

Technical Efficiency and Benchmarking Analysis of Saudi Islamic Banks (2020–2024)

تحليل الكفاءة الفنية والمقارنة المرجعية للبنوك الإسلامية السعودية (2024–2020)

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Abstract:

This study uses Data Envelopment Analysis (DEA) under both Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) input-oriented models to assess the technical efficiency, benchmarking dynamics, and efficiency trends of fully Islamic banks listed on the Saudi Stock Exchange over the 2020–2024 period. Annual financial data was used to examine three primary outputs (total financing, net income, and operational income) and four significant inputs (customer deposits, total assets, personnel costs, and fixed assets). The findings show that all banks consistently demonstrated strong management and operational performance, achieving full pure technical efficiency (1.000) under the VRS model. However, the CRS model revealed minor inefficiencies in certain banks and years, which were mostly caused by scale inefficiencies rather than managerial shortcomings. According to benchmarking studies, Al Rajhi Bank and Alinma Bank consistently lead in efficiency and serve as models for peers who occasionally experience scale inefficiencies. Additionally, trend research shows how resilient the industry is, as evidenced by its quick recovery from shocks like the COVID-19 pandemic. These results demonstrate that scale optimisation, not operational enhancements, will be the primary source of future efficiency gains. This has strategic ramifications for bank management, regulators, and legislators in line with the goals of Saudi Vision 2030. Reliance on financial data is one of its limitations; to capture dynamic efficiency patterns, future research could incorporate non-financial parameters and use productivity change methodologies.

Keywords: Islamic banking; Technical efficiency; Data Envelopment Analysis; Benchmarking; Scale efficiency.

JEL Classification Codes G21, C67, M21, O16, G28.

ملخص: تستخدم هذه الدراسة أسلوب تحليل مغلف البيانات (DEA) وفق نموذجين موجهين نحو المدخلات، أحدهما يعتمد على العوائد الثابتة للحجم (CRS) والآخر على العوائد المتغيرة للحجم (VRS)، وذلك لتقييم الكفاءة الفنية، وديناميكيات المقارنة المعيارية، واتجاهات الكفاءة في المصارف الإسلامية الكاملة المدرجة في السوق المالية السعودية خلال الفترة من 2020 إلى 2024. تم استخدام البيانات المالية السنوية لدراسة ثلاثة مخرجات رئيسية (إجمالي التمويل، صافي الدخل، والدخل التشغيلي) وأربعة مدخلات أساسية (ودائع العملاء، إجمالي الأصول، تكاليف الموظفين، والأصول الثابتة). أظهرت النتائج أن جميع المصارف أبدت باستمرار أداءً قوياً في الإدارة والتشغيل، محققة الكفاءة الفنية الصافية الكاملة (1.000) وفق نموذج VRS. ومع ذلك، كشف نموذج CRS عن بعض أوجه القصور البسيطة في بعض المصارف وفي بعض السنوات، والتي تعود في الغالب

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إلى عدم كفاءة الحجم وليس إلى قصور إداري. ووفقًا لدراسات المقارنة المعيارية، يتصدر مصرف الراجحي ومصرف الإنماء الكفاءة باستمرار ويعملان كنماذج تحتذى بها المصارف الأخرى التي تواجه أحيانًا قصورًا في كفاءة الحجم. كما تُظهر دراسة الاتجاهات مرونة القطاع من خلال تعافيه السريع من الصدمات مثل جائحة كوفيد-19. وتشير هذه النتائج إلى أن تحسين كفاءة الحجم، وليس التحسينات التشغيلية، سيكون المصدر الأساسي لتحقيق مكاسب الكفاءة المستقبلية، مما يترتب عليه آثار استراتيجية لإدارة المصارف، والجهات التنظيمية، والمشرعين بما يتماشى مع أهداف رؤية السعودية 2030. ومن بين القيود التي تواجه الدراسة الاعتماد على البيانات المالية فقط؛ إذ يمكن للأبحاث المستقبلية دمج مؤشرات غير مالية واستخدام منهجيات قياس التغير في الإنتاجية لالتقاط أنماط الكفاءة الديناميكية.

الكلمات المفتاحية: الصيرفة الإسلامية؛ الكفاءة الفنية؛ تحليل مغلف البيانات؛ المقارنة المعيارية؛ كفاءة الحجم.

تصنيفات JEL: G21, C67, M21, O16, G28.

INTRODUCTION:

Islamic banking in Saudi Arabia has witnessed remarkable expansion in recent years, driven by conducive political and economic factors that favor the sector's development (Lone & Alshehri, n.d.). Saudi Arabia is considered a regional pioneer in Islamic banking, with many banks operating either as fully Islamic entities or offering dedicated Islamic windows. Al Rajhi Bank, in particular, is recognized for its stability and safety within the GCC region (Mouna, Y., & Benlaria, A, 2025).

