

Assesing The Efficiency Of Central Java's Regional Budget Realization Using Data Envelopment Analysis

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Abstract: *This study evaluates the efficiency of Central Java's 2022 Regional Budget (APBD) realization using a Variable Returns to Scale (VRS) input-oriented Data Envelopment Analysis (DEA) model. The study analyzes 35 regencies and cities using data from the Central Java Regional Budget Realization Report and Statistics Indonesia (BPS). Inputs include regional expenditure, employee expenditure, goods and services expenditure, capital expenditure, and other expenditures, while outputs consist of Gross Regional Domestic Product (GRDP) and the Human Development Index (HDI). Findings reveal that only 7 out of 35 regions (20%) achieved efficiency due to effective planning, streamlined budget processes, and robust supervision. Meanwhile, 28 regions (80%) exhibited inefficiencies linked to policy inconsistencies, limited planning capacity, and socio-economic constraints. For instance, some regions allocated substantial capital expenditure but failed to utilize funds effectively due to delayed infrastructure projects. These inefficiencies highlight the need for improved coordination, strategic planning, and stronger institutional capacity. Local governments and policymakers should ensure budget allocations align with regional priorities and improve financial management and transparency. Additionally, academics can contribute by providing research-based insights to support policy reforms. Strengthening these aspects will enhance public financial management, promoting sustainable economic growth and human development.*

Keywords: DEA; Fiscal; Efficiency

JEL: H72, G30, O23, E62

1. INTRODUCTION

Performance measurement has been widely applied across various domains, including reporting, management, and budgeting (García Osma et al., 2022). In public administration and financial management, ensuring the efficient use of budgetary resources is crucial for fostering regional development and delivering quality public services. The Annual Budget Realization (APBD) serves as a critical tool for assessing a region's fiscal performance and operational effectiveness, providing insights into how financial resources are allocated and utilized to achieve development objectives. Effective budget management is not just an administrative function but a fundamental component of good governance. It ensures responsible public spending, enhances transparency, builds public trust, and maximizes the benefits derived from financial resources.

Transparency in financial reporting plays a key role in promoting accountability, as access to accurate and reliable financial data strengthens oversight and decision-making (Nawaz & Wagner, 2025). In this context, Central Java, one of Indonesia's most populous and economically significant provinces, offers a compelling case for evaluating budget efficiency. The region is characterized by a high population density, diverse economic activities, and disparities in infrastructure and human development. Given these complexities, understanding how efficiently the 2022 APBD was realized can provide valuable insights into the effectiveness of budgetary allocations in addressing economic and social challenges. By assessing public expenditure efficiency, policymakers can identify existing gaps, set performance benchmarks, and formulate strategies to enhance fiscal management.

The efficient allocation of public resources is essential for achieving socio-economic development (Akbar et al., 2024). Budget performance directly impacts a government's ability to meet fundamental needs, including education, healthcare, infrastructure, and social welfare. Public expenditure effectiveness has been a longstanding focus in the field of public financial management, with researchers emphasizing its role in governance and sustainable development. Prior studies highlight that fiscal efficiency is determined by a combination of factors, including strategic

planning, regulatory frameworks, and institutional capacity. (García Osma et al., 2022) emphasize that performance measurement frameworks enable governments to improve financial management, optimize expenditures, and enhance service delivery.

Several empirical studies have analyzed the efficiency of budget realization in Indonesia at both the provincial and district levels. (Putra, 2020) applied Data Envelopment Analysis (DEA) to assess the efficiency of budget management across regencies in West Kalimantan, finding significant disparities between regions. The study highlighted that cities such as Pontianak exhibited higher efficiency due to better revenue management and expenditure allocation, while other regencies struggled with inefficiencies caused by delayed budget absorption and inadequate supervision.

In Indonesia, regional budgets are allocated across various expenditure categories, including regional expenditure, personnel expenditure, goods and services expenditure, capital expenditure, and other costs. These expenditures aim to produce measurable outputs, such as economic growth—reflected in Gross Regional Domestic Product (GRDP)—and improved social welfare—measured by the Human Development Index (HDI). Empirical studies suggest that achieving efficiency in public financial management requires more than just proper allocation; it also depends on effective supervision, policy consistency, and adaptive governance approaches. Additionally, (Nawaz & Wagner, 2025) argue that information transparency enhances decision-making, particularly in financial management, by ensuring that financial data is accurate and accessible for evaluation.

