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Article

Performance Evaluation of the Branches of the Industrial Bank in Iraq Using Data Envelopment Analysis for the Period (2017–2018)

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Abstract: The Industrial Bank faces numerous transformations during its operations, particularly its shift from an industrial bank focused on achieving industrial development to a commercial bank by providing loans and developmental facilities. The bank primarily seeks to achieve profitable economic development through diversifying its activities, credit operations, and offering services to various sectors. This study is based on a main hypothesis divided into two sub-hypotheses: 1) There is a correlation between the extent of applying comprehensive banking operations and the profit rate generated from deploying various financial resources in income-generating credit activities. 2) There is a positive correlation between the volume of financing (loans) and the rate of economic growth.

The most important conclusions reached by the researcher are:

The economic, political, and social transformations experienced by the country, along with associated risks such as instability in political, economic, and security aspects, have led to a gap between the specialized and comprehensive activities of the Industrial Bank due to changes in decisions and instructions that directly affect the workflow, performance, and material and moral capabilities.

The key recommendations are:

It is essential to provide all means and methods enabling the Industrial Bank to operate within its specialized activity, primarily supporting economic development and the industrial sector, along with government support for the bank.

Keywords: Performance Evaluation, Industrial Bank of Iraq, Bank Efficiency, Operational Performance, Branch Productivity

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1. Introduction

The Industrial Bank is considered one of the most important pillars relied upon by both developed and developing countries, serving as a fundamental foundation for the progress and advancement of nations. Likewise, the industrial sector is a key element in developing the national economic structure, representing the material basis for economic and social development. The development level of the Industrial Bank today is one of the measures and indicators of progress in both developed and developing countries.[1]

Hence, the importance of the Industrial Bank emerges as it supports the economic development of both developed and developing countries and serves as a fundamental pillar in overcoming the economic and social underdevelopment experienced by third-world countries.

Significance of the Study

The significance of this study stems from the importance of the industrial sector, particularly the Industrial Bank, which is the primary driver of the national economy in any country in general, and the Iraqi economy in particular, which suffers from low cash reserves and limited attention to this vital sector.[2]

Problem Statement

The study problem lies in the lack of development of the industrial sector and its failure to meet local market needs, leading to reliance on imports that strain and weaken the country due to high expenditure on imported goods.

Hypothesis

The study hypothesizes that improving the efficiency of the Industrial Bank and identifying the strengths and weaknesses of its branches will have significant effects on the economic and social aspects. The fundamental role played by the Industrial Bank is crucial in the development and advancement of the industrial sector and other economic sectors.[3]

Research Objectives

1. To allocate banking resources fairly across all branches of the bank to achieve development.
2. To employ scientific methods in periodically evaluating the performance of the bank's branches.
3. To evaluate the performance of the Industrial Bank during the study period.[4]

2. Materials and Methods

To validate the proposed hypothesis, the historical method is used to study the Iraqi Industrial Bank from its establishment date through its stages of development until the present time.

Study Limits

1. Temporal limits: The study covers the period from 2017 to 2021 and utilizes data provided by the bank.
2. Spatial limits: The Industrial Bank was selected among other banks due to its impact on the socio-economic reality and the development of the country.

Chapter One: Theoretical Qualification of the Measurement Process and Performance Efficiency Evaluation

Section One: Linear Programming as a Mathematical Method in Performance Evaluation

Linear Programming (program nationlinear) is one of the most important mathematical techniques used to assist in making sound decisions, simplifying problems, and solving them, such as optimally distributing human resources to achieve maximum possible profit or minimizing costs. Linear programming emerged after World War II in 1947 as a result of the industrial revolution in computer usage and developed rapidly. It spread in fields such as mathematics, economics, and military services by 1974. Linear programming involves studying inputs and outputs in cases of maximizing profits or minimizing losses.

Components of Linear Programming

1. Decision Variables: These are variables whose values must be determined, including all expenditures on the output such as raw materials.
2. Objective: This aims to achieve the highest possible revenue (maximizing income) or minimizing costs, which is called the "ideal" condition.
3. Constraints: These are the limits and conditions that must be met by the materials used in production. They must be specific. The most important challenges facing the production process are raw materials, capital, labor, machinery, and primary materials.

