitiveness, and economic resilience. Third, the use of two consecutive years enables the study to identify short-term changes and consistency in regional efficiency performance rather than relying solely on a static single-year analysis.

The variables in this study consist of input and output variables. Input variables represent the economic components used in the process of forming regional output, whereas the output variable represents regional economic performance.

Table 2. Research Variables

Variable Type	Variable	Indicator	Description
Input	Household consumption	Household final consumption expenditure	Represents household consumption activity in the regional economy.
Input	Government expenditure	Government final consumption expenditure	Represents the role of government spending in regional economic activity.
Input	Investment	Gross fixed capital formation/investment	Represents capital formation and regional productive capacity.
Input	Net exports	Exports minus imports	Represents the external trade performance of the region.
Output	GRDP	Gross Regional Domestic Product	Represents regional economic output or regional income.

Conceptually, this study is grounded in regional income theory and regional economic efficiency. Regional income is an important indicator for describing a region's capacity to produce goods and services within a given period. Regional income can be used to examine economic capacity, regional economic structure, and the development of economic activity (Tarigan, 2005). Sjafrizal emphasizes that regional income does not only indicate economic output but can also be used to assess development disparities and interregional economic performance (Sjafrizal, 2012). Regional income is also an important indicator of the success of regional economic development because it reflects the ability of a region to create value added from various economic activities (Sebayang, 2024).

This study analyzes regional economic performance efficiency using Data Envelopment Analysis. DEA was selected because it can measure the relative efficiency of decision-making units that use multiple inputs to produce a given output. In regional economics, DEA is relevant because economic performance cannot be assessed solely by the size of GRDP; it must also be examined through the ability of regions to optimize economic inputs in producing regional output. Regional efficiency studies also emphasize

that DEA can simultaneously compare multiple regions based on various socioeconomic indicators and identify efficient regions as references for inefficient regions (Škare & Rabar, 2014).

GRDP is selected as the output variable based on the concept of regional income, which views GRDP as a measure of value added generated by economic activities in a region. Household consumption, government expenditure, investment, and net exports are used as input variables because these four components are essential elements of the expenditure approach to regional income formation.

The population of this study consists of all regencies/cities in South Sumatra Province. The sampling technique is saturated sampling, meaning that all members of the population are included as research objects. Thus, the sample consists of 17 regencies/cities in South Sumatra Province.

Each regency/city is treated as a Decision Making Unit (DMU). In DEA, a DMU is a unit whose efficiency is evaluated based on its ability to transform inputs into outputs. The use of regencies/cities as DMUs is relevant because each region has economic resources, fiscal capacity, economic structure, and development characteristics that can be compared relatively.

The DMUs in this study are Ogan Komering Ulu Regency, Ogan Komering Ilir Regency, Muara Enim Regency, Lahat Regency, Musi Rawas Regency, Musi Banyuasin Regency, Banyuasin Regency, South OKU Regency, East OKU Regency, Ogan Ilir Regency, Empat Lawang Regency, Penukal Abab Lematang Ilir Regency, Musi Rawas Utara Regency, Palembang City, Prabumulih City, Pagar Alam City, and Lubuk Linggau City.

This study uses secondary data obtained from official publications of Statistics Indonesia (BPS), including BPS of South Sumatra Province and regency/city-level BPS, covering the period 2024–2025. The data include Gross Regional Domestic Product (GRDP) and its expenditure components, namely household consumption, government expenditure, investment, and net exports. The use of official BPS data is intended to ensure data validity, consistency of definitions, and comparability across regions because the data are produced through standardized national statistical procedures. However, this study also recognizes several limitations related to the use of secondary regional data, including the possibility of estimation bias, differences in reporting quality among regions, and the inability of aggregate data to fully capture informal economic activities and institutional factors affecting regional performance.

Data were analyzed using Data Envelopment Analysis. DEA is a non-parametric method based on linear programming used to measure the relative efficiency of a unit based on input and output combinations. DEA constructs an efficiency frontier from best-performing units. Units located on the frontier are categorized as efficient, while those below the frontier are categorized as inefficient. DEA efficiency scores range from 0 to 1, where a score of 1 indicates efficiency and a score below 1 indicates inefficiency (Škare & Rabar, 2014).