Empirical evidence highlights a strong link between Islamic banking growth and national economic development. Studies have shown that the operations of Islamic banks positively correlate with economic activities in Gulf Arab States, including Saudi Arabia (İşik, 2018). Within Saudi Arabia's dual banking system, Islamic banks maintain a stable and significant long-term relationship with real indicators in the non-oil private sector, supporting both the "supply-leading" and "demand-following" economic development hypotheses (Mimoun, 2019). While Islamic banking plays an important role in promoting economic growth and financial stability, these contributions may be tempered by inflation and economic policy uncertainty (Chiad & Gherbi, 2024). As such, the sector's ongoing development is pivotal to the country's economic diversification agenda, as outlined in Saudi Vision 2030 (Chiad & Gherbi, 2024).

The expansion of Islamic banking in the GCC region, including Saudi Arabia, is supported by factors such as investment activities, growth in net loans, and increased customer deposits. These elements drive performance, which is evaluated using profitability, liquidity, and risk indicators (Rafiuddin & Alam, 2012). Overall, the Islamic banking sector in Saudi Arabia is positioned for continued growth, reinforced by strategic government policies and positive macroeconomic conditions.

In a broader context, measuring efficiency and benchmarking is increasingly recognized as essential across sectors. In higher education, benchmarking serves as a vital quality assurance tool, enabling institutions to foster continuous improvement and maintain competitiveness in an era characterized by heightened accountability (Achim et al., 2009). Within energy management, benchmarking—often supported by advanced methodologies including artificial intelligence—assesses and enhances energy performance (Sansaniwal & Gupta, 2024). In business, benchmarking is a strategic process for aligning organizational practices with industry

leaders, thereby facilitating productivity improvements, innovation, cost savings, and heightened competitiveness (Babovic et al., 2012; Tantau et al., 2010; Tan & Grigore, 2010). By linking benchmarking to performance management, organizations can identify key drivers of success and formulate targeted strategies for sustained advancement.

To rigorously evaluate and compare technical efficiency, scholars often employ tools such as Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). DEA, a non-parametric method, constructs an efficiency frontier to compare decision-making units based on multiple inputs and outputs, and is especially suitable for benchmarking organizations with similar operational structures (Rylková & Šebestová, 2019). This approach has been effectively used to highlight efficiency improvement potential in various sectors, from agriculture to service industries (Sabbaghi et al., 2014; Rylková & Šebestová, 2019). Conversely, SFA utilizes a parametric model incorporating a random error term to account for statistical noise, which is useful in contexts with variable data (Scippacercola & Sepe, 2016). The choice between DEA and SFA often hinges on the research setting and data characteristics, with DEA favored for its flexibility and robustness (Kalirajan & Shand, 1999).

Research Questions:

1. What are the technical efficiency levels of Saudi Islamic banks during the period 2020–2024?
2. Which banks serve as operational benchmarks within the sector, and how frequently do they fulfill this role for their peers?
3. How have efficiency patterns and peer-benchmarking relationships evolved throughout the study period?
4. What strategic lessons can inefficient banks derive from leading benchmarks to improve future efficiency and competitiveness?

Significance of the Study:

This study provides both academic and practical contributions. It equips managers and regulators with precise benchmarks and performance insights to guide strategic decision-making and policy formulation, supporting the goals of Saudi Vision 2030. Academically, the research enriches the literature by applying robust DEA methodologies to a unique banking environment, offering new empirical evidence regarding technical efficiency dynamics and internal best-practice diffusion in Saudi Arabia's Islamic banking sector.

1- Literature Review:

The theoretical exploration of bank efficiency is deeply rooted in the application of quantitative methodologies, most notably Data Envelopment Analysis (DEA). DEA has become a standard tool for evaluating the performance of banks by objectively comparing the relationships between inputs and outputs across similar decision-making units (DMUs) in the financial sector (Marjanović et al., 2018). Within this context, the Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) models provide two complementary perspectives. The CRS model assumes proportionality between input and output changes, making it suitable for banks presumed to be operating at optimal scale. In contrast, the VRS model offers greater flexibility by accommodating non-proportional returns, thereby capturing the efficiencies and inefficiencies experienced by banks of different sizes and scales (Zhu, 2014).