Section Two: Data Envelopment Analysis (DEA) Method

The first to propose this method were (Charnes and Cooper). The theoretical and quantitative basis of the model was developed by Farrell in 1957. Data Envelopment Analysis (DEA) is a mathematical method used to evaluate the productivity efficiency of a group of similar or homogeneous institutions or banks. This concept evaluates the efficiency of a group of institutions based on "optimal weights" for inputs and outputs. A bank curve that uses fewer resources than others to achieve the same output is considered more efficient. The frontier efficiency curve is formed by a combination of a hypothetical bank representing the best mix of input-to-output ratios, and this curve envelops all observations under study.

3. Results

Section Three: Performance and Economic Efficiency Evaluation

The concept of performance evaluation for institutions is the use of a set of financial and non-financial indicators or the achievement of tasks that help the company or institution achieve its defined goals.[5] It is also defined as a project aimed at measuring the actual results and comparing them with the set goals in order to identify deviations and diagnose their causes, while taking necessary steps to overcome those deviations .

Chapter Two:

Evaluation of the Performance of Industrial Bank Branches in Iraq Using Data Envelopment Analysis for the Period (2017–2018)

Section One: Estimation and Measurement of Technical Efficiency Using Data Envelopment Analysis

First: Data Envelopment Analysis Method

Data Envelopment Analysis (DEA) is a method for measuring efficiency chosen for data analysis because it provides detailed information for banks. It is defined as a method based on a mathematical approach and is characterized as a non-parametric technique that does not take into account random errors in its measurement. DEA is used to measure efficiency and applies linear programming to measure technical efficiency through the use of the optimal combination of input quantities and output quantities of administrative units.[6] It is also called the frontier analysis method.

In 1957, Farrell proposed an efficiency measurement method based on the concept of efficiency frontiers. The linear programming measurement method was first used to measure efficiency by Charnes, Cooper, and Rhodes (CCR). Efficiency was estimated through various methods, including the ratio of weighted outputs to weighted inputs according to the concept of constant returns to scale. Later, in 1990, others proposed the same approach but with variable returns to scale [7].

DEA also relies on Pareto Optimality, which states that any decision-making unit is inefficient if there exists another administrative unit or a combination of units that can produce at least the same quantity of outputs with fewer inputs or with no increase in any resource.

Second: Models of Data Envelopment Analysis (DEA):

1. Constant Returns to Scale Model (CCR Model):

This model is named CCR after Charnes, Cooper, and Rhodes in 1978 and is considered the basic DEA model . It is called the constant returns to scale (CRS) property because it operates on the basis that an inefficient unit changes its output quantity, which proportionally and steadily affects the quantity of inputs it uses while moving forward toward efficiency. The CRS assumption is appropriate only when all units under comparison operate at the same optimal scale or level .Figure(1)

Suppose there are several entities (X, Y, Z) located on the constant returns curve; these entities are efficient under the CRS assumption, while entity (C) is inefficient because it does not lie on the same curve.[8]

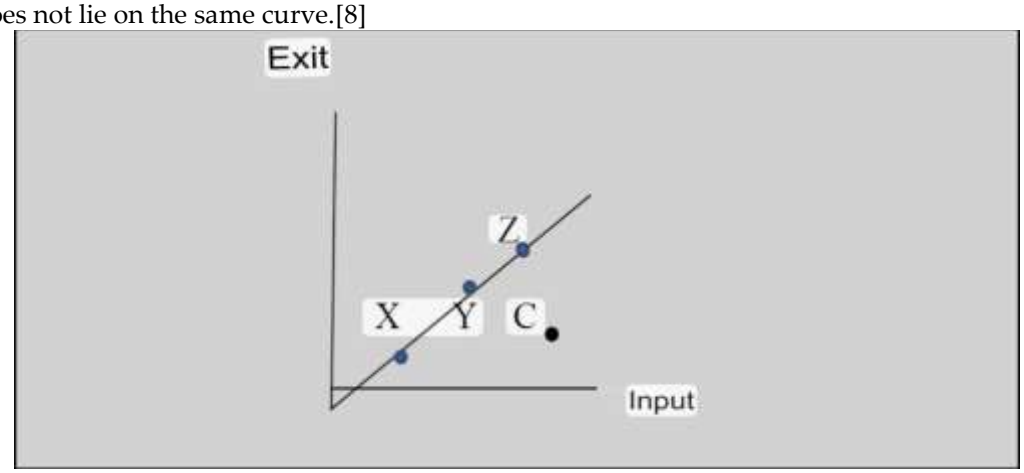


Figure 1. Constant Returns to Scale Curve
Source: (Sowlati, 2001, p. 40)

