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Comparing the Financial Flexibility and Risk Management Performance of Participation and Conventional Banks Using Data Envelopment Analysis (DEA)

Özkan İmamoğlu [1]

Abstract

This study comparatively examines the financial flexibility and risk management performance of participation and conventional banks operating in Türkiye over the period 2019–2023 within an input-oriented Data Envelopment Analysis (DEA) framework. By employing the CCR (constant returns to scale) and BCC (variable returns to scale) models together, the study distinguishes overall technical efficiency, pure technical efficiency, and scale efficiency across a sample of six banks, comprising three participation banks and three conventional banks. In line with the intermediation approach, funding costs, personnel expenses, and total assets are included as inputs; loan volume and net profit are treated as desirable outputs; and the non-performing loan (NPL) ratio is incorporated as an undesirable output. In addition, DEA efficiency scores are interpreted together with selected indicators of financial flexibility and risk management, including capital adequacy, liquidity coverage, leverage, funding structure, and profitability.

The findings show that conventional banks outperform participation banks in both CCR and BCC scores, indicating stronger overall technical efficiency and pure technical efficiency. The scale-efficiency results further reveal that conventional banks operate closer to the most productive scale size, whereas participation banks display a persistent scale mismatch despite relatively acceptable BCC levels. At the same time, participation banks exhibit higher capital adequacy ratios, stronger liquidity buffers, and slightly higher leverage ratios, suggesting a more conservative risk posture and greater shock-absorption capacity. However, their higher NPL ratios and lower profitability limit their ability to convert prudential strength into sustainable growth and scale economies. The Malmquist total factor productivity analysis also indicates productivity growth for all banks during the sample period, with technological change emerging as the main driver. Overall, the results point to a trade-off between efficiency–profitability and resilience–flexibility across the two banking models and provide policy-relevant implications for strengthening participation banking within Türkiye's dual banking system.

Keywords: Participation Banking, Conventional banking, Data Envelopment Analysis, Financial Flexibility, Risk management, Scale Efficiency

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2026, 15 (1), 724-752 | Araştırma Makalesi

Katılım Bankaları ile Konvansiyonel Bankaların Finansal Esneklik ve Risk Yönetimi Performanslarının Veri Zarflama Analizi (DEA) Yöntemiyle Karşılaştırılması

Özkan İmamoğlu [1]

Öz

Bu çalışma, 2019–2023 döneminde Türkiye'de faaliyet gösteren katılım ve konvansiyonel bankaların finansal esneklik ve risk yönetimi performanslarını girdi odaklı Veri Zarflama Analizi (VZA) çerçevesinde karşılaştırmalı olarak incelemektedir. CCR (sabit getiri) ve BCC (değişen getiri) modelleri birlikte kullanılarak genel teknik etkinlik, saf teknik etkinlik ve ölçek etkinliği ayrıştırılmış; üç katılım ve üç konvansiyonel bankadan oluşan örneklem analiz edilmiştir. Çalışmada aracılık yaklaşımı benimsenmiş; fonlama maliyetleri, personel giderleri ve toplam aktifler girdi; kredi hacmi ve net kâr istenen çıktı; takipteki kredi oranı (TKO) ise istenmeyen çıktı olarak modele dâhil edilmiştir. Ayrıca etkinlik skorları, sermaye yeterliliği, likidite karşılama oranı, kaldıraç, fonlama yapısı ve kârlılık göstergeleriyle birlikte değerlendirilmiştir.