A nuanced understanding of scale efficiency is essential within these frameworks. While

scale elasticity quantifies output responses to input changes, scale efficiency specifically measures how effectively a bank utilizes its operating scale to minimize costs (Evanoff & Israilevich, 1995). Empirical research indicates that smaller banks are more likely to exhibit increasing returns to scale, whereas larger banks tend toward constant or decreasing returns, underscoring the heterogeneity of efficiency dynamics in the sector (McAllister & McManus, 2008). Grasping these differences is critical for banks as they navigate regulatory demands and competitive pressures, striving for optimal operational configurations (Bikker & Bos, 2008). Ultimately, leveraging DEA with both CRS and VRS models offers banks actionable insight into operational and scale inefficiencies, arming them with a comparative advantage in an increasingly dynamic financial industry (Marjanović et al., 2018).

Research employing DEA to assess the efficiency of Islamic banking has spanned across various geographical contexts, providing both global and region-specific insights. In the Middle East and North Africa (MENA) region, a bootstrap DEA analysis found that pure technical inefficiency—rather than scale inefficiency—was the main contributor to overall inefficiency in Islamic banks across both GCC and non-GCC countries. Furthermore, this study observed a decline in efficiency in the later years post-2011, emphasizing the evolving challenges banks face (Bahrini, 2017). On a wider scale, an analysis of 79 Islamic banks across 16 countries from 2005 to 2020 revealed an upward trend in efficiency, even amidst the economic turmoil of the COVID-19 pandemic, demonstrating the sector's resilience and its potential to facilitate economic recovery (Mai et al., 2023). In South and Southeast Asia, countries such as Malaysia and Pakistan have demonstrated high technical and scale efficiencies, likely benefitting from their early and concurrent adoption of Islamic and conventional banking systems ("Bootstrap DEA Analysis of Comparative Ef...", 2023). Regarding Saudi Arabia, studies confirm that Islamic banks contribute positively to economic growth and financial stability, though challenges remain—notably in managing bad debts in the corporate sector (Chiad & Gherbi, 2024; Ssabai, n.d.). Elsewhere, research on the impact of regulatory spin-off policies in Indonesia found that Islamic banks created by spin-off were, paradoxically, less efficient than non-spin-off banks, suggesting a need for policy re-evaluation in such contexts (Nabilah & Arif, 2022). Collectively, these investigations reflect the adaptability and wide applicability of DEA as a tool for exploring Islamic banking efficiency, illuminating how regional context, market structure, and regulatory environment intersect to shape operational performance.

Benchmarking, meanwhile, plays a critical role in driving performance improvement, customer satisfaction, and economic growth in the banking sector. For example, in the Jordanian banking sector, benchmarking efforts have led to notable improvements in service quality and planning, thereby enhancing overall business outcomes (Al-Tarawneh, 2014). The development of benchmarking models, as noted by Al-Moulani and Alexiou, enables policymakers and practitioners to assess their banking sector's development against global leaders by factoring in structural, macroeconomic, and institutional determinants (Al-Moulani & Alexiou, 2021). In the United States, quality-adjusted DEA (Q-DEA) has facilitated cost reductions and operational efficiencies in bank branch networks while maintaining high standards of service quality, underscoring the value of integrating service quality metrics into benchmarking frameworks (Sherman & Zhu, 2006). Global initiatives, such as the IFC's benchmarking of SME banking practices, further reveal the pivotal success factors that drive superior performance, enabling banks to align their business models with best-in-class global standards

(Berryman et al., n.d.). Moreover, international benchmarking exercises involving development banks in China, South Korea, Germany, and France provide valuable lessons in best practice adoption, efficiency, and policy formulation for financial institutions in emerging markets such as Brazil. Taken together, these studies underscore the versatility of benchmarking as a multifaceted strategic tool that enhances efficiency, supports continual improvement, and fosters competitiveness both within and across national banking sectors.

2- Research Gaps:

Despite considerable growth and performance in Saudi Arabia's Islamic banking sector, there remain substantial gaps in existing scholarly research concerning efficiency measurement and benchmarking practices. Most previous studies have focused broadly on Islamic banking efficiency at a global or regional level, often using aggregated data from multiple countries and not accounting for the unique dual banking environment of Saudi Arabia (Bahrini, 2017; Mai et al., 2023). While DEA has been applied to gauge the efficiency of banks in various contexts, there are relatively few empirical studies that provide a detailed, longitudinal evaluation of technical and scale efficiency—as well as internal benchmarking dynamics—among Islamic banks listed on the Saudi financial market, especially using both CRS and VRS DEA models over recent years.

Furthermore, many studies have remained limited in scope, failing to differentiate clearly between pure technical inefficiency and scale inefficiency or to investigate how internal peer benchmarking operates within the Saudi context. The interplay between sector leaders and those temporarily lagging in scale optimization has not been sufficiently explored, nor has the practical impact of benchmarking on actual performance improvement been systematically documented for Saudi Islamic banks. The period of economic turbulence, such as the COVID-19 pandemic, also presents unanswered questions regarding banks' resilience and adaptability.