In general, DEA measures the relative efficiency of a Decision Making Unit (DMU) based on the ratio of weighted outputs to weighted inputs. According to Fauzi, the general DEA efficiency formulation is expressed as follows (Fauzi, 2019):

$$\max \theta_n = \frac{\sum_{r=1}^s u_r y_{rn}}{\sum_{i=1}^m v_i x_{in}}$$

subject to:

$$0 \leq \frac{\sum_{r=1}^s u_r y_{rn}}{\sum_{i=1}^m v_i x_{in}} \leq 1$$

$$u_r, v_i \geq 0$$

Where θ_n is the efficiency score of the n^{th} DMU, u_r is the weight of output r , v_i is the weight of input i , y_{rn} is the r^{th} output of DMU n , and x_{in} is the i^{th} input of DMU n .

To obtain technical efficiency scores, this study uses an input-oriented DEA model. The CRS or CCR model developed by Charnes, Cooper, and Rhodes is used to measure overall technical efficiency under the constant returns to scale assumption. The CCR/CRS model assumes that changes in input generate proportional changes in output. The input-oriented CRS model can be expressed as:

$$\theta_{CRS}^* = \min_{\lambda, \theta} \theta$$

Subject to:

$$\sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{io}, i = 1, 2, \dots, m$$

$$\sum_{j=1}^n \lambda_j y_{rj} \geq y_{ro}, r = 1, 2, \dots, s$$

$$\lambda_j \geq 0, j = 1, 2, \dots, n$$

The two basic DEA models commonly used are the Charnes-Cooper-Rhodes (CCR) model and the Banker-Charnes-Cooper (BCC) model (Charnes et al., 1978). The CCR model is characterized by constant returns to scale, whereas the BCC model is characterized by variable returns to scale. The VRS or BCC model developed by Banker, Charnes, and Cooper is used to measure pure technical efficiency. This model adds a convexity constraint so that each DMU can be evaluated while considering differences in operating scale (Banker et al., 1984). The input-oriented VRS model is expressed as:

$$\theta_{CRS}^* = \min_{\lambda, \theta} \theta$$

Subject to:

$$\sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{io}, i = 1, 2, \dots, m$$

$$\sum_{j=1}^n \lambda_j y_{rj} \geq y_{ro}, r = 1, 2, \dots, s$$

$$\lambda_j \geq 0, j = 1, 2, \dots, n$$

The constraint:

$$\sum_{j=1}^n \lambda_j = 1$$

The main difference between the VRS/BCC model and the CRS/CCR model. This constraint indicates that a DMU is compared with a combination of other DMUs operating at a comparable scale. Therefore, the VRS model is relevant for regencies/cities because regions differ in economic capacity, territorial structure, population size, investment, and fiscal resources.

Scale efficiency is calculated by comparing CRS and VRS efficiency scores using the following formula:

$$SE = \frac{\theta_{CRS}^*}{\theta_{VRS}^*}$$

Where *SE* denotes scale efficiency, θ_{CRS}^* denotes technical efficiency under the CRS/CCR model, and θ_{VRS}^* denotes pure technical efficiency under the VRS/BCC model. If $SE = 1$, the regency/city operates at an optimal scale. Conversely, if $SE < 1$, the regency/city experiences scale inefficiency. The comparison between CRS and VRS models is used to distinguish whether regional inefficiency is caused by technical weaknesses in input management or by inappropriate economic scale. This approach aligns with the Banker, Charnes, and Cooper model for estimating technical and scale inefficiencies (Škare & Rabar, 2014).

Results and Discussion

The Data Envelopment Analysis results show that the level of regional economic performance efficiency across regencies/cities in South Sumatra Province varies across regions and years. Efficiency was measured using three indicators: CRS, VRS, and scale efficiency. CRS represents overall technical efficiency under the constant returns to scale assumption, VRS represents pure technical efficiency under the variable returns to scale assumption, and scale efficiency is used to determine whether a region operates at an optimal economic scale.

