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The Method of Bank Efficiency Analysis: Cost and Profit Function

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Abstract:

Understanding the factors influencing bank efficiency is crucial for maintaining the health of financial institutions and fostering broader economic growth. From a strategic management perspective, suboptimal bank performance often stems from specific internal and external factors, such as inefficiencies in resource management, organizational development, and competitive strategy implementation. Over the past two decades, scholars, practitioners, and policymakers have increasingly focused on analyzing the complexities of bank performance. This study employs a qualitative descriptive approach to provide a comprehensive analysis of bank efficiency, focusing on cost and profit functions. The cost function examines the relationship between input prices and output levels, illustrating that costs vary with changes in output quantity and input prices. Conversely, the profit function assesses how profits are influenced by variations in both input and output prices, offering a more nuanced understanding of how banks can optimize their financial performance. By integrating these two critical functions, the research makes significant contributions to the literature on bank efficiency, providing practical insights for bank management and regulators. It underscores the importance of closely monitoring and optimizing cost and profit functions to ensure sustained efficiency within the banking sector. Additionally, the study advances theoretical understanding by bridging traditional economic models with modern strategic management theories, offering a more holistic view of bank efficiency. The research also suggests avenues for future studies to explore the interplay between cost and profit functions across various banking environments, thereby enhancing both the theoretical and practical knowledge of bank performance.

Keywords: *Bank Efficiency, Cost Function, Profit Function, Strategic Management, Economic Growth*

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1. Introduction

Bank efficiency is a multifaceted concept that plays a critical role in both the financial health of banks and their contribution to broader economic growth (Allen & Gale, 2000; Levine, 2005). It encompasses various aspects of financial performance and operational management, reflecting how well a bank can utilize its resources to generate profits while minimizing costs. Over the past two decades, the scope of bank operations has dramatically transformed due to financial deregulation and market integration, expanding beyond traditional intermediation roles to include a variety of new enterprises (Clark & Siems, 2002). This evolution has introduced new

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complexities in measuring efficiency, as banks now face a wider array of challenges and opportunities.

Understanding the factors that contribute to bank efficiency is essential for both scholars and practitioners, as these factors directly influence the stability and performance of the financial sector. Research has shown that bank efficiency is affected by both internal factors, such as resource management and organizational development, and external factors, including market conditions and regulatory environments. From a strategic management perspective, inefficiencies often arise from deliberate choices or external pressures that lead to suboptimal resource utilization, ineffective competitive strategies, and inadequate organizational development (Coltman, 2007; de Vaz, 2000).

This study aims to deepen our understanding of bank efficiency by analyzing it through the lens of cost and profit functions. The cost function examines the relationship between input prices and output levels, while the profit function assesses how profits are influenced by variations in both input and output prices. By integrating these two functions, the study provides valuable insights into the operational efficiency of banks and offers practical implications for improving strategic management practices within the industry. The paper is structured as follows: Section 2 offers a comprehensive review of the literature on bank efficiency, Section 3 outlines the research methodology, Section 4 presents a detailed analysis of cost and profit functions, and Section 5 concludes with a discussion of the findings and their practical, theoretical, and research implications.

2. Theoretical Background

Bank Efficiency: *Theoretical Perspectives*

Bank efficiency is a critical concept that reflects the operational and financial performance of banking institutions. It is a determinant of how well banks utilize their resources to generate profits, manage risks, and contribute to broader economic stability. The evaluation of bank efficiency has been a central focus in both academic research and practical analysis, leading to the development of two main methodological approaches: the non-structural and structural approaches. Each approach provides distinct insights into the efficiency of banks, and both have their own strengths and limitations.

Non-Structural Approach

The non-structural approach to evaluating bank efficiency primarily utilizes financial ratios derived from banks' financial statements. Commonly used ratios include Return on Equity (ROE), Return on Assets (ROA), and Net Interest Margin (NIM), which are employed to analyze the performance of banks and compare their efficiency across institutions (Badreldin, 2009; Caruntu & Romanescu, 2008; Halkos & Salamouris, 2004). These financial ratios serve as key indicators of profitability, asset utilization, and income generation relative to banks' capital and assets. Additionally, advanced metrics such as Risk-Adjusted Return on Capital (RORAC) and Tobin’s Q, which

incorporates market value, have been introduced to refine the assessment of bank performance by accounting for financial risks and market conditions.