The CCR model is formulated mathematically under the assumption that the evaluated units operate under the hypothesis of Constant Returns to Scale (CRS) as follows:

Max $\theta\pi = \frac{\sum_{r}^{s}=1 u r y r \pi}{\sum_{i}^{m}=1 v i x i \pi}$ ……. (3)

S . c; $0 \leq$

$$0 \leq \frac{\int_{r}^{S}=1 u r y r j \boldsymbol{\pi}}{\int_{i}^{m}=1 v i x i j \pi} \leq 1 \text{ …… (4)}$$

j=1,..., n

r=1 ,..., s

ur, vi ≥0 i=1, ..., m

θ: Efficiency score of the Decision Making Unit (DMU) under the DEA measurement approach, where theta leq 1 .

i: Number of inputs used by each Decision Making Unit (DMU).

r: Number of outputs produced by each Decision Making Unit (DMU).

j: Number of Decision Making Units (DMUs) being compared within the DEA approach.

y_{rj} : The value of output r produced by Decision Making Unit j .

x_{ij} : The value of input i used by Decision Making Unit j .

u_r : The coefficient or weight assigned by DEA to output r to achieve an efficiency score of 100%.

v_i : The coefficient or weight assigned by DEA to input i to achieve an efficiency score of 100%.

The objective function in the above mathematical formulation aims to maximize the efficiency score theta for the Decision Making Unit pi , subject to the constraint that for any Decision Making Unit with the set of weights u and v assigned, no Decision Making Unit exceeds the value of 1 (i.e., 100%), which represents full efficiency.[9]

-2 BCC Model or Variable Returns to Scale (VRS) Model:

This model is called BCC after its developers (Banker, Charnes, and Cooper) in 1984. It is an extension of the earlier CCR model and is also known as the Variable Returns to Scale (VRS) model . This model differs from the CCR model in that it provides an efficiency measure that incorporates the scale of operations used by the service unit in decision-making during the evaluation.[10] It can also determine the type of returns to scale (constant, increasing, or decreasing) with respect to the quantity of services or inefficient output, achieved by adjusting the amount of inputs until reaching efficiency . Additionally, it identifies the optimal output level at which scale efficiency equals one.

Mathematical model:

BCC _0… Maximization model

BCC _1… Minimization model

Section Two: Measurement of Technical Efficiency and Scale Efficiency under Constant and Variable Returns to Scale for the period (2017-2018).

First: Measurement of Technical Efficiency and Scale Efficiency under Constant and Variable Returns to Scale for the Year 2017.

The efficiency index value for the branches of the Industrial Bank ranges between (0-1). If it equals one, this indicates that the bank's efficiency is (100%) and falls within the efficiency frontier, meaning these banks are the best performers. If it is less than one, it means that the bank operates at a level relative to the efficiency achieved by comparable efficient banks, as shown in Table .[11]

Reviewing the technical efficiency results of the Industrial Bank branches in Table , the average technical efficiency under constant returns to scale (CRS) was (0.962), while under variable returns to scale (VRS) it was (0.830). To be efficient under CRS, these banks need to increase their output quantity by (3.8%) while maintaining the current input levels, and by (17.0%) under VRS while maintaining the actual input levels.

The number of banks that achieved full technical efficiency at (100%) was banks, representing (55%) of the total banks in the studied sample. These banks (the main Industrial Bank, Babel, Al-Zaafarania, Al-Kadhimiya, and Karbala branches) operated on the efficient frontier curve and can be considered as reference banks (the highest efficiency

banks) for the other inefficient banks, whose efficiency is below the frontier by varying degrees. This means that technically efficient banks can reduce input quantities to achieve the same output level or use the same input quantities to achieve higher output levels.[12]

The number of banks that were efficient and operated at their optimal scale under VRS was , equal to the number under CRS. For the other banks, their technical efficiency ranged between the maximum and the minimum (0.524) under CRS, and (0.525) under VRS. The highest efficiency reached under both CRS and VRS at (55%-55%), as shown in Tables.