Given these needs, this research addresses the gap by providing a thorough comparative analysis of technical efficiency using both CRS and VRS DEA models, mapping internal benchmarking relationships among listed Saudi Islamic banks, and evaluating efficiency trends through a multi-year panel data set (2020–2024). By doing so, it offers novel evidence on operational dynamics, leader-peer relationships, and strategic lessons for management and policymakers, contributing unique insights to the literature on Islamic bank efficiency and benchmarking in Saudi Arabia.

3- Methodology:

3-1 Research Design:

This study adopts a quantitative, non-parametric efficiency analysis approach using Data Envelopment Analysis (DEA). DEA is employed to evaluate the relative efficiency of Saudi Islamic banks listed on the Saudi Stock Exchange (Tadawul) over the period 2020–2024. Banks are treated as Decision-Making Units (DMUs) transforming multiple inputs into multiple outputs. In order to capture both operational (pure technical) efficiency and scale efficiency, the study applies input-oriented CRS and input-oriented VRS DEA models. The input orientation was chosen because bank management typically exercises greater control over resource utilization (inputs) than over output demand under prevailing market conditions.

This approach enables:

- CRS–VRS comparison to separate pure technical efficiency from scale effects.

- Benchmarking analysis, identifying efficient frontier banks and the peers they serve.
- Trend analysis for efficiency changes over five years.
- Peer group profiling to derive strategic improvement opportunities.

3-2 Sample Selection:

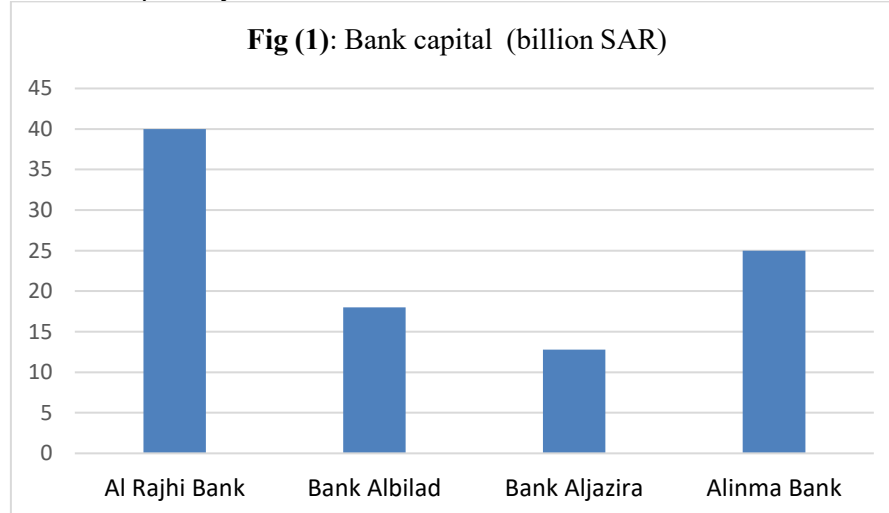
The analysis covers four fully Islamic banks that are listed and actively traded on the Saudi Stock Exchange and publish complete annual financial statements for 2020–2024. The sample selection criteria were:

1. Fully compliant with Islamic banking principles.
2. Consistent data reporting over the analysis period.
3. Availability of all selected input and output variables.

Table (1) : Profile of Saudi Islamic Banks in the Study

Bank Name	Year of Establishment	Symbol on Tadawul	Bank capital (billion SAR)
Al Rajhi Bank	1957	1120	40
Bank Albilad	2004	1140	18
Bank Aljazira	1975	1020	12.8125
Alinma Bank	2008	1150	25

Source: Prepared by the researcher based on bank websites and the Tadawul website



Source: Based on Microsoft Excel

Al Rajhi Bank (founded in 1957) is the oldest and most highly capitalised of the four banks, with SAR 40 billion, a testament to decades of market dominance and accumulated financial strength. On the other hand, Bank Aljazira (1975) has been in business for a long time, but it has the smallest capital base (SAR 12.81 billion), which suggests a more modest growth trajectory. Although they have less experience, the more recent entrants, Bank Albilad (2004) and Alinma Bank (2008), were established with significant initial funding (SAR 18 billion and SAR 25 billion, respectively), indicating strong initial support and a strategic intent to compete fiercely. The different growth strategies and market positions within Saudi Arabia's Islamic banking industry are highlighted by this mix of maturity and capital scale.

3-3 Data Sources:

Secondary data for the selected inputs and outputs were collected from:

- Audited annual reports of each bank (2020–2024).
- Tadawul official database.
- Banks' official financial disclosures on their websites.

