

Article

Evaluation of Commercial Banks' Interest Rate Policy Efficiency Based on the DEA–SFA Approach

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Abstract: This article investigates methodological approaches to assessing the efficiency of commercial banks' interest rate policy. The main objective of the study is to determine the efficiency of lending and interest income generation through the use of mobilized resources and the management of related costs in commercial banks. The study uses panel data covering 11 commercial banks in Uzbekistan for the period 2015–2024. A multifactor frontier approach was employed to assess the efficiency of interest rate policy, with the volume of deposits, interest expenses, and operating expenses selected as inputs, while the loan portfolio and interest income were selected as outputs. First, the relative efficiency of commercial banks was assessed using the Data Envelopment Analysis (DEA) model. In addition, the Stochastic Frontier Analysis (SFA) model was employed to distinguish random statistical error from the inefficiency component. Based on the complementary characteristics of the DEA and SFA approaches, the study substantiates the possibility of conducting a comprehensive assessment of the efficiency of banks' interest rate policy. The findings indicate that the efficiency of commercial banks' interest rate policy depends not only on the level of lending and deposit interest rates, but also on the effective utilization of mobilized resources, management of interest and operating expenses, and the ability to generate loan portfolios and interest income. The proposed approach provides a methodological basis for assessing and improving interest rate policy in commercial banks based on efficiency criteria.

Citation: Kizi, O. D. O. Evaluation of Commercial Banks' Interest Rate Policy Efficiency Based on the DEA–SFA Approach. American Journal of Economics and Business Management 2026, 9(9), 265-273.

Received: 14th Jun 2026

Revised: 27th Jul 2026

Accepted: 18th Aug 2026

Published: 09th Sep 2026



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Keywords: commercial banks, interest rate policy, interest rate policy efficiency, asset operations, liability operations, deposits, interest expenses, operating expenses, loan portfolio, interest income, DEA, SFA, Data Envelopment Analysis, Stochastic Frontier Analysis, panel data, banking efficiency.

1. Introduction

Today, the effective formulation and management of interest rate policy play an important role in ensuring the stability and competitiveness of commercial banks. Interest rate policy is one of the key instruments for coordinating the economic interests associated with banks' asset and liability operations, managing the cost of mobilized resources, and efficiently allocating credit and other income-generating assets. Therefore, alongside setting interest rates, assessing the efficiency with which mobilized resources are utilized through these rates has become an increasingly important issue [1].

The use of multifactor frontier approaches is of significant scientific and practical importance in the comprehensive assessment of the efficiency of commercial banks' interest rate policy [2]. In particular, while the Data Envelopment Analysis (DEA) model

enables the assessment of banks' relative efficiency, the Stochastic Frontier Analysis (SFA) model makes it possible to distinguish random statistical error from the technical inefficiency component. The combined application of these two approaches provides an opportunity to assess banks' interest rate policy more comprehensively in terms of resource utilization and performance outcomes [3].

The scientific significance of the study lies in the application of a comprehensive methodological approach that enables the efficiency of commercial banks' interest rate policy to be assessed not only through the level of interest rates but also through the efficiency of mobilizing resources, managing their cost, and transforming them into income-generating assets [4].

The Data Envelopment Analysis (DEA) model developed by Charnes, Cooper, and Rhodes makes it possible to evaluate the relative technical efficiency of decision-making units based on multiple input and output indicators. Subsequently, Banker, Charnes, and Cooper proposed the Variable Returns to Scale (VRS) model, which allows pure technical efficiency to be distinguished from scale efficiency. This approach is particularly important in banking research because it enables researchers not only to assess how effectively banks utilize their available resources but also to determine whether banks operate at an optimal scale of activity [5].

The Stochastic Frontier Analysis (SFA) model is also an important methodological tool for investigating bank efficiency. Developed by Aigner, Lovell, and Schmidt and independently by Meeusen and van den Broeck, the SFA approach makes it possible to distinguish technical inefficiency from random statistical noise. In this respect, the combined application of DEA and SFA provides a more comprehensive assessment of banking efficiency by incorporating both the relative efficiency frontier and stochastic factors affecting efficiency [6].

Studies examining the relationship between interest rate policy and banking efficiency emphasize interest rate liberalization, the cost of mobilizing financial resources, and the efficiency of allocating these resources to lending operations as important determinants [7]. In particular, Wu investigated the impact of interest rate liberalization on the efficiency of Chinese commercial banks using a DEA-based approach. Their findings suggest that the effectiveness of interest rate policy should be assessed not only through the level of interest rates but also through the efficiency of resource mobilization and the subsequent allocation and utilization of those resources in banking operations [8].