Based on the data processing results (Table 3), five regencies/cities were efficient under the CRS model in 2024: Muara Enim, Musi Banyuasin, PALI, Palembang, and Pagar Alam. These five regions obtained a CRS score of 1.000. Meanwhile, 12 other regencies/cities remained inefficient. The lowest CRS scores in 2024 were recorded by Ogan Komering Ulu at 0.802, OKU Timur at 0.835, and Lahat at 0.844. This indicates that most regencies/cities had not achieved overall technical efficiency in transforming economic inputs into GRDP output.

Table 3. Technical Efficiency and Scale Efficiency of Economic Performance of Regencies/Cities in South Sumatra Province, 2024-2025

Regency/City	CRS 2024	VRS 2024	SE 2024	CRS 2025	VRS 2025	SE 2025
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Ogan Komering Ulu	0.802	0.973	0.825	0.837	0.946	0.885
Ogan Komering Ilir	0.939	0.989	0.949	0.978	0.993	0.985
Muara Enim	1.000	1.000	1.000	1.000	1.000	1.000
Lahat	0.844	1.000	0.844	0.930	1.000	0.930
Musi Rawas	0.944	1.000	0.944	0.979	1.000	0.979
Musi Banyuasin	1.000	1.000	1.000	1.000	1.000	1.000
Banyuasin	0.917	0.992	0.924	0.939	0.991	0.948
OKU Selatan	0.946	1.000	0.946	0.977	1.000	0.977
OKU Timur	0.835	0.978	0.854	0.883	0.969	0.912
Ogan Ilir	0.897	0.958	0.936	1.000	1.000	1.000
Empat Lawang	0.983	1.000	0.983	0.765	0.868	0.882
Penukal Abab Lematang Ilir	1.000	1.000	1.000	1.000	1.000	1.000
Musi Rawas Utara	0.852	0.929	0.917	0.869	0.955	0.911
Palembang	1.000	1.000	1.000	1.000	1.000	1.000
Prabumulih	0.898	1.000	0.898	0.919	0.941	0.977
Pagar Alam	1.000	1.000	1.000	1.000	1.000	1.000
Lubuk Linggau	0.936	1.000	0.936	0.948	1.000	0.928

This condition may be associated with differences in regional economic structure, fiscal capacity, and the dominance of leading sectors that support economic productivity. Muara Enim, Musi Banyuasin, and PALI are regions with strong contributions from the mining and energy sectors, which tend to generate high regional income and fiscal capacity. Strong fiscal capacity enables local governments to support infrastructure development, public services, and investment facilitation more effectively, thereby improving economic productivity. Meanwhile, Palembang as the provincial capital benefits from urban agglomeration effects, concentration of trade and service activities, better infrastructure availability, and higher investment flows compared to other regions. Pagar Alam's efficiency may also reflect the relatively focused utilization of regional resources and smaller economic scale, allowing more optimal management of inputs relative to outputs.

In contrast, regions with low CRS scores such as Ogan Komering Ulu, OKU Timur, and Lahat indicate that economic inputs had not yet been transformed efficiently into regional output. This inefficiency may reflect structural challenges, including dependence on primary sectors with lower value-added productivity, limited industrial diversification, uneven infrastructure quality, and weaker fiscal capacity compared to more efficient regions. In several regencies, relatively high government expenditure and development inputs may not have been accompanied by proportional increases in regional productivity and economic output.