All monetary figures were standardized to Saudi Riyals (SAR) for comparability. Where necessary, adjustments were made to ensure uniform reporting periods and reconcile minor discrepancies in published statements

3-4 Selection of Input and Output Variables:

The DEA model's input and output selection was informed by prior Islamic banking research as well as theoretical considerations in banking efficiency analysis (Bahrini, 2017; Mai et al., 2023; Chiad & Gherbi, 2024). The variables chosen capture the primary resources used by banks as inputs and the primary financial returns and services produced as outputs, which is consistent with previous empirical research.

3-4-1 Input Variables (4):

1. **Customer Deposits** – the primary funding source for Islamic banks, reflecting their capacity to mobilize resources from the market.
2. **Total Assets** – a comprehensive measure of bank size and capital base, encapsulating the physical, financial, and operating resources available.
3. **Personnel Expenses** – representing human capital investment, which is critical for service-intensive Islamic banking activities.
4. **Fixed Assets** – covering tangible infrastructure such as branches, ATMs, and technological equipment that facilitate operations.

3-4-2 Output Variables (3):

1. **Total Financing** – the total value of Sharia-compliant financing contracts (e.g., Murabaha, Ijarah, Musharaka), representing the core function of Islamic banks in providing credit and investment.
2. **Net Income** – a measure of overall profitability after expenses, reflecting the bank's ability to convert resources into bottom-line gains.
3. **Operating Income** – revenue from the bank's principal operations, excluding non-operating gains/losses, providing a direct measure of operational performance.

3-4-3 Rationale for Variable Selection

This combination of four inputs and three outputs guarantees thorough coverage of the performance side (finance provision, profitability, operational revenue) as well as the resource side (capital, deposits, infrastructure, and human capital). A helpful distinction in identifying possible variations in performance drivers is the inclusion of both Net Income and Operating Income, which enable the analysis to reflect both overall profitability and core operational effectiveness. Relevance and comparability within the literature on Islamic banking efficiency are guaranteed by the fact that these variables are consistently available for all Decision-Making Units (DMUs) in the study and have been widely used in similar DEA research.

3-5 DEA Model Specification

The DEA models were computed using **DEA Frontier**.

- **CRS Input-Oriented Model:**
 - Assumes constant returns to scale, evaluating overall technical efficiency (mix of pure technical and scale efficiency).
- **VRS Input-Oriented Model:**
 - Relaxes the CRS assumption, isolating pure technical efficiency by allowing for variable returns to scale.

3-5-1 Mathematical Formulation (Input-Oriented CRS) :

The input-oriented CCR model, introduced by Charnes, Cooper, and Rhodes (1978), assumes constant returns to scale. The linear programming formulation for DMU₀ is as follows (Mouna.Y, 2025) :

$$\begin{aligned} & \min_{\theta, \lambda} \theta \\ & \text{subject to } Y\lambda \geq y_0 \\ & \theta x_0 - X\lambda \geq 0 \\ & \lambda \geq 0 \end{aligned}$$

Where:

- θ is the efficiency score (scalar) for DMU₀ (with $\theta \leq 1$; $\theta = 1$ indicates efficiency),
- x_0 and y_0 are the input and output vectors of DMU₀,
- X and Y are the matrices of all DMUs' inputs and outputs,
- λ is a vector of weights assigned to peer DMUs.

3-5-2 Mathematical Formulation (Input-Oriented VRS)

The input-oriented BCC model, introduced by Banker, Charnes, and Cooper (1984), extends the CCR model to allow for variable returns to scale by adding a convexity constraint:

$$\begin{aligned} & \min_{\theta, \lambda} \theta \\ & \text{subject to } Y\lambda \geq y_0 \\ & \theta x_0 - X\lambda \geq 0 \\ & e^T \lambda = 1 \\ & \lambda \geq 0 \end{aligned}$$

where:

- e is a vector of ones (of appropriate dimension),
- the constraint $e^T \lambda = 1$ ensures convexity and thus variable returns to scale.

3-5-3 Scale Efficiency

Scale efficiency (SE) is computed as the ratio of the CRS efficiency score (θ_{CRS}) to VRS efficiency score (θ_{VRS}) for each DMU:

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

A value of $SE = 1$ indicates operation at optimal scale, while $SE < 1$ suggests scale inefficiency (cooper et al., 2011).

3-6 Benchmarking and Peer Identification

DEA naturally produces **reference sets** (benchmarks) for inefficient DMUs. For each inefficient bank under the CRS model, the **efficient frontier banks** (VRS score = 1) are identified as peers. Benchmarking analysis in this study:

1. Lists inefficient banks by year.
2. Specifies their benchmark (reference) banks.
3. Tracks the frequency of each bank serving as a benchmark.

4. Generates strategic recommendations based on these internal best-practice models.

3-7 Trend Analysis

Efficiency trend analysis was conducted using annual CRS and VRS scores from 2020 to 2024 to:

- Observe performance shifts over time.
- Identify resilience patterns during COVID-19 and post-pandemic recovery.
- Distinguish between temporary inefficiencies and structural/scaling issues.