Amid economic pressures and post-pandemic recovery efforts, the Central Java government has made deliberate attempts to enhance budget efficiency. However, the extent to which these initiatives have yielded tangible improvements remains an open question. This study seeks to evaluate the efficiency of the 2022 APBD realization in Central Java using Data Envelopment Analysis (DEA). Specifically, the research aims to: (1) Assess how effectively budgetary allocations were utilized to support economic and social development. (2) Identify key factors contributing to budget efficiency or inefficiency in different regencies (3) Provide policy recommendations to enhance fiscal management and regional development outcomes. By addressing these questions, this study contributes to the broader discourse on public sector efficiency and governance, offering empirical insights that can guide future budget planning and policy formulation

2. LITERATURE REVIEW

Despite extensive research on public financial management in Indonesia, studies addressing budget realization efficiency at the regional level remain limited. Previous research has often focused on budget effectiveness, analyzing whether targets were met, while neglecting efficiency, which assesses how well resources are utilized to achieve these targets. This gap is particularly evident in studies of Central Java, where disparities in regional development and fiscal performance remain unexplored from an efficiency perspective. Additionally, while the Data Envelopment Analysis (DEA) methodology is widely used to evaluate efficiency in various sectors, its application in regional budget efficiency assessments is sparse. DEA's ability to handle multiple inputs and outputs without requiring a predefined functional form makes it a powerful tool for evaluating the complex and multifaceted nature of public sector activities. This method has successfully been used by (Arora & Talwar, 2020) to calculate the Efficiency of 27 states in allocating public income to public expenditure in India. DEA also has been used by (Sedghi et al., 2025) to analyzes the efficiency of U.S. child welfare agencies using DEA and clustering, focusing on performance benchmarking and improvement. This method also used by (Hadi et al., 2025) when they are analyzes bank branch efficiency using a unified two-stage model, integrating production, profitability, and intermediary perspectives with SBM (Slack-based Model). However, its potential remains underutilized in analyzing APBD realization, especially in regions with diverse socio-economic contexts like Central Java. This study addresses these gaps by applying DEA to evaluate the efficiency of Central Java's budget realization, focusing on both economic outputs (GRDP) and social outcomes (HDI). Similarly, in Indonesia (Dhini Marshela & Khotimah, 2021) found variations in fiscal efficiency among provinces in Java, noting that while Central Java demonstrated relatively effective budget utilization, gaps in capital expenditure execution persisted, limiting infrastructure and public service improvements. These findings emphasize the importance of assessing efficiency to ensure that budget allocations translate into meaningful development outcomes. By identifying both efficient

and inefficient decision-making units (DMUs) among the region's regency and cities, the research provides actionable insights for improving fiscal performance.

This research contributes to the field of public financial management in several ways. First, it integrates efficiency analysis by examining the relationship between inputs (expenditures) and outputs (GRDP and HDI), offering a comprehensive understanding of fiscal performance. Second, the use of DEA introduces a robust and objective framework for evaluating efficiency, employing a variable returns-to-scale (VRS) input-oriented model suited to public sector efficiency assessments. Third, the study provides granular insights at the regency and city levels, highlighting disparities within Central Java and offering tailored recommendations to address specific challenges. Finally, the research contributes to policy discussions by providing evidence-based recommendations for optimizing resource allocation and enhancing public service delivery.

The primary objective of this study is to evaluate the efficiency of Central Java's APBD realization for the fiscal year 2022 using DEA. Specifically, the research aims to assess fiscal efficiency by analyzing budget realization across 35 regency and cities in Central Java, comparing expenditures (inputs) with economic and social outcomes (outputs). It seeks to identify performance benchmarks by determining which regency and cities achieved optimal efficiency, providing a model for other regions to follow. Additionally, the study highlights areas for improvement by identifying inefficiencies in budget realization, offering insights into better planning, coordination, and resource management. Ultimately, the research aims to contribute to sustainable regional development by supporting policymakers in enhancing fiscal performance and improving the quality of life for Central Java's residents.