Another widely used metric within the non-structural framework is Economic Value Added (EVA). EVA builds on the concept of opportunity cost by incorporating adjusted earnings and the opportunity cost of capital, offering a more nuanced measure of economic profit (Simanjuntak, 2011). By adjusting traditional profit measures for the cost of capital, EVA provides insights into whether a bank is creating value over and above its cost of capital.

The non-structural approach has been effective in providing a snapshot of bank performance and efficiency. It allows for comparisons across institutions and over time, helping to identify trends and patterns in bank operations. For example, the correlation between profitability ratios like ROE or ROA with strategic choices such as loan expansion, product mix, or responses to macroeconomic shocks can provide valuable insights into the effectiveness of bank strategies.

However, the non-structural approach is not without its limitations. One of the main criticisms is its reliance on standard correlation or regression analysis techniques, which may oversimplify the complexities of bank operations. Financial ratios alone do not offer a systematic explanation or comprehensive theory of bank behavior and performance (Hughes & Mester, 2008). They provide an overall picture of efficiency levels and changes over time but fall short in revealing the specific causes of inefficiency. This limitation can lead to misleading conclusions, particularly when comparing banks with different sizes, product mixes, or market conditions.

Moreover, the non-structural approach does not account for the diverse range of outputs produced by banks, the varying input prices they face, or other external factors that influence their performance. For instance, a bank that appears cost-efficient based on financial ratios may actually have higher cost ratios due to a focus on producing a more expensive bundle of outputs or facing higher input costs. As a result, it may be mistakenly perceived as less efficient (Berger et al., 2009; Simanjuntak, 2011). Furthermore, comparing financial ratios across multiple banks is challenging unless the institutions being compared are nearly identical in terms of size, product mix, market share, and other relevant criteria (DeYoung, 1997).

Structural Approach

In contrast, the structural approach is grounded in neoclassical microeconomic theory and offers a more rigorous and theoretically sound method for analyzing bank efficiency. This approach considers banks as profit-maximizing firms that seek to optimize the allocation of resources to achieve various forms of efficiency: technical, allocative, and economic. Technical efficiency refers to the ability of a bank to produce the maximum output from a given set of inputs or to minimize the inputs required to produce a given level of output. Allocative efficiency, on the other hand, focuses on the optimal combination of inputs and outputs, taking into account their respective prices. Economic efficiency is the broader concept that encompasses both

technical and allocative efficiency, aiming to maximize profit by efficiently allocating inputs and outputs at market prices (Berger & Mester, 1997; Hughes & Mester, 2008).

The structural approach is more comprehensive than the non-structural approach because it incorporates internal organizational factors, external market conditions, and the risks associated with financial intermediation. These risks include credit risk, liquidity risk, market risk, and operational risk, all of which can significantly impact a bank's operational efficiency and profitability. By considering these elements, the structural approach goes beyond purely economic input-output relationships and examines how banks adapt to risks and uncertainties in a dynamic market environment.

For example, credit risk, which relates to the possibility of default by borrowers, can influence a bank's decisions regarding resource allocation and loan portfolio structure. Market risk, involving fluctuations in the prices of financial assets, can impact the assessment of a bank's performance and investment strategies. Similarly, liquidity risk, which pertains to a bank’s ability to meet its short-term obligations, and operational risk, associated with failures in internal processes or systems, are crucial factors that must be considered when evaluating bank efficiency.

The structural approach allows banks to optimize their performance in a more holistic manner. Rather than merely aiming for the highest ratio between outputs and inputs, banks can pursue an optimal blend of inputs and outputs that takes into account the cost of inputs, the prices of outputs, and the risks associated with their activities. This approach recognizes that banks operate in an environment full of uncertainties and risks, necessitating a broader and more flexible framework to accurately analyze efficiency.

One of the strengths of the structural approach is its ability to develop more complex and realistic models that better reflect bank behavior and performance. By integrating principles from modern financial intermediation theory and strategic management, the structural approach offers a more comprehensive view of bank efficiency in a more complex environment. For instance, earlier literature often overemphasized purely input-output relationships derived from microeconomic analysis without considering the influence of risk, internal organizational factors, and external market conditions. However, the modern structural approach acknowledges these factors, making it more resilient and applicable in real-world scenarios.