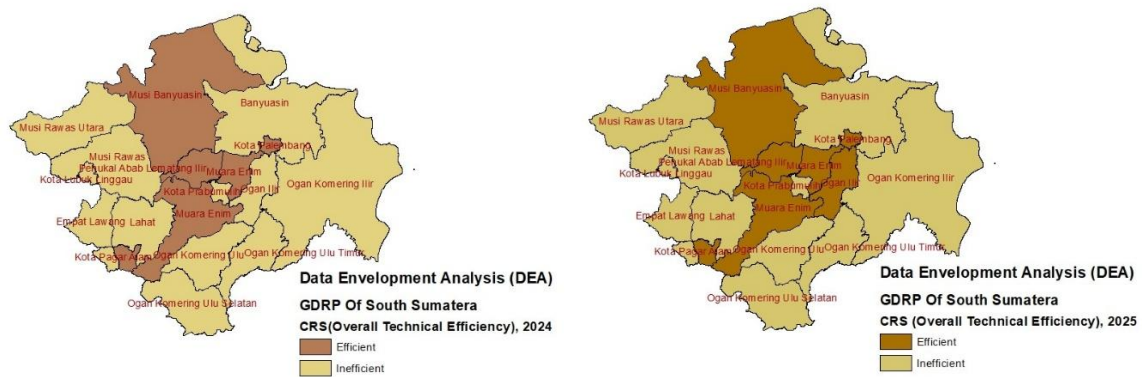


Figure 2. Spatial Distribution of Overall Technical Efficiency Based on the CRS Model in South Sumatra Province, 2024-2025

In 2025, the number of efficient regions under the CRS model increased to six: Muara Enim, Musi Banyuasin, Ogan Ilir, PALI, Palembang, and Pagar Alam. Ogan Ilir showed the most notable improvement, with its CRS score increasing from 0.897 in 2024 to 1.000 in 2025. This indicates an improvement in overall technical efficiency. However, Empat Lawang experienced a substantial decline, from a CRS score of 0.983 in 2024 to 0.765 in 2025.

The spatial distribution of overall technical efficiency based on the CRS model in 2024 and 2025 indicates that regional economic efficiency in South Sumatra Province is closely related to geographical location, economic connectivity, and disparities in regional development capacity. Efficient regions tend to be concentrated in areas with stronger infrastructure networks, better accessibility, higher investment concentration, and stronger linkages to strategic economic sectors such as mining, trade, and services. Regions located near growth centers such as Palembang generally benefit from urban agglomeration effects, including easier market access, labor mobility, logistics connectivity, and greater circulation of goods and services. In contrast, regions with lower efficiency are often characterized by limited infrastructure connectivity, dependence on primary sectors with lower value-added productivity, and weaker integration into regional economic networks. These spatial differences suggest that regional efficiency is influenced not only by internal resource management but also by interregional economic interactions and unequal territorial development. Therefore, the efficiency gap among regencies/cities in South Sumatra reflects broader structural disparities in infrastructure, accessibility, and regional economic integration.

The VRS results show a different pattern from the CRS results. In 2024, 11 regencies/cities were efficient under the VRS model: Muara Enim, Lahat, Musi Rawas, Musi Banyuasin, OKU Selatan, Empat Lawang, PALI, Palembang, Prabumulih, Pagar Alam, and Lubuk Linggau. This number is higher than that under the CRS model. It indicates that several regions were actually purely technically efficient but remained inefficient overall because they had not yet reached an optimal economic scale.

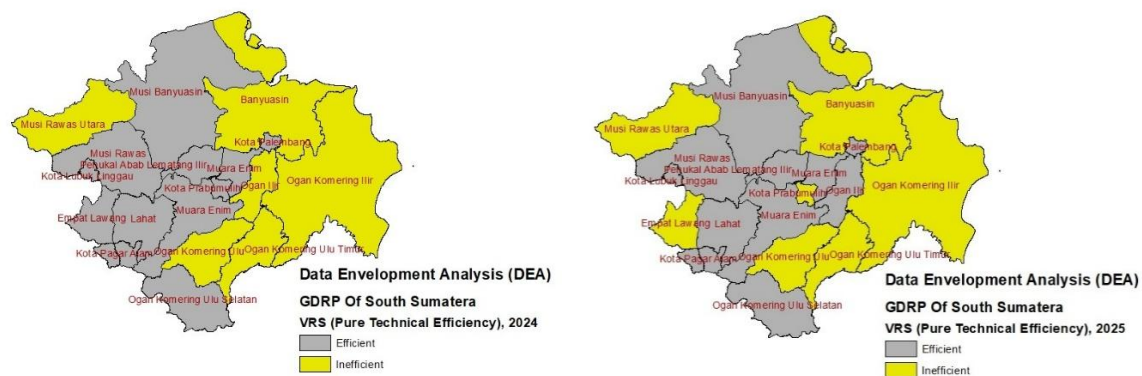


Figure 3. Spatial Distribution of Pure Technical Efficiency Based on the VRS Model in South Sumatra Province, 2024 -2025