Regarding scale efficiency results, they were varied, ranging between (1 – 0.841) with an average of (83%), meaning these banks could increase their efficiency by (7%) or are losing some economic resources used at the current output level, which results in a (7%) increase in cost.

The number of banks operating under increasing returns to scale was , representing (33%) of the total sample, and there were no banks operating under decreasing returns to scale. This indicates that the rate of increase in output volume exceeds the rate of increase in input factors actually used in banking efficiency.[13]

Table 1. Measurement of Technical Efficiency and Scale Efficiency under Constant and Variable Returns to Scale for the Branches of the Industrial Bank in Iraq in 2017

The Farm	Technical Efficiency (Constant Returns to Scale)	Technical Efficiency (Variable Returns to Scale)	Capacity Efficiency	Returns to Scale	Reference Banks	
Main	1	1	1	Constant	Main	
Babel	1	1	1	Constant	Babel	
Nineveh	0.736	0.875	0.841	Increasing	Al-Zaafraniya	**Al-Kadhimiya**
Al-Zaafarania	1	1	1	Constant	Al-Zaafraniya	
Basra	0.524	0.525	0.998	Increasing	Al-Zaafraniya	**Babel**
Al-Kadhimiya	1	1	1	Constant	Al-Kadhimiya	
Al-Karrar	0.579	0.636	0.909	Increasing	Al-Kadhimiya	**Al-Zaafraniya**
Beirut Square	0.636	0.700	0.909	Constant	Al-Zaafraniya	**Al-Kadhimiya**
Karbala	1	1	1	Constant	Karbala	
Average	0.962	0.830	0.930			

Table (1) shows that the number of banks with full efficiency under both variable and constant returns to scale was about five banks, representing an efficiency rate of 55%. The efficiency level between 0.80 and 0.89 included one bank under variable returns to scale, with an efficiency rate of 11%. Efficiency levels between 0.70–0.79 and 0.60–0.69 under variable and constant returns to scale were each represented by one bank, accounting for 11% efficiency. The efficiency level between 0.50 and 0.59 included two banks under constant returns to scale, representing 22% efficiency, and one bank under variable returns to scale, representing 11% efficiency.[14]

Table 2. Number and percentage of banks according to technical efficiency levels

Efficiency Level	Returns to Scale	Number of Banks	Percentage of Banks
1	Constant	5	55%

	Variable	5	55%
0.90-0.99	Constant	0	0%
	Variable	0	0%
0.80-0.89	Constant	0	0%
	Variable	1	11%
0.70-0.79	Constant	1	11%
	Variable	1	11%
0.60 – 0.69	Constant	1	11%
	Variable	1	11%
0.50 – 0.59	Constant	2	22%
	Variable	1	11%

Source: Prepared by the researcher based on Table (2) and the results of technical efficiency.

It is observed from Figure (2) that the average technical efficiency was (0.962) under constant returns to scale, while the average technical efficiency under variable returns to scale was (0.83). Additionally, the average scale efficiency was (0.83).