Furthermore, the structural approach facilitates more relevant comparisons between banks, both within the same time period and across different periods. The efficiency scores generated through structural analysis can reflect how closely a bank's performance aligns with that of the best-performing banks in the industry. These scores provide a valuable tool for bank managers to measure and continuously improve their performance by identifying areas where efficiency can be enhanced. For example, banks that are lagging in efficiency can analyze the practices of frontier

banks—those operating at the highest level of efficiency—and implement strategies to close the efficiency gap.

Moreover, the structural approach is better suited for capturing the dynamic nature of bank operations. Banks do not operate in a vacuum; they are influenced by a range of external factors such as changes in regulatory environments, macroeconomic conditions, and technological advancements. The structural approach allows for the incorporation of these variables into the efficiency analysis, providing a more accurate representation of a bank's performance over time.

Comparative Analysis: Non-Structural vs. Structural Approaches

While both the non-structural and structural approaches offer valuable insights into bank efficiency, they serve different purposes and are suited to different types of analysis. The non-structural approach is simpler to apply and is particularly useful for benchmarking and comparing banks on a relative basis. It provides quick and accessible insights into the financial health and performance of banks through the use of commonly available financial ratios. However, its simplicity comes at the cost of theoretical depth and the ability to account for the complexities and nuances of bank operations.

In contrast, the structural approach is more theoretically grounded and comprehensive, allowing for a deeper understanding of the factors that drive bank efficiency. It incorporates a wider range of variables, including risks and external factors, and is capable of generating efficiency scores that can be used for more meaningful comparisons across different contexts. However, the structural approach is also more complex and requires a more detailed understanding of economic theory and statistical methods.

The choice between these two approaches depends on the specific objectives of the analysis. For instance, if the goal is to quickly assess the financial performance of a large number of banks and compare them on a relative basis, the non-structural approach may be more appropriate. On the other hand, if the objective is to gain a deeper understanding of the underlying factors that influence bank efficiency and to develop strategies for improving performance, the structural approach is likely to be more effective.

From the above discussion it can be summarized that the evaluation of bank efficiency is a complex and multifaceted task that requires careful consideration of both methodological approaches. The non-structural approach provides a useful starting point for assessing bank performance, offering accessible insights through financial ratios. However, its limitations in capturing the full complexity of bank operations and its reliance on standard analytical techniques make it less suitable for more in-depth analysis.

The structural approach, on the other hand, offers a more comprehensive and theoretically robust framework for analyzing bank efficiency. By incorporating a

broader range of variables, including risks, internal organizational factors, and external market conditions, the structural approach provides deeper insights into how banks can operate more efficiently in the face of various challenges within the financial industry. As the banking sector continues to evolve, the structural approach is likely to play an increasingly important role in guiding both academic research and practical decision-making in the pursuit of greater bank efficiency.

This integrated literature review highlights the importance of selecting the appropriate methodological approach based on the specific objectives of the analysis. It also underscores the need for continuous refinement and development of efficiency analysis models to keep pace with the changing dynamics of the banking industry

3. Methodology

This research employs a qualitative descriptive approach designed to provide a comprehensive and detailed analysis of bank efficiency through the lens of cost and profit functions. The primary objective of this research is to offer a factual and nuanced description of the factors influencing bank efficiency, without relying heavily on pre-existing theoretical frameworks. Instead, the study seeks to explore the intricacies of bank operations by examining empirical issues within specific settings using case studies. This approach enables a more focused and context-specific investigation, allowing for a deeper understanding of the subject matter.

The descriptive method is particularly well-suited for this type of research as it allows for a thorough examination of phenomena that may not be fully captured through quantitative methods alone. By utilizing qualitative techniques, the study is able to identify patterns, relationships, and underlying factors that influence bank efficiency. Secondary data, primarily obtained from existing literature on bank efficiency and related concepts, forms the foundation of the study's methodology. The data are meticulously sorted, selected, and connected to the research questions, ensuring that the analysis is both relevant and comprehensive.

An inductive approach is employed in this study, starting with specific observations and individual facts, and gradually building towards broader generalizations. This method allows for the extrapolation of findings to more general principles, contributing both theoretically and practically to the field. By developing methods that can be applied to various market conditions and different banks, the research aims to enhance the understanding of how cost and profit functions can be utilized to measure and improve bank efficiency. This comprehensive approach not only provides insights into current practices but also offers guidance for future research and practical applications in the banking industry.