In 2025, the VRS map shows a slight change in efficiency distribution. Ogan Ilir entered the efficient category, while Empat Lawang and Prabumulih were no longer categorized as purely technically efficient. This change indicates that pure technical efficiency is dynamic and may shift according to the ability of regions to manage economic inputs from year to year. The VRS map also shows that several regions have sufficient technical capacity to transform economic inputs into GRDP output, although not all of them have achieved overall technical efficiency and scale efficiency.

The number of efficient regions under the VRS model in 2025 was 10: Muara Enim, Lahat, Musi Rawas, Musi Banyuasin, OKU Selatan, Ogan Ilir, PALI, Palembang, Pagar Alam, and Lubuk Linggau. Prabumulih and Empat Lawang, which were efficient under VRS in 2024, declined in 2025. Prabumulih decreased from 1.000 to 0.941, while Empat Lawang declined from 1.000 to 0.868.

Scale efficiency indicates whether a regency/city operates at an optimal economic scale. In 2024, five regions achieved scale efficiency: Muara Enim, Musi Banyuasin, PALI, Palembang, and Pagar Alam. These regions obtained scale scores of 1.000. In 2025, the number of scale-efficient regions increased to six: Muara Enim, Musi Banyuasin, Ogan Ilir, PALI, Palembang, and Pagar Alam.

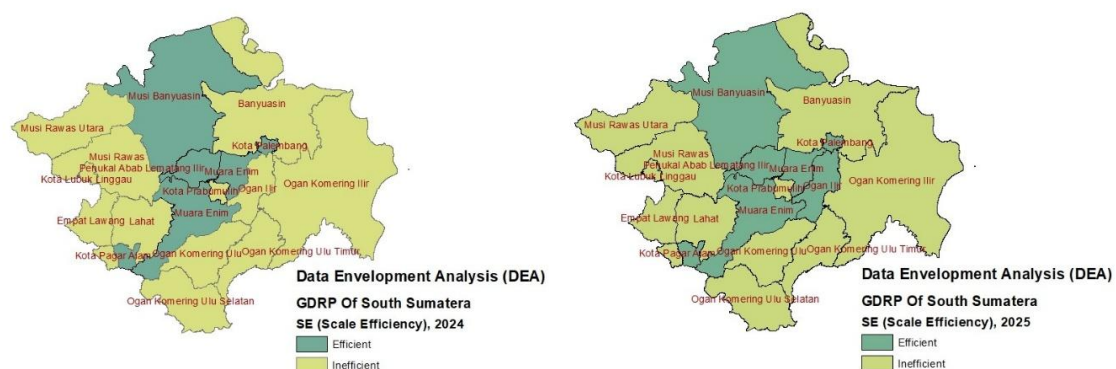


Figure 4. Spatial Distribution of Scale Efficiency in South Sumatra Province, 2024 - 2025

In 2025, the scale efficiency map shows improvement with the inclusion of Ogan Ilir as a scale-efficient region. This indicates that Ogan Ilir improved not only in overall technical efficiency and pure technical efficiency but also reached an optimal economic scale. However, most other regions remained scale inefficient, implying room for improvement in economic capacity adjustment and input optimization.

Thus, the scale efficiency maps for 2024 and 2025 strengthen the finding that regional economic efficiency in South Sumatra Province is related to two main aspects: technical capability in managing inputs and the suitability of economic operating scale. Measuring technical efficiency and scale efficiency through DEA is important for identifying productivity improvement space and formulating more targeted policy interventions (Boakye et al., 2024). Scale-inefficient regions need policies that strengthen economic capacity, expand productive activities, and improve intersectoral linkages so that economic inputs can generate GRDP output more optimally.