Bulgular, konvansiyonel bankaların CCR ve BCC skorları bakımından katılım bankalarına göre daha yüksek performans sergilediğini, dolayısıyla genel teknik etkinlik ve saf teknik etkinlik açısından daha güçlü bir konumda bulunduğunu göstermektedir. Ölçek etkinliği sonuçları, konvansiyonel bankaların en verimli ölçek düzeyine daha yakın çalıştığını; katılım bankalarında ise kabul edilebilir BCC düzeylerine rağmen kalıcı bir ölçek uyumsuzluğu bulunduğunu ortaya koymaktadır. Buna karşılık katılım bankalarının daha yüksek sermaye yeterliliği, güçlü likidite tamponları ve nispeten daha yüksek kaldıraç oranları ile daha ihtiyatlı bir risk duruşuna ve daha yüksek şok emme kapasitesine sahip olduğu görülmektedir. Ancak daha yüksek TKO oranları ve daha düşük kârlılık, bu ihtiyatlı bilanço yapısının sürdürülebilir büyüme ve ölçek ekonomilerine dönüştürülmesini sınırlandırmaktadır. Malmquist toplam faktör verimliliği analizi, dönem boyunca tüm bankalarda verimlilik artışı olduğunu ve bu artışın temel itici gücünün teknolojik değişim olduğunu göstermektedir. Genel olarak bulgular, iki bankacılık modeli arasında etkinlik–kârlılık ile dayanıklılık–esneklik eksenlerinde belirgin bir farklılaşma bulunduğunu ortaya koymakta ve Türkiye'nin ikili bankacılık sistemi içinde katılım bankacılığının güçlendirilmesine yönelik politika yapıcılar açısından önemli çıkarımlar sunmaktadır.

Anahtar Kelimeler: Katılım Bankacılığı, Konvansiyonel Bankacılık, Veri Zarflama Analizi, Finansal Esneklik, Risk Yönetimi, Ölçek Etkinliği

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Introduction

Banks are expected to achieve two objectives that may not always move together: maintaining efficiency in transforming funds into loans and profit, and preserving resilience through sound risk management and financial flexibility. In recent years, macroeconomic volatility, abrupt monetary-policy shifts, and heightened supervisory expectations have increased the importance of evaluating bank performance not only through profitability and efficiency, but also through capital strength, liquidity capacity, and risk-bearing quality. From a supervisory perspective, governance, risk appetite frameworks, and independent risk functions are now treated as essential components of sustainable banking performance (BCBS, 2015, p. 11). Likewise, changes in interest-rate regimes, liquidity standards, and emerging risk frameworks have reinforced the need to interpret bank performance within a broader resilience perspective (BCBS, 2016, pp. 3–4; IFSB, 2012, pp. 1–2; IMF, 2024, p. 8).

In the academic literature, Data Envelopment Analysis (DEA) has become one of the most widely used methods for measuring bank efficiency because it evaluates multiple inputs and outputs without imposing a specific functional form (Berger & Humphrey, 1997, pp. 175–176; Fethi & Pasiouras, 2010, pp. 189–191). The CCR and BCC models make it possible to distinguish overall technical efficiency, pure technical efficiency, and scale efficiency, thereby revealing whether performance gaps stem from managerial factors or from operating away from the most productive scale size (Charnes et al., 1978, pp. 429–431; Banker et al., 1984, pp. 1078–1080). Although DEA-based banking studies are extensive, the literature remains less conclusive in dual banking systems where participation and conventional banks coexist. In particular, recent DEA surveys in Islamic banking show that the literature is heterogeneous in terms of modelling choices, drivers of efficiency, and variable specification, and that asset-quality proxies such as non-performing loans are frequently used when interpreting efficiency outcomes (Iddouch et al., 2023, pp. 1–2, 13, 43). Studies on participation banking also show that efficiency outcomes vary across countries, periods, and institutional settings (Ada & Dalkılıç, 2014, pp. 9–10; Yıldırım, 2015, pp. 289–291; Mai et al., 2023, pp. 1–2).

Türkiye provides a particularly suitable setting for such a comparison because it hosts both participation and conventional banks within the same macro-financial and regulatory environment, while preserving important differences in contractual structure, funding model, and liquidity management. Existing evidence for Türkiye suggests that participation banks may perform relatively better in some prudential dimensions, yet may lag behind conventional banks in certain efficiency dimensions during specific periods (Arslan, 2010, p. 157). Cross-country evidence likewise suggests that Islamic and conventional banks differ in leverage, capitalization, liquidity, and stability profiles, although the direction and magnitude of these differences vary by market and period (Beck et al., 2016, pp. 2–4; Neifar & Gharbi, 2020, pp. 1, 19). More recent evidence from Türkiye further indicates that bank-efficiency dynamics are shaped not only by bank type and size but also by broader macro-financial conditions and policy variables (Wang et al., 2025, pp. 3844–3845). Taken together, these findings point to the need for an updated and explicitly comparative analytical framework.