2. Materials and Methods

The study employs panel data covering 11 commercial banks in Uzbekistan for the period 2015–2024 to evaluate the efficiency of their interest rate policy. The empirical analysis is based on a multifactor frontier approach combining Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA).

For the DEA model, three input variables deposit volume, interest expenses, and operating expenses and two output variables loan portfolio and interest income were selected. The DEA approach was applied under both Variable Returns to Scale (VRS) and Constant Returns to Scale (CRS) assumptions to estimate pure technical and overall technical efficiency, respectively. Scale efficiency and Returns to Scale (RTS) were subsequently analyzed to identify whether banks operated under increasing, constant, or decreasing returns to scale.

To complement the DEA results, the Stochastic Frontier Analysis (SFA) model was employed to estimate technical efficiency while distinguishing random statistical noise from inefficiency. The DEA and SFA results were then jointly considered to obtain a more comprehensive assessment of banks' interest rate policy efficiency.

3. Results and Discussion

The purpose of this study is to assess the efficiency of interest rate policy in commercial banks in Uzbekistan using DEA and SFA models and to determine the efficiency of banks' utilization of available resources. The study employs panel data from 11 commercial banks in Uzbekistan covering the period 2015–2024. To assess the efficiency of banks' interest rate policy, deposit volume, interest expenses, and operating expenses were selected as inputs, while the loan portfolio and interest income were selected as outputs [9].

Table 1. DEA model results

№	Bank	VRS_TE	CRS_TE	SCALE
1	O'zSQB	0.962428	0.893750	0.926878
2	Milliybank	0.956123	0.896646	0.936732
3	Poytaxtbank	0.953956	0.914155	0.954996
4	Ipotekabank	0.883169	0.768250	0.861192
5	Hamkorbank	0.861976	0.702277	0.809617
6	Asakabank	0.859922	0.805838	0.928772
7	Agrobank	0.852508	0.786255	0.910699
8	Xalqbank	0.845013	0.645983	0.775544
9	Mkbank	0.842426	0.741834	0.865025
10	Kapitalbank	0.677264	0.582811	0.846516
11	Garantbank	0.647173	0.590343	0.909818

The DEA analysis shows that Uz sanoat qurilish bank has the highest pure technical efficiency score, indicating that the bank utilizes its existing resources with 96% efficiency. In other words, with the same level of resources, the bank could potentially achieve results that are approximately 4% higher. The lowest score was recorded for Garantbank, which utilizes only approximately 65% of its potential [10].

According to the results of overall technical efficiency (CRS_TE), Poytaxt Bank recorded the highest efficiency score. This means that the bank formed its loan portfolio and interest income with 95% efficiency using attracted deposit resources, interest expenses, and operating expenses [11]. The lowest result was recorded for Kapital Bank at 58%. Its pure technical efficiency (VRS_TE) was 68%. This situation indicates that the efficiency of resource utilization in implementing the bank's interest rate policy is insufficient. In particular, the bank has not fully utilized the potential to generate a loan portfolio and interest income based on its existing deposit base, interest expenses, and operating expenses [12].

According to the results for the SCALE indicator, Poytaxt Bank also recorded a relatively high score of 95%, indicating that the scale of the bank's operations is close to optimal and that there is a high degree of proportionality between the volume of resources and financial outcomes. These results suggest that Poytaxt Bank has established effective management mechanisms for implementing its interest rate policy [13].

One of the distinctive features of the DEA model applied in the study is its ability to determine the returns to scale (RTS) of commercial banks. The results indicate that the effectiveness of banks' interest rate policies depends not only on market interest rates but also on the size of the bank. The econometric results obtained made it possible to classify banks into groups according to their scale:

Table 2. Structural analysis of RTS in Commercial banks, %

№	Bank	Drs	Irs	optimal
1	Agrobank	80	0	20
2	Asakabank	60	30	10
3	Garantbank	100	0	0
4	Hamkorbank	100	0	0
5	Ipotekabank	90	10	0
6	Kapitalbank	90	10	0
7	Milliybank	50	0	50
8	Mkbank	90	0	10
9	O'zSQB	60	0	40
10	Poytaxtbank	33	17	50
11	Xalqbank	100	0	0

The scale efficiency (RTS) of commercial banks was analyzed using the DEA model. The results indicate that decreasing returns to scale (DRS) predominates across a large part of the banking system. In particular, this indicator reached 100% for Garantbank, Hamkorbank, and Xalq Bank, indicating that as the resource base expands, the efficiency of interest rate policy does not increase proportionally in these banks. This situation can be explained by the rising cost of deposit resources, constraints on the efficient allocation of credit resources, and relatively high operating expenses [14].