Table 4. Projected GRDP Improvement of Regencies/Cities in South Sumatra Province Based on DEA Results, 2024-2025

Regency/City	Original Value 2024	Projected Value 2024	Radial Movement	Percentage of GRDP Improvement	Original Value 2025	Projected Value 2025	Radial Movement	Percentage of GRDP Improvement
Ogan Komering Ulu	11,798	12,127	329	2.79%	12,417	13,126	709	5.71%
Ogan Komering Ilir	27,723	28,019	296	1.07%	29,172	29,380	208	0.71%
Muara Enim	55,305	55,305	0	0.00%	58,300	58,300	0	0.00%
Lahat	15,645	15,645	0	0.00%	16,508	16,508	0	0.00%
Musi Rawas	15,942	15,942	0	0.00%	16,699	16,699	0	0.00%
Musi Banyuasin	52,754	52,754	0	0.00%	55,448	55,448	0	0.00%
Banyuasin	24,184	24,378	194	0.80%	25,464	25,695	231	0.91%
OKU Selatan	6,828	6,828	0	0.00%	7,177	7,177	0	0.00%
OKU Timur	12,285	12,563	278	2.26%	12,986	13,402	416	3.20%
Ogan Ilir	8,955	9,344	389	4.35%	9,399	9,399	0	0.00%
Empat Lawang	4,122	4,122	0	0.00%	4,341	5,004	663	15.27%
Penukal Abab Lematang Ilir	5,530	5,530	0	0.00%	5,807	5,807	0	0.00%
Musi Rawas Utara	6,501	7,000	499	7.67%	6,828	7,153	325	4.76%
Palembang	124,671	124,671	0	0.00%	131,646	131,646	0	0.00%
Prabumulih	6,408	6,408	0	0.00%	6,752	7,177	425	6.29%
Pagar Alam	2,678	2,678	0	0.00%	2,819	2,819	0	0.00%
Lubuk Linggau	5,105	5,105	0	0.00%	5,357	5,357	0	0.00%

The potential productivity improvement can be observed by comparing actual GRDP values (original values) and projected GRDP values based on the DEA results. The difference between the actual and projected values indicates radial movement, namely the amount of output increase that a region can still achieve to approach the efficiency frontier.

The higher the percentage of GRDP improvement, the greater the room for improving regional economic performance.

Based on the DEA projection results (Table 4), several regencies/cities in South Sumatra Province still require GRDP improvement to approach the efficiency frontier. In 2024, the highest required GRDP improvement was recorded by Musi Rawas Utara at 7.67%, followed by Ogan Ilir at 4.35%, Ogan Komering Ulu at 2.79%, OKU Timur at 2.26%, Ogan Komering Ilir at 1.07%, and Banyuasin at 0.80%. In 2025, the highest required GRDP improvement was recorded by Empat Lawang at 15.27%, followed by Prabumulih at 6.29%, Ogan Komering Ulu at 5.71%, Musi Rawas Utara at 4.76%, OKU Timur at 3.20%, Banyuasin at 0.91%, and Ogan Komering Ilir at 0.71%. These figures indicate the extent of output improvement that requires attention from local governments.

Policy recommendations can be directed toward three main agendas. First, regions with a required GRDP improvement above 5%, namely Empat Lawang at 15.27%, Prabumulih at 6.29%, and Ogan Komering Ulu at 5.71%, should prioritize regional spending on programs that directly increase economic activity, such as production-road development, revitalization of local markets, strengthening of MSME clusters, facilitation of investment in leading sectors, and expansion of market access for local products. Second, regions with moderate improvement needs, namely Musi Rawas Utara at 4.76% and OKU Timur at 3.20%, should strengthen downstream processing of local commodities, expand interregional market access, and direct government spending toward productive activities rather than routine expenditure. Third, efficient regions such as Muara Enim, Musi Banyuasin, PALI, Palembang, and Pagar Alam can be used as policy references for managing economic inputs and strengthening leading sectors.