3-8 Peer Group Analysis

Banks were grouped into categories:

- **Consistent Leaders** – full CRS & VRS efficiency.
- **Stable Peers** – sustained efficiency, occasional minor dips.
- **Adaptive Improvers** – recovered from inefficiency through benchmarking.

This classification enables targeted recommendations for bank management and regulatory policy.

If you'd like, I can now also prepare a **flowchart diagram** to visually show the methodology from **data collection** → **DEA modeling** → **analysis (CRS vs VRS)** → **benchmarking** → **trend & peer analysis** for inclusion in your paper.

4- Results and Analysis

4-1 Descriptive Statistics

Table (2): Summary of Input and Output Variables (2020-2024, Average SAR Million)

Bank	Customer Deposits	Total Assets	Personnel Expenses	Fixed Assets	Total Financing	Net Income	Operating Income
Al Rajhi	532,193	715,846	3,351	11,797	524,899	15,769	17,576
Albilad	96,423	126,842	1,275	2,091	91,122	2,097	2,256
Aljazira	86,927	117,844	1,029	1,150	74,938	880	993
Alinma	156,826	208,866	1,324	2,734	151,978	3,789	4,227

Source: Based on Microsoft Excel

Observations: Al Rajhi Bank has more than five times the customer deposits of smaller banks, indicating that it operates on a much larger scale than its competitors. The wide range of input and output values is indicative of the sector's varied operational structure. Although the size of operations and branch networks is correlated with variations in fixed assets and personnel costs, these variations are still moderate and do not show stark differences.

4-2 Technical Efficiency Scores: CRS vs VRS Comparison

4-2-1 CRS Input-Oriented Model Results

Table (3): CRS Efficiency Scores (2020-2024)

Bank	2020	2021	2022	2023	2024	Average
Al Rajhi	1.000	1.000	1.000	1.000	1.000	1.000
Albilad	1.000	1.000	0.954	0.971	1.000	0.985
Aljazira	0.993	1.000	1.000	1.000	1.000	0.999
Alinma	1.000	1.000	1.000	1.000	1.000	1.000

Source: Based on DEA Frontier

Interpretation:

- Al Rajhi and Alinma banks operated at the efficient frontier each year, consistently achieving perfect efficiency scores (1.000).

- Aljazira only showed slight inefficiency in 2020 (probably due to a pandemic), after which it reached complete efficiency.
- In 2022–2023, Albilad displayed efficiency declines (<1.0), indicating times when scale was suboptimal.

4-2-2 VRS Input-Oriented Model Results

Table (4): VRS Efficiency Scores (2020-2024)

Bank	2020	2021	2022	2023	2024	Average
Al Rajhi	1.000	1.000	1.000	1.000	1.000	1.000
Albilad	1.000	1.000	1.000	1.000	1.000	1.000
Aljazira	1.000	1.000	1.000	1.000	1.000	1.000
Alinma	1.000	1.000	1.000	1.000	1.000	1.000

Source: Based on DEA Frontier

Interpretation: All four banks annually attained full technical efficiency (1.000), demonstrating the best possible resource allocation when scale effects are taken out of the equation. Throughout the industry, no instances of pure technical inefficiency were found.

4-2-3 CRS vs VRS: Comparative Table and Analysis

Table (5): CRS vs VRS and Scale Efficiency

Bank	CRS Avg.	VRS Avg.	Scale Efficiency (CRS/VRS)	Efficiency Gap (VRS-CRS)
Al Rajhi	1.000	1.000	1.000	0.000
Albilad	0.985	1.000	0.985	0.015
Aljazira	0.999	1.000	0.999	0.001
Alinma	1.000	1.000	1.000	0.000

Source: Based on DEA Frontier

The discrepancy between the CRS and VRS efficiency scores emphasises that scale effects, not bad management, are the cause of inefficiencies.

4-3 What Causes Perfect Efficiency in VRS Results?

- The VRS model accounts for scale differences and measures only "pure" technical (managerial) efficiency.
- The results demonstrate that all banks function completely efficiently, irrespective of their precise size or scope.
- Scale efficiency and technical efficiency are combined in the stricter CRS model. Therefore, rather than being the result of poor management, any inefficiencies found are related to non-optimal scale.

4-3-1 The Primary Differentiator: Scale Efficiency

- Scale efficiency = CRS efficiency / VRS efficiency; for example, Albilad's 0.985 suggests that optimising the scale of operations could improve performance instead of changing management strategies.
- Interpretation: Although the management of all banks is extremely skilled, some institutions can further boost their efficiency by altering their operational scale.
- Albilad and, to a lesser extent, Aljazira can focus on achieving Most Productive Scale Size (MPSS) in order to reach the sector's absolute frontier.