The analysis also showed that the DRS condition predominates at Kapitalbank and Ipotekabank, accounting for 90%. This indicates that these banks are operating above their optimal scale. Therefore, within the framework of improving their interest rate policies, there is a need to optimize the structure of attracted resources and improve the efficiency of interest expenses [15].

At the same time, Poytaxtbank, Milliybank, and Uzsanoatqurilishbank (UzSQB) demonstrated relatively high shares of the optimal scale condition. In particular, this indicator accounted for 50% at Poytaxtbank and Milliybank, indicating a relatively high degree of proportionality between the scale of these banks' operations and the outcomes of their interest rate policies. In particular, the simultaneous occurrence of increasing returns to scale (IRS) and DRS at Poytaxtbank indicates that the bank is at a stage of development and, during certain periods, has approached its optimal operating scale.

Overall, the results of the analysis indicate that the main challenge to improving the efficiency of interest rate policy in Uzbek commercial banks is not an insufficient resource base, but rather the failure to maintain the resource base at an optimal scale.

Table 3. Average efficiency indicators of commercial banks estimated using the SFA and DEA models

No	Bank	Average DEA efficiency score	SFA technical efficiency score	Overall Efficiency (OE)
1	Poytaxtbank	0,953956	0,571684	0,914155
2	Milliybank	0,956123	0,844082	0,896646
3	O'zSQB	0,962428	0,885324	0,893750
4	Asakabank	0,859922	0,611344	0,805838
5	Agrobank	0,852508	0,472413	0,786255
6	Ipotekabank	0,883169	0,534292	0,768250
7	Mkbank	0,842426	0,421578	0,741834
8	Hamkorbank	0,861976	0,370134	0,702277

No	Bank	Average DEA efficiency score	SFA technical efficiency score	Overall Efficiency (OE)
9	Xalqbank	0,845013	0,316117	0,645983
10	Garantbank	0,647173	0,265651	0,590343
11	Kapitalbank	0,677264	0,220888	0,582811

The table 3 presents the results of a comprehensive assessment of the effectiveness of interest rate policy in commercial banks in Uzbekistan based on DEA, SFA, and overall efficiency (OE) indicators. The analysis demonstrates significant differences in the level of efficiency among the banks.

According to the table, Poytaxtbank recorded the highest level of overall efficiency (OE = 0.914155). The bank also demonstrated a high level of efficiency under the DEA model (0.953956). However, its SFA technical efficiency score (0.571684) was comparatively lower. This indicates that although Poytaxtbank operates relatively efficiently in terms of resource utilization, there are still untapped efficiency reserves from the perspective of the stochastic frontier.

National Bank (OE = 0.896646) and Uzpromstroybank (OE = 0.893750) also ranked among the banks with high efficiency levels. In particular, the DEA efficiency score of National Bank was 0.956123, while its SFA technical efficiency score was 0.844082. These results indicate that the processes of utilizing available resources and transforming them into lending activities and interest income are relatively well organized.

Asakabank, Agrobank, Ipotekabank, and Mikroreditbank fall into the medium-efficiency group. The overall efficiency indicators of these banks ranged from 0.71 to 0.81. This suggests that although the effectiveness of interest rate policy in these banks is at a relatively satisfactory level, there remains potential for further improving the efficiency of resource utilization. In particular, the differences between the DEA and SFA indicators suggest that certain sources of technical inefficiency persist and that there is scope for improving the management and utilization of available resources.

Hamkorbank, Xalq Bank, Garant Bank, and, in particular, Kapitalbank demonstrated relatively lower levels of efficiency. Specifically, Kapitalbank recorded an overall efficiency score of 0.582811, while its DEA (0.677264) and, particularly, SFA (0.220888) efficiency scores were considerably lower. This indicates that the bank has significant potential to improve the efficiency of resource utilization in implementing its interest rate policy. Therefore, greater attention should be paid to optimizing the structure of the resource base, managing interest expenses, and improving the profitability of the loan portfolio.