The Government of South Sumatra Province can use DEA results as an instrument for evaluating regional development by utilizing projected GRDP scores, radial movement, and benchmarks as the basis for setting assistance priorities for regencies/cities. Such assistance may include strengthening planning capacity, evaluating expenditure structures, facilitating investment, and coordinating across sectors so that development interventions are more targeted, evidence-based, and aligned with the economic characteristics of each region. Local governments play a strategic role in managing local potential, developing infrastructure, improving regional competitiveness, empowering the community economy, and strengthening synergy with the central government in economic development (Suhardi & Panjaitan, 2025). Furthermore, DEA results also identify benchmark regions for each regency/city. Benchmark information is used to identify comparison units located on the efficiency frontier, thereby serving as an analytical basis for regions that still require improvement in economic performance. The benchmark references for regencies/cities in 2024-2025 are presented in Table 5.

Based on Table 5, benchmark regions in 2024 generally originated from regencies/cities that had reached the efficiency frontier, such as Muara Enim, PALI, Palembang, Musi Banyuasin, and Musi Rawas. Several regions also served as their own benchmarks because they had achieved full efficiency. For example, Ogan Komering Ulu had Muara Enim and PALI as benchmarks, indicating that these regions may provide relevant references for improving regional economic efficiency. However, benchmarking

in this study should not be interpreted as a direct replication of policies or economic structures. The relevance of benchmark regions lies in their ability to demonstrate how available resources, fiscal capacity, and leading sectors can be managed more productively under similar territorial conditions. In practical terms, regions with low efficiency may adopt adaptive strategies from benchmark regions, such as improving investment management, strengthening sectoral productivity, optimizing government expenditure, or enhancing intersectoral economic linkages according to their local characteristics and development capacity.

Table 5. Benchmark References for Regencies/Cities Based on DEA Results, 2024-2025

Regency/City	2024		2025	
	Benchmark 1	Benchmark 2	Benchmark 1	Benchmark 2
Ogan Komering Ulu	Muara Enim	PALI	Muara Enim	PALI
Ogan Komering Ilir	Muara Enim	Palembang	Ogan Ilir	Muara Enim
Muara Enim	Muara Enim		Muara Enim	
Lahat	Lahat		Lahat	
Musi Rawas	Musi Rawas		Musi Rawas	
Musi Banyuasin	Musi Banyuasin		Musi Banyuasin	
Banyuasin	Muara Enim	Musi Rawas	Musi Banyuasin	PALI
OKU Selatan	OKU Selatan		OKU Selatan	
OKU Timur	Muara Enim	Musi Banyuasin	Palembang	Muara Enim
Ogan Ilir	Musi Rawas	Muara Enim		
Empat Lawang	Empat Lawang		PALI	Lahat
PALI	PALI		PALI	
Musi Rawas Utara	Musi Rawas	Lubuk Linggau	Lahat	PALI
Palembang	Palembang		Palembang	
Prabumulih	Prabumulih		OKU Selatan	
Pagar Alam	Pagar Alam		Pagar Alam	
Lubuk Linggau	Lubuk Linggau		Lubuk Linggau	

In 2025, the benchmark pattern changed in line with interregional efficiency dynamics. Ogan Ilir emerged as one of the benchmark regions, particularly for Ogan Komering Ilir together with Muara Enim, after achieving a score of 1.000 in CRS, VRS, and scale efficiency. This finding suggests that regional efficiency is dynamic and may improve when local governments are able to optimize resource allocation and regional economic management. The appearance of Ogan Ilir as a benchmark also indicates that benchmark regions are not exclusively dominated by large or resource-rich regions, but may also emerge from regions capable of improving governance effectiveness and aligning

development strategies with regional potential. Therefore, the benchmark analysis in this study provides evidence-based policy implications by identifying regions that can function as adaptive learning references for less efficient regions, particularly in designing more targeted fiscal policies, strengthening leading sectors, and improving the effectiveness of regional development planning.