4-3-2 Practical Implications

- **For banks:** Since there aren't many more opportunities for operational efficiency gains, concentrate on strategic growth or consolidation to maximise scale.
- **For regulators:** Policies should support the maintenance of operational standards and allow for optimal scaling, as the sector exhibits mature managerial practices.

• **For researchers:** Technical efficiency does not differentiate in this sample; additional research could introduce quality/customer satisfaction metrics or use the Malmquist Index to measure productivity change.

4-4 Strategic Insights & Sector Resilience

- **COVID-19 Impact (2020):** Sectoral resilience was demonstrated by the only marginal inefficiency noted (Aljazira).
- **Recovery and normalisation after the crisis:** Despite changes in the economy, all banks were able to maintain or swiftly return to full technical efficiency.
- Strong regulatory frameworks, widespread adoption of technology, and comparable sharia-compliant product offerings are probably the reasons for the uniformity of operational procedures among Saudi Islamic banks.

4-5 Benchmarking Analysis

Table (6): Reference Banks for Inefficient Saudi Islamic Banks under CRS Model (2020–2024)

Year	Inefficient Bank	Reference (Benchmark) Banks
2020	Aljazira	Al Rajhi, Alinma
2022	Albilad	Al Rajhi, Alinma
2023	Albilad	Al Rajhi, Alinma

Source: Based on DEA Frontier

Al Rajhi and Alinma consistently serve as benchmarks. Inefficient banks can improve by emulating their operational and scale strategies. The internal benchmarking system suggests a strong sectoral best-practice culture.

4-6 Trend Analysis (2020–2024)

Table (7): Reference Banks for Inefficient Saudi Islamic Banks under CRS Model (2020–2024)

Period	% Change in Avg CRS Efficiency
2020–2021	0.00%
2021–2022	-1.15%
2022–2023	+0.43%
2023–2024	+0.72%

Source: Based on DEA Frontier

Efficiency remained stable in early years, declined in 2022 due to Albilad’s scale challenges, then improved and fully recovered by 2024. The VRS model shows no fluctuation, confirming stable managerial efficiency.

4-7 Peer Group Analysis

- **Al Rajhi Bank:** Consistent leader with full technical and scale efficiency.
- **Alinma Bank:** Strong peer, also consistently efficient and benchmark for others.
- **Aljazira Bank:** Quickly recovers from minor inefficiencies, showing adaptability.
- **Albilad Bank:** Exhibited temporary scale inefficiency but improved after benchmarking peers.

This peer grouping demonstrates stable leadership and an effective internal benchmarking dynamic within Saudi Islamic banks, reinforcing their operational resilience and competitive positioning.

5- Discussion

5-1 Interpretation of CRS vs. VRS Results: Managerial vs. Scale Efficiency

Important new information about the nature of efficiency in Saudi Islamic banks between 2020 and 2024 can be gained by comparing the input-oriented DEA models with Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). The results of the VRS model demonstrate that every bank runs with perfect technical efficiency, demonstrating the high level of competence and effectiveness of the sector's management and operational procedures in making use of input resources. On the other hand, the CRS model, which incorporates both scale efficiency and pure technical efficiency, finds minor inefficiencies in specific banks and years that are mostly caused by scale inefficiency rather than operational mismanagement.

This distinction emphasises that suboptimal scale of operations—banks operating at sizes smaller or larger than the most productive scale size—rather than managerial failings are the primary cause of the variations in overall technical efficiency identified under the CRS assumption. For example, Albilad Bank's pure technical efficiency was unaffected by scale inefficiency during 2022–2023, indicating that the bank's operational scale could be better matched with its input-output structure to improve overall performance.

5-2 Benchmarking and Internal Sector Best-Practice Dynamics

Al Rajhi Bank and Alinma Bank were found to be reference or benchmark banks for peers who demonstrated inefficiency under CRS in particular years, according to benchmarking analysis. In the Saudi Islamic banking industry, these banks are the efficient frontier, exhibiting best-practice operational and scale strategies. The Albilad and Aljazira banks' return to full efficiency following periods of inefficiency is proof that this internal benchmarking system promotes knowledge diffusion and performance improvement.

The sector's embedded culture of peer learning and continuous improvement is highlighted by Al Rajhi and Alinma's consistent role as benchmarks, which also reflects a stable internal sector leadership. By allowing banks to imitate high-performing peers in scale management and resource utilisation, benchmarking serves as a tool for measuring performance as well as a means of promoting strategic alignment and operational excellence.