Overall, the results demonstrate significant differences in the effectiveness of interest rate policy among commercial banks. While banks with higher efficiency levels exhibit relatively greater alignment between resource utilization and interest rate policy outcomes, technical and organizational inefficiencies are more pronounced among banks with lower efficiency levels. The combined application of the DEA and SFA models enables a more comprehensive and in-depth assessment of the effectiveness of interest rate policy in commercial banks.

Another finding of the study is that the effectiveness of interest rate policy in commercial banks was assessed using three indicators SFA, DEA-VRS, and DEA-CRS which demonstrated varying trends over the study period. The DEA-VRS (Variable Returns to Scale) model makes it possible to assess a bank's pure technical efficiency, that is, to isolate the effect of the bank's scale of operations and evaluate its managerial efficiency. The DEA-CRS (Constant Returns to Scale) model, in turn, measures overall technical efficiency and provides an assessment of the bank's overall efficiency level.

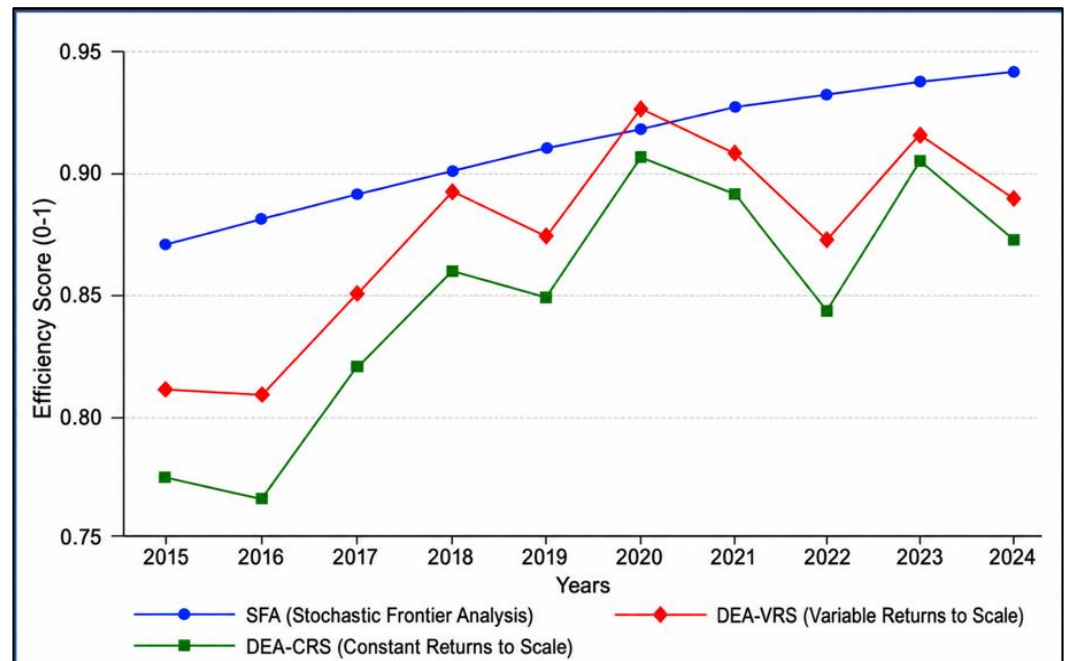


Figure 1. Dynamics of the efficiency of interest rate policy for commercial banks' asset and liability operations (SFA, DEA-VRS, and CRS approaches)

The SFA indicator demonstrates a steady upward trend throughout the study period, which provides empirical evidence that the risk management systems of commercial banks have been continuously improving and that banks have become more adaptable to macroeconomic changes. In addition, the DEA-VRS model made it possible to fairly assess the pure technical efficiency (management quality) of banks in managing their asset and liability operations.

The DEA-VRS indicator recorded its lowest value of 0.75 in 2016, while in 2020 it reached the highest value of 0.93 during the study period. This indicates that, during this period, banks' management decisions were properly organized and that banks were able to create income-generating assets to the maximum extent possible. The downward trend observed after 2023 can be explained by the rapid increase in interest expenses and the decline in profitability.

The fact that the DEA-CRS indicator followed a trend similar to that of the DEA-VRS indicator suggests that these indicators changed under the influence of the same economic processes. In particular, these changes were associated with changes in monetary policy, reforms in the banking system, and increasing competition. An important aspect is that, at the beginning of the study period, the gap between the two indicators was relatively large, while it gradually narrowed toward the end of the period. This indicates that banks' scale of operations and level of resource utilization became more balanced.