4. Empirical Findings/Result

Production Function and Its Limitations

The production function is a fundamental tool in economic analysis, serving as the basis for evaluating the technical efficiency of firms, including banks. It describes the relationship between the inputs used in the production process and the output generated. In its general form, the production function can be expressed as:

$$Y = f(x_1, x_2, \ldots, x_n) \quad (1)$$

Where:

- y represents the total output produced,
- $x_1, x_2, \ldots, x_n$ represent the different inputs utilized in the production process, such as labor, capital, and raw materials.

This equation reflects the maximum possible output (y) that a firm can produce given a set of inputs. It is instrumental in assessing the technical efficiency of the firm, which is the ability to achieve the maximum output from a given amount of inputs.

However, the production function has inherent limitations when used in isolation for analyzing economic efficiency. While it effectively captures the technical relationship between inputs and outputs, it does not consider the economic aspects such as input prices and output prices, and values. Without including these factors, the analysis falls short in evaluating the cost efficiency and profitability of the firm, which are crucial for determining overall economic performance.

For instance, a firm might be technically efficient, producing the maximum output possible from the inputs at its disposal. However, if the costs of these inputs are prohibitively high or the market price of the output is low, the firm may still be economically inefficient. This is because the production function does not address the pricing of inputs (x) or the revenue generated from the output (y), both of which are critical for understanding the firm's financial viability.

To gain a comprehensive understanding of a firm's efficiency, it is necessary to complement the production function with additional economic functions that account for the cost of inputs (i.e cost function) and the pricing of outputs (profit function). These additional analyses enable firms to optimize their operations not only in terms of producing the maximum output but also in terms of minimizing costs and maximizing profits.

In summary, while the production function provides a valuable framework for understanding the technical efficiency of a firm, its limitations necessitate the inclusion of cost and profit considerations for a full economic efficiency analysis. This paper will proceed to explore these additional aspects through the examination of cost and profit functions in the context of bank efficiency, offering a more holistic approach to understanding how banks can optimize their operations for better financial performance and sustainability.

Cost Function Analysis

The cost function is a critical tool in analyzing the economic efficiency of banks. This function represents the relationship between the input prices faced by banks and the output levels they produce, and its properties are essential for understanding how banks can minimize costs while maintaining desired output levels (Coelli et al., 2005; Jehle & Reny, 2000). The four basic properties of the cost function—non-negativity, non-decreasing in input prices, non-decreasing in output, and homogeneity of degree one—provide a strong foundation for assessing bank cost efficiency.
The cost function can be expressed as follows:

$$C = c(y_k, r_i) = f(y_1, y_2, y_3,\ldots,y_k; r_1, r_2, r_3,\ldots, r_i) \quad (2)$$

Where:

- C is the total cost,
- $y = (y_1, y_2, y_3,\ldots, y_k)$ is the vector of outputs produced by the bank, and
- $r = (r_1, r_2, r_3,\ldots, r_i)$ is the vector of input prices faced by the bank.

The basic properties of the cost function are as follows:

1. **Non-negativity:** Costs can never be negative, $C \geq 0$
2. **Non-decreasing in r**: An increase in input prices rrr will not decrease costs, assuming other factors are constant.
3. **Non-decreasing in y**: Costs increase as the output level y increases, assuming input prices remain constant. This reflects the idea that producing more output generally requires more inputs, leading to higher costs.
4. **Homogeneous of degree 1 in r**: If all input prices increase by a certain percentage (e.g., 100%), the total cost will increase by the same percentage. This property implies that the cost function is linear in prices when all prices change proportionally.

The primary objective of cost analysis is to determine the minimum cost achievable within a range of technically efficient input-output combinations. From this standpoint, a cost-efficiency study can be utilized to assess how closely a bank's costs align with those of a frontier bank, which is considered the most efficient in producing a similar bundle of products under comparable market conditions (Berger & Mester, 1997).