Overall, Muara Enim, Musi Banyuasin, PALI, Palembang, and Pagar Alam consistently appeared as efficient regions during the observation period. This consistency places these regions as the main benchmark group because they are able to manage economic inputs proportionally in producing GRDP. In the DEA framework, regions on the efficiency frontier can be used as comparators for regions that still require performance improvement (Pribadi, 2000).

Changes in benchmarks between 2024 and 2025 also indicate that relative efficiency patterns across regions are dynamic. Banyuasin, for instance, referred to Muara Enim and Musi Rawas in 2024, while in 2025 it referred to Musi Banyuasin and PALI. This change indicates that regional efficiency improvement strategies should consider annual developments, territorial characteristics, and changes in the input-output performance of each regency/city.

From a policy perspective, benchmark results can be used as the basis for formulating more targeted improvement strategies. Inefficient local governments can use benchmark regions as comparators in managing consumption, government expenditure, investment, net exports, and GRDP formation. However, the benchmarking process should be adjusted to local characteristics, including economic structure, fiscal capacity, leading sectors, population size, and geographic conditions. Thus, DEA benchmark results can serve as an instrument for interregional policy learning and as a basis for formulating more targeted and evidence-based regional economic development strategies.

Conclusion

This study confirms that regional economic performance efficiency across regencies/cities in South Sumatra Province during 2024–2025 remains uneven and reflects persistent interregional disparities. Under the CRS model, the number of efficient regions increased from five in 2024 to six in 2025 after Ogan Ilir achieved full efficiency. However, the VRS and scale efficiency results indicate that several regions still face structural challenges in optimizing the scale of their economic activities and transforming development inputs into productive regional outputs. Muara Enim, Musi Banyuasin, PALI, Palembang, and Pagar Alam consistently remained on the efficiency frontier and can serve as benchmark regions for less efficient areas. Conversely, several regions in 2025 still required significant GRDP improvement to approach the efficiency frontier, including Empat Lawang at 15.27%, Prabumulih at 6.29%, Ogan Komering Ulu at 5.71%, Musi Rawas Utara at 4.76%, and East OKU at 3.20%. These findings suggest that regional economic efficiency is strongly influenced not only by resource availability, but also by differences in fiscal capacity, regional economic structure, infrastructure connectivity, and the ability of local governments to optimize leading sectors and development strategies.

Theoretically, this study contributes to the regional economic efficiency literature by extending DEA analysis beyond static efficiency measurement and emphasizing the importance of territorial heterogeneity, interregional interaction, and adaptive benchmarking in evaluating regional economic performance. This study also strengthens the perspective that regional efficiency should be interpreted not merely as the ability to maximize outputs from inputs, but as the capacity of regions to manage development resources effectively according to their territorial characteristics and economic potential.

From a policy perspective, these findings highlight the need to reorient regional economic development policies toward interventions that are more productive, measurable, and directly linked to regional output formation. Local governments need to prioritize productive sector spending, strengthen the quality of capital expenditure, accelerate investment facilitation, improve infrastructure connectivity, and expand market access for regional commodities and leading products. Such policy directions are expected to generate more efficient GRDP growth, reduce interregional performance gaps, and strengthen evidence-based regional development planning. Nevertheless, this study has several limitations. First, DEA measures relative efficiency based on observed regions, meaning that efficiency scores are sensitive to sample composition and variable selection. Second, the study relies on secondary regional data that may contain estimation bias and may not fully capture informal economic activities, governance quality, or institutional factors influencing regional performance. Third, the analysis covers only the 2024–2025 period, limiting the ability to observe long-term efficiency dynamics and structural regional transformation. Therefore, future studies are recommended to incorporate longer time-series data, spatial econometric approaches, and additional institutional or governance variables to better explain the determinants of regional efficiency and interregional disparities. Further research may also integrate DEA with spatial analysis or panel data methods to provide a more comprehensive understanding of regional economic performance and development inequality.

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