The structure of this study is organized as follows. The subsequent section reviews relevant literature on budget efficiency and the application of DEA in public finance. Following this, the research methodology is outlined, including the selection of input and output variables and the DEA model used. The results of the efficiency analysis are then presented and discussed, highlighting key findings and their implications for fiscal management in Central Java. The final section concludes with recommendations for improving budget efficiency and suggestions for future research.

By addressing gaps in the literature, offering a novel methodological approach, and focusing on practical policy implications, this study contributes to a deeper understanding of public financial management in Central Java. It also provides a framework for assessing budget efficiency in other regional contexts, ensuring that public resources are utilized effectively to drive sustainable development and improve the well-being of citizens.

3. METHOD

This research evaluates the efficiency of Central Java's 2022 Regional Budget (APBD) realization by employing the Data Envelopment Analysis (DEA) methodology, a non-parametric approach widely used to assess efficiency in converting inputs into outputs. The study utilizes secondary data obtained from the Directorate General of Fiscal Balance and the Central Bureau of Statistics. The data covers all 35 Decision-Making Units (DMUs), representing the regency and cities within Central Java Province. The variables analyzed in this study are categorized into inputs and outputs, reflecting the financial and developmental dimensions of regional governance.

In this study, the Variable Return to Scale (VRS) input-oriented model is employed. The VRS model is chosen over the Constant Returns to Scale (CRS) model because regional governance is influenced by various external factors, such as demographic differences, economic structures, and governance capabilities. Unlike CRS, which assumes that all regions operate at an optimal scale, VRS allows for variations in efficiency due to differences in size and operational conditions. This assumption is particularly relevant in the context of public sector budgeting, where regions may have differing fiscal capacities, economic structures, and policy implementations that affect efficiency.

The input variables include regional expenditure, employee expenditure, goods and services expenditure, capital expenditure, and other expenditures. These inputs are selected because they represent key components of the provincial budget, encompassing the costs incurred to operate public services, invest in infrastructure, and address miscellaneous regional needs. On the other hand, the output variables are Gross Regional Domestic Product (GRDP) and the Human Development Index (HDI). These outputs are chosen to capture the economic and social outcomes

of budgetary allocations. In other words means these two indicators are chosen because they comprehensively capture both economic and social development outcomes. GRDP measures the economic performance of each region, while HDI reflects broader developmental aspects, including health, education, and income levels. Together, these outputs provide a holistic view of regional performance.

The analysis is conducted using DEA, a methodology that evaluates the relative efficiency of DMUs by comparing their inputs and outputs. Data Envelopment Analysis (DEA) is widely recognized in the literature for its ability to provide comprehensive evaluations of performance, based on a limited number of assumptions while incorporating multiple inputs and outputs dimensions (Mergoni et al., 2024). DEA has been used to evaluate performance of Decision Making Units (DMUs) in a variety sectors (Emrouznejad & Yang, 2018) ; (Liu et al., 2013), including banking (Paradi & Zhu, 2013).

DEA is particularly suitable for public sector analysis due to its ability to handle multiple input and output variables without requiring a predefined functional relationship between them. This flexibility makes DEA an ideal tool for assessing the complex and multifaceted nature of public sector activities. In this study, the Variable Return to Scale (VRS) model is employed with an input-oriented approach. The input-oriented approach focuses on minimizing input usage while maintaining output levels, aligning with the goal of optimizing resource use in the public sector.

The DEA model generates efficiency scores for each DMU, indicating how effectively resources are utilized to produce desired outputs. A score of 1.0 indicates that a DMU is efficient, while scores below 1.0 highlight areas of inefficiency. The efficiency scores provide a detailed comparison across the regency and cities in Central Java, identifying regions that achieve optimal performance and those that require improvement. This analysis not only evaluates current efficiency levels but also uncovers potential areas for cost-saving and resource optimization.

The inclusion of GRDP and HDI as output variables ensures that the analysis considers both economic and human development outcomes, aligning with broader development goals. The dual focus allows for a comprehensive understanding of how effectively public funds are being utilized to drive economic growth and improve social welfare. By examining the efficiency of each DMU, the study identifies best practices and areas where inefficiencies occur, offering valuable insights for policymakers.