5-3 Effects of Sector Leadership, Resilience, and Adaptability

Resilience in the industry has been promoted by the leadership shown by banks such as Al Rajhi and Alinma, both in terms of scale and operational effectiveness. Following the start of the COVID-19 pandemic, all banks recovered steadily and maintained full efficiency, highlighting the industry's resilience and adaptability. The Saudi Islamic banking industry used good management practices and scale optimisation to stay effective and competitive in spite of external economic challenges.

Such resilience is in line with the expanding body of empirical research demonstrating that Islamic banks under sound management are capable of successfully navigating economic shocks and favourably influencing economic stability and expansion in their respective jurisdictions. A level playing field where leadership and best practices spread, improving the industry's overall stability and efficiency, seems to be supported by the sector's operational uniformity and regulatory oversight.

5-4 Recommendations for Scale Optimization and Regulatory Support

Since the majority of observed deviations from perfect efficiency are caused by scale inefficiency rather than managerial inefficiency, banks should give priority to strategies that optimise their scale of operations. This might mean combining underperforming operations that

fall below ideal scale thresholds or growing in areas or business lines where economies of scale can be achieved.

Regulatory bodies, such as the Saudi Central Bank (SAMA), play a vital role in enabling this optimisation by promoting organic growth, permitting mergers or strategic alliances, and endorsing innovations that can increase scale efficiency while upholding Islamic finance principles.

Furthermore, banks may be able to make proactive operational adjustments with the support of focused supervisory interventions and continuous scale efficiency monitoring, particularly in the dynamic post-pandemic economic environment. It is recommended that policymakers integrate scale considerations into their Vision 2030-aligned sectoral growth and diversification strategies.

5-5 Contextualization with Previous Literature and Industry Trends

The results are consistent with earlier research showing the value of DEA in separating scale and managerial inefficiencies in banking (Marjanović et al., 2018; Zhu, 2014). The excellence of pure technical efficiency is in line with recent evidence of sector resilience and efficiency improvements even during economic crises (Mai et al., 2023), but it also somewhat contradicts previous reports of Islamic banking inefficiency in larger MENA contexts (Bahrini, 2017).

Furthermore, the Saudi Islamic banking industry's internal benchmarking culture is in line with international best practices, which state that peer benchmarking promotes operational excellence and industry competitiveness (Al-Moulani & Alexiou, 2021; Sherman & Zhu, 2006).

All things considered, this study confirms that the Saudi Islamic banking industry is developing a solid operational base, supported by capable leadership, regulatory backing, and adaptability—essential qualities that will allow it to maintain growth and competitiveness in the changing financial environment.

A clear narrative on managerial versus scale efficiency, peer dynamics, sector robustness, strategic priorities, and alignment with existing research is provided by this discussion, which combines your empirical findings with more general theoretical and practical viewpoints.

6- Conclusion

The technical efficiency, benchmarking dynamics, and efficiency trends of Saudi Islamic banks from 2020 to 2024 were examined in this study using both CRS and VRS input-oriented DEA models. The findings demonstrate that, using the VRS model, all banks annually achieved full pure technical efficiency (1.000). This indicates that the sector's operations and management are incredibly successful. However, in some years, the CRS model discovered that a few banks were only marginally less efficient than ideal. These inefficiencies were entirely caused by scale issues rather than management or resource usage issues. According to benchmarking studies, Al Rajhi Bank and Alinma Bank consistently rank highest among the most efficient banks. These banks provided models for other banks experiencing short-term scale issues. The sector demonstrated remarkable resilience overall, rapidly overcoming operational challenges such as those brought on by the COVID-19 pandemic and maintaining strong performance over the course of the study.

From the perspective of management, the findings indicate that optimising size—rather than enhancing operational procedures, which are already fairly good—will be the primary means of increasing efficiency in the future. Bank management should concentrate on making strategic adjustments to the size of operations and the way resources are used in order to reach the most productive scale size. The findings imply that while maintaining the high operational standards already present in the industry, policymakers and regulators—particularly the Saudi Central Bank (SAMA)—should promote factors that are favourable for optimal scaling, such as permitting mergers, fostering strategic alliances, and permitting organic growth. This approach will help increase Saudi Arabia's competitiveness and align with the country's economic diversification objectives under Saudi Vision 2030.

The study's reliance on financial metrics gathered from publicly accessible annual statements limits it even though it provides strong empirical insights into efficiency and benchmarking trends. A more comprehensive picture of a bank's performance may be obtained by including non-financial metrics like customer satisfaction, service quality, and innovation capacity. Additionally, the analysis only looks at static efficiency scores; to capture efficiency dynamics over time, future studies could apply productivity change metrics, like the Malmquist Productivity Index, to broaden the scope. Comparative research that includes local or international Islamic banks would also provide crucial background information, allowing for global performance benchmarking.

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