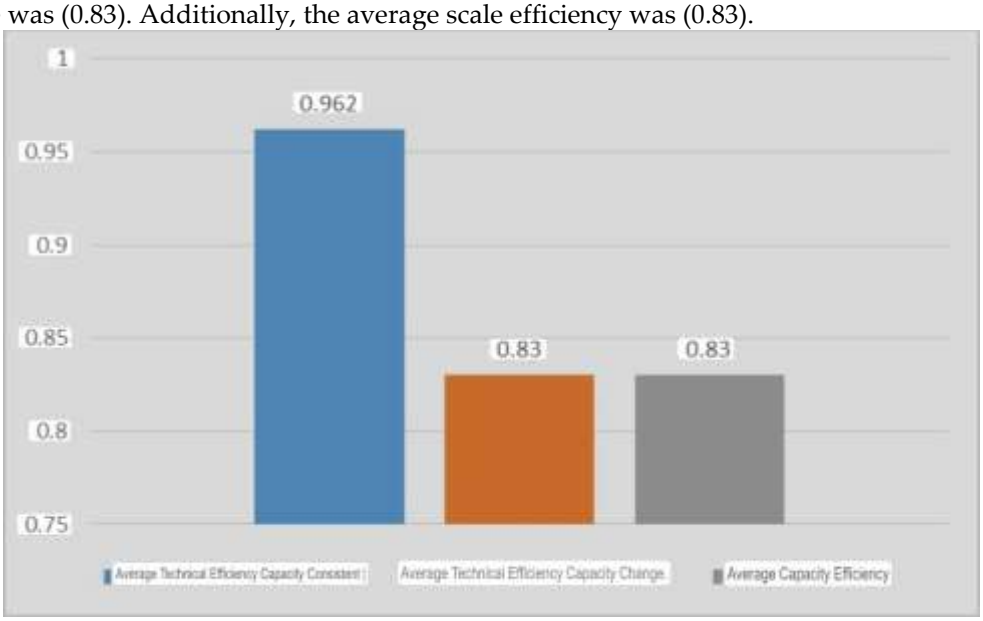


Figure 2. Average Technical Efficiency under Constant and Variable Returns to Scale and Scale Efficiency

Secondly: Measurement of Technical Efficiency and Scale Efficiency under Constant and Variable Returns to Scale for the Year 2018.

It is noted from Table (2) that the review of the technical efficiency results for the branches of the Industrial Bank shows that the average technical efficiency under constant returns to scale reached (0.920), while the average technical efficiency under variable returns to scale reached (0.939). For these banks to be efficient under constant returns to scale, output quantities must increase by (8%) while maintaining actual input levels, and by (6.1%) under variable returns to scale with actual input levels maintained. The number of banks achieving full technical efficiency of 100% was banks, constituting (55%) of the banks in the studied sample. These banks are , which operated on the efficient frontier curve and can be considered reference banks (the most efficient banks) for the other less efficient banks, whose efficiency deviates from the frontier curve by varying percentages. This means that technically efficient banks can reduce the amounts of inputs used to obtain the same level of outputs or use the same input quantities to achieve a higher output level. The number of banks efficient under constant returns to scale, i.e., operating at their optimal scale under variable returns to scale, was banks, namely [15].

As for the other banks, their technical efficiency ranged between the maximum of (1) and the minimum of (0.603) under constant returns to scale, and between and (0.622)

under variable returns to scale. Reviewing scale efficiency results shows variation, ranging between (1 – 0.928) with an average of (97.9%), meaning these banks could increase their efficiency by (2.1%). The number of banks operating under increasing returns to scale was , representing (44%) of the total studied sample, and there were no banks operating under decreasing returns to scale. This indicates that the rate of increase in output volume is greater than the rate of increase in input factors actually used in banking efficiency.

Table 3. Measurement of Technical Efficiency and Scale Efficiency under Constant and Variable Returns to Scale for the Branches of the Industrial Bank in Iraq for the Year 2018

The Farm	Technical Efficiency under Constant Returns to Scale	Technical Efficiency under Variable Returns to Scale	Capacity Efficiency	Returns to scale	Reference banks			
Main	1	1	1	Constant	Main			
Babil	0.833	0.869	0.959	Increasing	Nineveh	Karbala		
Nineveh	0.928	1	0.928	Increasing	Nineveh			
Al-Zafaraniya	1	1	1	Constant	Al-Zaafaraniya			
Basra	0.603	0.622	0.970	Increasing	Nineveh	Karbala		
Al-Kadhimiya	1	1	1	Constant	Al-Kadhimiya			
Al-Karrar	1	1	1	Constant	Al-Karrar			
Beirut Square	0.914	0.957	0.955	Increasing	Al-Kadhimiya	Al-Karrar	Al-Zaafaraniya	Nineveh
Karbala	1	1	1	Constant	Karbala			
Average	0.920	0.939	0.979					

(Annual Report of the Industrial Bank for the Year 2018)

It is observed from Table (3) that the number of banks with full efficiency under constant returns to scale was about banks, representing an efficiency percentage of (55%), while under variable returns to scale, the number was banks with an efficiency percentage of (66%). As for the efficiency level (0.90-0.99), there was one bank under variable returns to scale with an efficiency percentage of (11%) and two banks under constant returns to scale with an efficiency percentage of (22%). The efficiency level (0.80-0.89) included one bank under both variable and constant returns to scale with an efficiency percentage of (11%). The efficiency level (0.60-0.69) included one bank under both variable and constant returns to scale, each with an efficiency percentage of (11%).