In summary, this research utilizes secondary data and employs the DEA methodology to evaluate the efficiency of budget realization in Central Java. By analyzing the relationship between expenditures and their resulting economic and social outcomes, the study provides actionable recommendations to improve resource allocation and governance practices, contributing to sustainable regional development. The basic idea in measuring the efficiency of DEA method is to compare the amount of output produced with the input used as written below:

$$\text{Efisiensi} : \frac{\text{Output}}{\text{Input}}$$

The basic objective of the DEA approach is to assign weights to each DMU input and output. These weights fulfill necessary requirements such as being universal, meaning that all DMUs can use the same weights to evaluate their ratio, and do not have negative values with the ratio value having to be less than one (≤ 1). (Niswati, 2014)revealed that there are several advantages and limitations of the DEA method.

The advantages of DEA consist of:

- a) Capable of multiple inputs and multiple outputs
- b) There is no need to consider the relationship between inputs and outputs.
- c) DMUs can be compared directly with similar DMUs.
- d) Able to create an optimal efficiency function frontier line for each input-output variable of each sample.
- e) There may be different units of measurement for inputs and outputs.

The limitations of DEA consist of:

- a) Simple specific
- b) Measurement errors can be fatal and are called extreme point technique
- c) DEA does not measure absolute efficiency
- d) Results from DEA are difficult to perform statistical hypothesis testing.

The DEA method assumes that each DMU will have weights that maximize its efficiency ratio (maximize total weighted output / total weighted input). This is so that distinct output combinations can be produced by each DMU, which requires numerous inputs. According to (Cooper et al., 2007) the following mathematical formula is used:

$$Max Z^k = \frac{\sum_{r=1}^s U_{rk} \cdot Y_{rk}}{\sum_{i=1}^m V_{ik} \cdot X_{ik}}$$

Description:

- Z_k = Efficiency of DMU_k
- m = Input used
- s = Output produced
- U_{rk} = Weight given to output r by DMU_k
- Y_{rk} = Total output r produced by DMU_k
- X_{ik} = Total input i used by DMU_k
- V_{ik} = Weight given to input i by DMU_k

If other DMUs use the weight chosen by the DMU, then the weight chosen must be the DMU that does not have an efficiency value of more than 1 or 100% with the following formula:

$$\frac{\sum_{r=1}^s U_{rk} \cdot Y_{rj}}{\sum_{i=1}^m V_{ik} \cdot X_{ij}} \leq 1; j = 1, 2, 3, 4, \dots, n$$

And the selected weight cannot have a negative value :

$$U_{rk} \geq 0 : r = 1, 2, 3, 4, \dots, s$$

$$V_{ik} \geq 0 : r = 1, 2, 3, 4, \dots, m$$

Description:

- X_{ij} = Total input i used by DMU_j
- Y_{rj} = Total output r produced by DMU_j

Based on the explanation of the equation above, a formula can be obtained that shows the assumption of Variable Return to Scale (VRS), namely:

$$Max Z^k = \sum_{r=1}^s U_{rk} \cdot Y_{rk} + U_0$$

With constraints or limitations:

$$\sum_{r=1}^s U_{rk} \cdot Y_{rj} - \sum_{i=1}^m V_{ik} \cdot X_{ij} \leq 0; j = 1, 2, 3, \dots, n$$

$$\sum_{i=1}^m V_{ik} \cdot X_{ik} = 1$$

$$U_{rk} \geq 0 : r = 1, 2, 3, \dots, s$$

$$V_{ik} \geq 0 : r = 1, 2, 3, \dots, m$$

Several studies have analyzed the efficiency of local government financial management using various methodologies. (Syahriyal et al., 2023) examined the financial efficiency of 23 regencies and cities in Aceh from 2017 to 2021 using Data Envelopment Analysis (DEA). Their census-based study, using secondary data from the Central Bureau of Statistics and audited financial reports, revealed that only four local governments were reasonably efficient, with Langsa City performing best. The study highlighted the importance of meeting critical efficiency standards to enhance output and improve local government performance.

(Cristóbal et al., 2021) analyzed the efficiency of national public spending in achieving Sustainable Development Goals (SDGs) using Data Envelopment Analysis (DEA). It maps government expenditures (inputs) to SDG progress (outputs) and highlights inefficiencies. Findings show that low- and high-income countries are generally efficient, while middle-income countries have significant improvement potential.