Further, assuming the cost function meets these properties, it is possible to derive conditional input-demand equations for each input used in the production process. These input demand equations are derived using Shepard's Lemma, which involves taking the partial derivative of the cost function with respect to each input price:

$$xi\ (x, y) = \frac{\partial c(y,r)}{\partial r_i} \quad (3)$$

Where:

- $x_i(y, r)$ represents the demand for the i-th input,
- $c(y, r)$ is the cost function, and
- r_i is the price of the i-th input.

This analysis allows banks to identify the most cost-effective combination of inputs needed to produce a specific level of output, which ultimately can enhance operational efficiency and profitability.

Profit Function Analysis

The profit function extends the analysis of bank efficiency by incorporating output prices, providing a more comprehensive view of how banks can maximize profits given their levels of inputs and outputs. The properties of the profit function—non-increasing in input prices, non-decreasing in output prices, homogeneity of degree one, and non-negativity—are crucial for understanding how banks can optimize their financial performance (Coelli et al., 2005; Jehle & Reny, 2000).

The profit function can be expressed as follows:

$$\Pi = \pi(p_k, r_i) = f(p_1, p_2, p_3,\ldots, p_k; r_1, r_2, r_3,\ldots, r_i) \qquad (4)$$

Where:

- Π represents total profit,
- p = (p1, p2, p3,…, pk) is the vector of output prices, and
- r = (r1, r2, r3,…, ri) is the vector of input prices faced by the bank.

The basic properties of the profit function are:

1. **Non-increasing in r**: An increase in input prices r will not increase profits Π, assuming other factors remain constant.
2. **Non-decreasing in p**: Profits will not decrease when output prices p increase, assuming other factors are constant.
3. **Homogeneous of degree 1 in rrr and ppp:** If all input prices and output prices increase by the same percentage, total profits will also increase by that percentage.
4. **Non-negativity:** Profits cannot be negative, Π≥0.

If the profit function satisfies these properties, Hotelling's Lemma can be employed to derive input demand and output supply equations. The input demand equation is obtained by taking the partial derivative of the profit function with respect to each input price:

$$x_i(p,r) = \frac{\partial \pi(p,r)}{\partial r_i} \qquad (5)$$

The output supply equation is derived by taking the partial derivative of the profit function with respect to each output price:

$$y_k(p,r) = \frac{\partial \pi(p,r)}{\partial p_k} \qquad (6)$$

The goal of profit analysis is to determine the maximum achievable profit from a given set of input-output combinations that are technically efficient. A profit efficiency study measures the proximity of a bank's profit to the profit of a best-practice bank, considering the same output bundle and specific input and output prices (Berger & Mester, 1997).

However, accurately collecting data on output prices can be challenging, and it is not uncommon for banks to experience negative profits, indicating operational losses. In such cases, various forms of the profit function have been used in banking efficiency studies, as seen in the work of Akhavein et al. (1997), Berger & Mester (1997), Casu & Girardone (2003), and DeYoung & Hasan (1998).

Alternatively, the profit function can be reformulated by substituting output quantities and input prices from the right-hand side variables of the cost function into the standard profit function:

$$\Pi_{alt} = \pi(y_k, r_i) = f(y_1, y_2, y_3, \ldots, y_k; r_1, r_2, r_3, \ldots, r_i) \qquad (7)$$

Where:

- Π_{alt} represents alternative profit,
- $y = (y_1, y_2, y_3, \ldots, y_k)$ is the vector of outputs produced by the bank, and
- $r = (r_1, r_2, r_3, \ldots, r_i)$ is the vector of input prices faced by the bank, assumed to be given in a perfectly competitive market.

5. Discussion

The findings from the analysis of cost and profit functions have significant practical implications for bank management and regulatory authorities. For bank management, understanding how costs and profits are influenced by input and output prices enables them to make more informed decisions regarding resource allocation, pricing strategies, and overall operational efficiency. This, in turn, can enhance the bank's competitiveness in the market and its financial stability.

From a regulatory perspective, a deep understanding of cost and profit efficiency can aid in designing policies that promote efficiency in the banking sector. For instance, policies that encourage transparency in input and output pricing or provide incentives for banks to achieve optimal efficiency can contribute to the overall stability of the financial system. Additionally, these findings can serve as evaluation tools in assessing bank health and monitoring risk.