Let us examine the results of the analysis conducted using the example of individual banks. For this purpose, we selected Asakabank and Xalq Bank, two of the major banks of the Republic of Uzbekistan, as the subjects of our analysis.

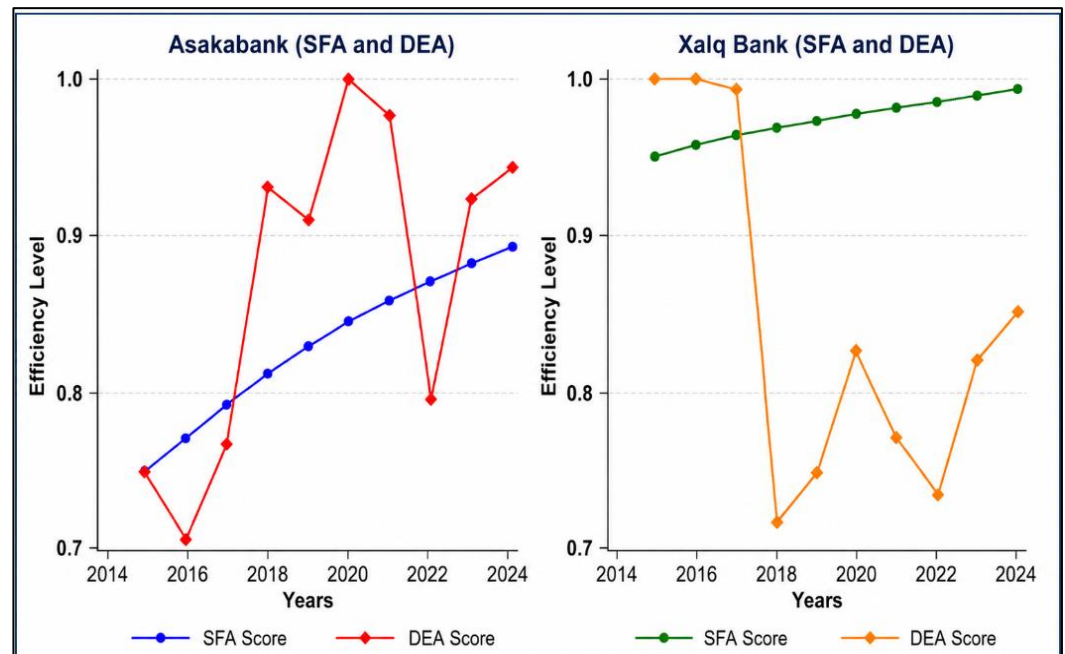


Figure 2. Comparative analysis of the efficiency indicators of Asakabank and Xalqbank

First, focusing on the SFA indicator, Asakabank JSC recorded its lowest value of 0.75 in 2015, while by 2024 it had reached its highest level, at approximately 0.90. A similar trend can be observed for Xalq Bank, where the indicator approached a coefficient of 1.00 by the end of 2024.

This indicates that these commercial banks have established effective interest rate risk management practices in accordance with the stringent requirements of the Central Bank and international standards, particularly Basel III. In other words, despite external influences, the banks have managed to maintain a positive spread between the cost of attracted deposits and the returns generated from issued loans.

The DEA indicator of Xalq Bank was at the level of absolute efficiency (1.00) during 2015–2017; however, it declined sharply to 0.72 in 2018. This period coincided with the systematic reforms aimed at liberalizing interest rates. During this period, the bank's operational management was unable to adapt rapidly enough to the new market conditions. As a result, the interest margin narrowed, leading to a sharp decline in pure technical efficiency. In subsequent years (2019–2024), fluctuations in the indicator were observed, suggesting that management was gradually attempting to transition toward a more market-oriented interest rate policy.

The DEA analysis of Asakabank was considerably more volatile, indicating the bank management's sensitivity to changing market conditions. In particular, during 2017–2020, the bank significantly improved its management efficiency, reaching a level of 1.00. This achievement was most likely attributable to the bank's efforts to attract alternative and less expensive sources of funding instead of relying predominantly on deposits, as well as to expand high-yielding asset operations. However, the decline observed in 2022 indicates that the bank may have encountered challenges related to short-term liquidity or an increase in the cost of funding within its interest rate policy. The subsequent improvement confirms that the bank was able to gradually overcome these difficulties and restore its efficiency.

The continuous optimization of the spread between passive and active operations in line with market requirements, together with the implementation of a flexible interest rate policy, is a fundamental condition for the long-term competitiveness of commercial banks.