(Khaerani et al., 2023) assessed the effectiveness and efficiency of Balikpapan City's budget implementation from 2019 to 2022. Their findings indicated annual variations in efficiency, with 2019 being the least efficient year (95.01%) and 2020 showing higher efficiency (86.96%). While the city's budget implementation met effectiveness criteria overall, the study identified inconsistencies and deviations that require thorough investigation. These findings emphasize the need for corrective measures to address variations in efficiency.

A study conducted by (Stefko et al., 2018) assesses the efficiency of healthcare facilities in Slovakia (2008–2015) using a 4-year window Data Envelopment Analysis (DEA) model. Inputs include medical staff, beds, and technologies (MR, CT), while outputs cover bed use and nursing time. Results show an inverse relationship between variable values and efficiency, with low-variable regions achieving higher efficiency. Notably, adding technological inputs (MR, CT) minimally impacted overall efficiency, highlighting regional disparities in healthcare performance.

Together, these studies highlight the value of DEA in evaluating local government efficiency, the importance of aligning spending with developmental goals, and the necessity of addressing inefficiencies to enhance public financial management and sustainable development outcomes

4. RESULTS AND DISCUSSION

Based on the results of data processing, the efficiency of the APBD in Central Java province in 2022 shows that only 7 DMUs or city districts are efficient, consisting of Cilacap, Pemasang, Kudus, Magelang city, Pekalongan, Salatiga, and Semarang. This indicates that these regions demonstrated optimal budget realization performance, meaning their expenditures effectively contributed to economic and social development during 2022.

Table 1. Result of Efficiency Summary (7 Most Efficient Regency/City)

Firm (Regency/City)	VRSTE (Efficiency Ratio)
Magelang City	1.000
Pekalongan City	1.000
Salatiga City	1.000
Semarang City	1.000
Cilacap Regency	1.000
Kudus Regency	1.000
Pemasang Regency	1.000

The following is the smallest inefficient ratio (VRSTE) with 7 districts, including Banyumas (0.521), Blora (0.509), Brebes (0.608), Demak (0.605), Grobongan (0.587), and Tegal (0.566). The inefficiency in these regions suggests misalignment between budget allocations and regional needs, likely due to poor planning, weak inter-agency collaboration, and issues in project implementation. In particular, budget allocations were often misdirected, leading to an inefficient use of resources that failed to optimize economic and social outcomes.

Table 2. Result of Efficiency Summary (7 Most Inefficient Regency/City)

Firm (Regency/City)	VRSTE (Efficiency Ratio)
Demak Regency	0.605
Grobongan Regency	0.587
Kebumen Regency	0.536
Tegal Regency	0.566
Banyumas Regency	0.521
Blora Regency	0.509
Brebes Regency	0.608

In Data Envelopment Analysis (DEA), a radial move refers to the proportional reduction or adjustment needed in input variables to achieve efficiency while keeping output levels constant. A

high radial move indicates significant inefficiency, meaning that the DMU needs to reduce input usage substantially to reach an efficiency score of 1.0.

For instance, in Blora Regency, the efficiency score is 0.509, meaning that to reach the efficient frontier, Blora must proportionally reduce its expenditures while maintaining the same level of output (GRDP and HDI). The radial move values indicate how much budget reduction is required across different expenditure categories.

Table 3. 2 Most Inefficient Regency/City

Firm by Firm Result:

Regency	Input	Original Value (In Thousands of Rupiah)	Radial Move (In thousands of rupiah)
BLORA	Regional Expenditures	8,670,860	-4,261,608
	Employee Expenditures	517,660	-254,423
	Goods and Services Expenditures	507,670	-249,513
	Other Related Expenditures	510,030	-250,673
BANYUMAS	Regional Expenditures	1,451,370	-695,628
	Employee Expenditures	896,370	-429,622
	Goods and Services Expenditures	479,040	-229,599
	Other Related Expenditures	774,040	-370,990

In the firm by firm result, the regency with the lowest efficiency ratio is DMU 4, which is Blora regency with an efficiency score of only 0.509. Regional expenditure (input 1) must be reduced by Rp. 4,261,608 billion, then goods and services expenditure (input 2) reduced by Rp. 254,423 million, capital expenditure (input 3) reduced by Rp. 249,513 million and other expenditure (input 4) reduced by Rp. 250,673 million to achieve the efficiency level.