Theoretically, this study contributes to the existing body of knowledge by integrating cost and profit functions into the analysis of bank efficiency. By doing so, it bridges the gap between traditional economic models and modern strategic management theories, providing a more comprehensive framework for understanding how banks operate in complex and dynamic environments. The study also emphasizes the importance of considering both internal and external factors, including risk, in analyzing bank efficiency, thus advancing the theoretical understanding of how banks can optimize their operations.

Furthermore, this research enhances the theoretical discourse on bank efficiency by demonstrating how structural approaches can be applied to different banking contexts, allowing for more accurate and context-specific analyses. The integration of risk

considerations into efficiency analysis offers a more nuanced understanding of bank performance, which is crucial for developing more robust economic theories in the banking sector.

This study opens new avenues for future research by highlighting the importance of incorporating both cost and profit functions in the analysis of bank efficiency. Future studies could further explore the interplay between these functions in different banking environments, such as during financial crises or periods of regulatory change. Additionally, researchers could investigate how different types of risks—credit, market, operational—specifically impact cost and profit efficiency in banks.

Moreover, the methodological approach used in this study, which combines qualitative descriptive analysis with case studies, provides a framework that can be adapted to various banking contexts. Future research could build on this approach by applying it to different regions or types of financial institutions, thereby contributing to a more global understanding of bank efficiency

5. Conclusions

Bank efficiency is a fundamental determinant of financial stability and economic growth. The ability of banks to operate efficiently influences not only their own performance but also the broader economy's health. This study has provided an in-depth analysis of bank efficiency through the dual perspectives of cost and profit functions, offering significant theoretical insights and practical implications. The findings highlight the critical role that cost and profit functions play in enhancing bank performance and underline the importance of these variables in the strategic management of banks.

From a theoretical standpoint, this research underscores the complex interplay between input prices, output levels, and profitability in determining bank efficiency. By focusing on cost and profit functions, the study expands the existing literature on bank efficiency, bridging gaps between traditional economic models and modern strategic management theories. It demonstrates that suboptimal bank performance can often be traced to inefficiencies in resource management, organizational development, and competitive strategy implementation.

These insights contribute to a more nuanced understanding of how banks can optimize their operations, not just technically, but economically, by aligning their cost structures and revenue strategies with market realities.

Practically, the research offers valuable guidance for bank management and regulators. The optimization of cost and profit functions is not merely a theoretical exercise but a practical necessity for ensuring the efficiency and competitiveness of banks. Bank managers are encouraged to closely monitor and adjust their cost structures and pricing strategies in response to changes in input costs and market conditions. Regulators, on the other hand, can use these insights to design policies that

promote transparency in pricing and cost management, thereby fostering a more stable and efficient banking sector. Ensuring that banks operate efficiently is crucial for maintaining their financial health and, by extension, the stability of the broader financial system.

This study also opens up several avenues for further research. Future studies could explore the dynamic aspects of cost and profit functions under varying economic conditions, such as during financial crises or periods of significant regulatory change. Additionally, research could investigate how different types of risks—credit, market, operational—specifically impact bank efficiency and how banks can develop strategies to mitigate these risks while maintaining profitability. Another potential area of research could involve cross-country comparisons of bank efficiency, which would provide insights into how different regulatory environments and market structures influence the cost and profit dynamics of banks.

Recommendations and Future Directions
Based on the findings, several recommendations can be made for bank management and policymakers. Banks should invest in advanced analytical tools and data management systems that allow for real-time monitoring and optimization of cost and profit functions. This would enable more responsive and agile management practices, particularly in rapidly changing market environments. Additionally, there should be a focus on enhancing the skillsets of bank personnel in financial analysis and strategic management to ensure that they are equipped to implement the insights gained from efficiency analysis.

For policymakers, it is recommended that regulatory frameworks be designed to encourage transparency and efficiency in the banking sector. This could include the implementation of reporting standards that require banks to disclose more detailed information about their cost structures and profit strategies, allowing for better oversight and benchmarking of performance across the industry.

In summary, optimizing bank efficiency through careful management of cost and profit functions is essential for enhancing bank performance and ensuring long-term financial stability. By integrating these functions into both strategic planning and regulatory oversight, banks can better navigate the complexities of the modern financial landscape, leading to more robust economic growth and financial stability. Future research should continue to explore these themes, providing deeper insights and more refined strategies for achieving optimal bank efficiency in diverse economic contexts.

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