One of the distinctive features of the DEA model employed in this study is its ability to determine the Returns to Scale (RTS) of commercial banks. The results demonstrate that the effectiveness of banks' interest rate policies depends not only on market interest rates but also on the scale of the bank's operations. The obtained results make it possible to classify banks into three groups according to their scale efficiency:

1. Banks operating at their optimal scale Constant Returns to Scale (CRS)

According to the analysis, banks such as O'zsanoatqurilishbank and Agrobank are operating close to their optimal scale. These banks demonstrate a relatively high degree of balance between their asset and liability operations. Therefore, rather than focusing primarily on expanding their branch networks, it would be advisable for these banks to emphasize improving the quality of services provided to existing customers, expanding digital technologies, and reducing operating costs.

2. Banks characterized by Decreasing Returns to Scale (DRS)

The analysis revealed that several banks with a significant state ownership share, including National Bank, Asakabank, Ipotekabank, Xalq Bank, Kapitalbank, Mikrokreditbank, and Hamkorbank, operate within the DRS zone. This indicates that these banks possess relatively large resource bases and extensive branch networks, while their ability to manage these resources efficiently and transform them into profitable assets remains comparatively limited.

For these banks, it is advisable to limit the excessive attraction of costly deposits, optimize low-profitability branches, and focus primarily on the quality of the loan portfolio and improvement of the interest margin rather than simply increasing the scale of operations.

3. Banks characterized by Increasing Returns to Scale (IRS)

The results indicate that Garantbank operated under Increasing Returns to Scale (IRS) during the study period, suggesting that the bank has considerable potential to expand its market scale. The bank's management is using its existing resources relatively efficiently; however, its market share remains insufficient.

Accordingly, implementing a more active interest rate policy in passive operations and using it to attract additional resources and expand the scale of operations could contribute to a significant improvement in the bank's overall efficiency.

4. Conclusion

The findings of the study demonstrate that the efficiency of interest rate policy varies considerably across commercial banks in Uzbekistan. The combined application of DEA and SFA models made it possible to assess the ability of banks to transform mobilized resources into loan portfolios and interest income from different perspectives. Overall, banks with higher efficiency levels demonstrated a relatively stronger proportionality between resources and interest policy outcomes, whereas technical and organizational inefficiency factors were more pronounced among less efficient banks. According to the DEA results, Uzsanoatqurilishbank recorded the highest pure technical efficiency, with a coefficient of 0.962428. In terms of overall technical efficiency, Poytaxtbank ranked first with a score of 0.914155. Kapitalbank recorded one of the lowest overall technical efficiency scores among the analyzed banks, at 0.582811. These results indicate that some banks have unused efficiency reserves in terms of resource utilization, interest expense management, and improving the profitability of their loan portfolios. The combined analysis of the SFA and DEA results also confirmed significant differences in efficiency among the banks. Poytaxtbank recorded an overall efficiency score of 0.914155, followed by Milliybank at 0.896646 and Uzsanoatqurilishbank at 0.893750. In contrast, Kapitalbank recorded an overall efficiency score of 0.582811. This indicates the need for certain banks to improve the efficiency of resource utilization, strengthen interest expense management, and increase the profitability of their loan portfolios. The RTS analysis showed that the

efficiency of banks' interest rate policy depends not only on market interest rates but also on the optimal scale of banking operations. A decreasing returns to scale (DRS) effect was predominant among a large proportion of the analyzed banks. This indicates that an expansion of the resource base and operational scale does not necessarily lead to a proportional increase in the efficiency of interest rate policy. Therefore, optimizing the structure of mobilized resources, reducing operating expenses, and efficiently allocating available resources to income-generating assets are necessary. Based on the research findings, improving interest rate policy in commercial banks requires optimization of the cost of deposit resources, effective management of interest and operating expenses, improvement of loan portfolio quality, and market-oriented management of the interest rate spread between asset and liability operations. In particular, for banks characterized by a large resource base but decreasing returns to scale, improving the quality of resource utilization should be prioritized over merely expanding the scale of operations. Thus, the DEA-SFA approach can be considered an effective methodological tool for comprehensively assessing the efficiency of commercial banks' interest rate policy, identifying unused efficiency reserves, and determining priority areas for improving interest rate policy at the bank level. The application of this approach can contribute to more efficient resource utilization, optimization of interest expenses, and improvement of lending and interest income generation processes in commercial banks.

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