Table 4. Number and percentage of banks according to technical efficiency level

Efficiency Level	Returns to Scale	Number of Banks	Percentage of Banks
1	Constant	5	55%
	Variable	6	66%
0.90-0.99	Constant	2	22%
	Variable	1	11%
0.80-0.89	Constant	1	11%
	Variable	1	11%
0.70-0.79	Constant	0	0%
	Variable	0	0%
0.60 – 0.69	Constant	1	11%

	Variable	1	11%

Source: Prepared by the researcher based on Table (4) and the technical efficiency results.

It is observed from Figure (4) that the average technical efficiency was (0.92) under constant returns to scale, while the average technical efficiency under variable returns to scale was (0.939), and the average technical efficiency under scale efficiency was (0.979).

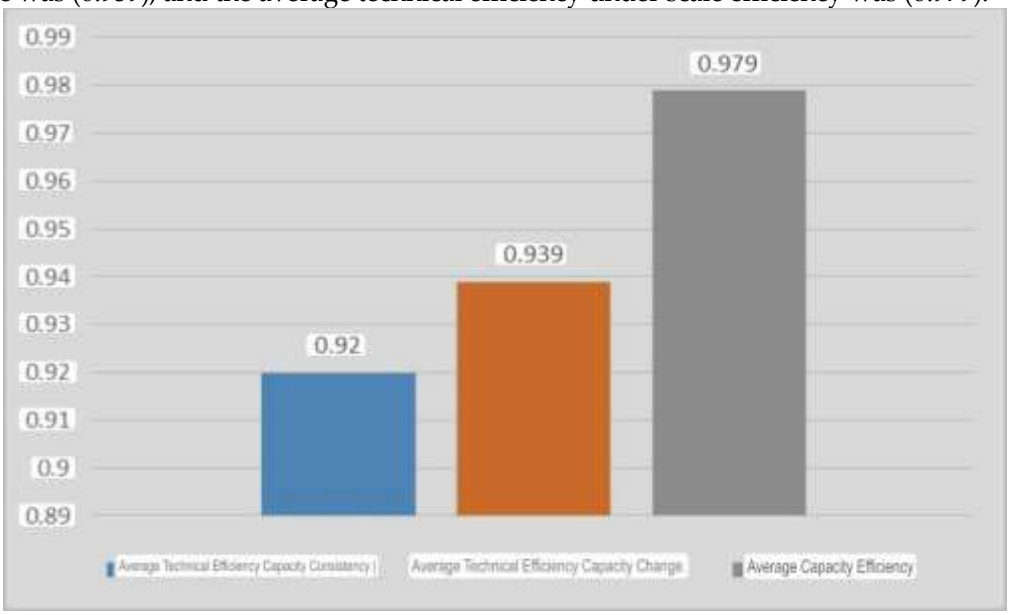


Figure 3. Average Technical Efficiency under Constant and Variable Returns to Scale and Scale Efficiency

4. Conclusion

1. Limited data available on the Industrial Bank.

2. Lack of economic feasibility studies for projects granted loans.

3. Insufficient funding and weak sources of financing, relying mainly on the state's annual budget.

4. Lack of funding for investment participations, with financing directed toward small and non-essential projects.

Recommendations

1. Conduct economic feasibility studies for projects applying for loans.

2. Increase the bank's capital to provide loans for large investment projects that contribute to economic development.

3. Ensure transparency of data for the public so depositors can be informed about the bank's status.

4. Utilize modern technology in loan processing to reduce time and minimize financial and administrative corruption.

The evaluation of the performance of the Industrial Bank branches in Iraq using Data Envelopment Analysis (DEA) for the period 2017–2018 revealed significant disparities in efficiency levels across branches. The analysis showed that while some branches operated near the efficiency frontier, others lagged behind due to administrative, financial, and structural weaknesses. The limited availability of reliable data on the Industrial Bank created challenges in ensuring accuracy and consistency in the evaluation process. Moreover, the lack of comprehensive economic feasibility studies for loan-approved projects weakened the bank's ability to ensure the profitability and sustainability of its financing activities.The study also highlighted insufficient funding and the heavy dependence on the state's annual budget as major constraints that hinder the bank's financial independence and capacity to support productive sectors. Most financing was directed toward small-scale and non-strategic projects, leaving large investment opportunities underfunded.

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