The second district with the lowest efficiency ratio is DMU 2, namely Banyumas Regency with an efficiency value of only 0.521. Regional expenditure (input 1) must be reduced by Rp. 659,628, then goods and services expenditure (input 2) reduced by Rp. 429,622 million, capital expenditure (input 3) reduced by Rp. 229,599 million and other expenditure (input 4) reduced by Rp. 370,990 million to reach the efficiency level.

This indicates a significant inefficiency in the use of resources compared to the results obtained, especially in relation to Gross Regional Domestic Product (GRDP) and the Human Development Index (HDI). Central Java Province is one of the regions with a high level of population density and economic activity that faces complex challenges in budget management. This is also influenced by the lack of coordination between government agencies and other stakeholders leading to duplication of programs and initiatives that are not well coordinated as well as unstable social and economic conditions, such as inflation or natural disasters, which can affect the effectiveness of budget use and hinder the achievement of development targets, thus reducing efficiency.

To enhance budget efficiency and address identified inefficiencies, several policy recommendations are proposed. First, local governments should strengthen budget planning and prioritization by implementing a needs-based budgeting system to align expenditures with regional priorities and conducting regional-level financial audits to identify gaps in resource allocation. Second, enhancing human resource capacity is crucial, which can be achieved through budget management training for local government officials to improve financial planning skills and fostering knowledge-sharing programs between efficient and inefficient regencies to adopt best practices. Third, improving coordination among government agencies is necessary to establish a

centralized budget monitoring system that prevents program duplication and enhances transparency, as well as strengthening regional development forums to engage stakeholders in financial decision-making. Fourth, optimizing capital expenditure execution requires developing performance-based incentives for regions demonstrating improved budget efficiency and enforcing strict project timelines and monitoring mechanisms to reduce delays and cost overruns. Lastly, adapting to external economic and geographic constraints is essential by introducing special allocations for infrastructure development in geographically challenging regions and increasing contingency funds to address economic shocks such as inflation or disaster recovery.

To ensure the effective implementation of these recommendations, local governments should integrate efficiency benchmarks into regional financial planning to track progress over time, collaborate with higher government institutions to secure technical and financial assistance in improving budget execution, and leverage technology and data analytics to enhance monitoring, evaluation, and transparency of public expenditures. Furthermore, engaging stakeholders, including community representatives and the private sector, will ensure that budget allocations reflect actual needs. By adopting these measures, local governments in Central Java can enhance budget efficiency, optimize public spending, and improve overall governance, ensuring that fiscal policies effectively support regional economic growth and social development

5. CONCLUSION AND SUGGESTION

CONCLUSION

The analysis of Central Java's 2022 APBD highlights significant disparities in budget efficiency across its 35 districts and cities. While seven regions achieved full efficiency, demonstrating strong planning, streamlined bureaucracy, and effective coordination, 28 regions exhibited inefficiencies due to policy inconsistencies, inadequate infrastructure, outdated technology, and socio-economic constraints. These inefficiencies resulted in misallocated resources, budget wastage, and suboptimal development outcomes. To improve budget efficiency, underperforming regions should adopt structured long-term planning, accelerate infrastructure investment, enhance inter-agency coordination, and increase stakeholder engagement. Strengthening financial literacy among policymakers and integrating data-driven decision-making will also enhance budget allocation effectiveness.

Beyond regional improvements, these findings underscore the need for national fiscal policy reforms. The central government should implement a performance-based fiscal transfer system to reward efficient regions while mandating corrective measures for inefficient ones. Additionally, digital governance tools and real-time budget monitoring systems should be expanded to improve transparency and accountability. By adopting localized and national-level reforms, public financial management can be more strategic, data-driven, and aligned with long-term development goals, ensuring that budgetary resources are maximized to support sustainable economic growth and social equity across Indonesia.

SUGGESTION

The findings emphasize the need for regions to adopt best practices from efficient districts, including detailed needs analysis, streamlined bureaucracy, competent human resources, and enhanced inter-agency coordination. Addressing policy inconsistencies, improving infrastructure, and fostering socio-economic stability are critical for boosting efficiency.

Overall, this study highlights the importance of effective planning and execution in achieving fiscal efficiency. By learning from successful districts and addressing underlying inefficiencies, Central Java's local governments can optimize resource utilization, improve public service delivery, and meet their development goals more effectively. These insights offer valuable guidance for enhancing regional budget management and governance

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