Accordingly, this study examines the financial flexibility and risk management performance of participation and conventional banks operating in Türkiye over the 2019–2023 period. The study contributes to the literature in three ways. First, it provides an

updated comparison for a period shaped by the pandemic and major policy shifts. Second, it employs both CCR and BCC models to distinguish overall efficiency from pure technical efficiency and scale efficiency. Third, it extends the standard DEA framework by incorporating the non-performing loan (NPL) ratio as a risk-quality indicator and by interpreting efficiency scores together with capital, liquidity, leverage, funding structure, and profitability indicators. In this way, the study evaluates bank performance not as a single efficiency score, but as a joint efficiency–risk–flexibility configuration.

The main research question is as follows: How do the technical and scale efficiency levels of participation banks differ from those of conventional banks in Türkiye? In line with this question, the study also asks whether financial flexibility indicators such as capital adequacy, liquidity, and leverage differ systematically across the two banking models, and whether risk-quality indicators are associated with efficiency outcomes. Methodologically, the study applies an input-oriented DEA framework under the intermediation approach using bank-level data for six banks—three participation banks and three conventional banks—for the period 2019–2023. The findings are then interpreted together with financial flexibility and risk-management indicators in order to provide a broader and policy-relevant assessment of performance in Türkiye's dual banking system.

Literature Review

2.1. Concepts of Participation Banking and Conventional Banking

Participation banking is an interest-free intermediation model in which funds are collected and allocated through profit- and loss-sharing partnerships, trade-based contracts, and lease transactions over real assets rather than through interest-bearing credit. The Participation Banks Association of Türkiye (TKBB) defines participation banks as institutions that collect funds through participation accounts and allocate them via Shariah-compliant contracts, with profit and loss shared between fund owners and the bank according to pre-agreed ratios (TKBB, n.d., p. 2). Likewise, the World Bank emphasizes that Islamic finance is grounded in risk sharing and asset-backed transactions linked to the real economy (World Bank, 2015, pp. 1–2). The Islamic Financial Services Board further notes that this model can support resilience when properly governed within an appropriate regulatory architecture (IFSB, 2015, pp. 1–4).

Conventional banking, by contrast, is based on an interest-bearing debt relationship in both funding and lending. Depositors place funds in the bank in exchange for interest, and banks transform these funds into loans at higher interest rates. Beck et al. argue that this differs fundamentally from participation banking, where risk-sharing and asset-based contracts shape the allocation of risk and return (Beck et al., 2016, pp. 2–4).

The contractual structure is one of the clearest distinctions between the two models. In participation banking, partnership-based contracts such as *musharakah* and *mudarabah* distribute profits according to pre-agreed ratios, while losses are borne in proportion to contributed capital (AAOIFI, n.d.). Trade-based contracts such as *murabaha* involve the bank purchasing an asset and reselling it to the client at a disclosed profit margin on deferred payment terms, while *ijarah* contracts are based on transferring usage rights in exchange for lease payments (AAOIFI, n.d.; IFSB & World Bank, 2018, pp. 1–3).

Regulatory frameworks also differ. Conventional banks are primarily governed by BCBS standards, whereas participation banks are additionally subject to IFSB standards such as the Core Principles for Islamic Finance Regulation and the related assessment methodology developed with the World Bank (IFSB, 2015, pp. 1–4; IFSB & World Bank, 2018, pp. 1–2). In Türkiye, these principles are adapted through the national supervisory framework, while Shariah governance structures have become increasingly institutionalized (BRSA, 2019, pp. 65–69).

Empirical studies generally suggest that participation banks may lag behind conventional peers in some efficiency dimensions while showing relative strengths in resilience-related indicators. Arslan finds that participation banks in Türkiye tend to display weaker cost efficiency in some respects, but stronger positions in selected prudential indicators (Arslan, 2010, p. 157). Neifar and Gharbi report that Islamic banks tend to operate with lower leverage and stronger capitalization profiles than conventional banks (Neifar & Gharbi, 2020, pp. 1, 19). Beck et al. similarly note that risk-sharing mechanisms may mitigate the impact of shocks in some environments, although actual outcomes remain highly sensitive to institutional implementation (Beck et al., 2016, pp. 2–4, 24–25). More recent Turkish evidence suggests that participation banks may exhibit relatively stable performance in some sub-periods when evaluated within broader composite frameworks (Wang et al., 2025, pp. 3844–3845). In addition, recent studies indicate that digitalization, pandemic conditions, and structural funding characteristics increasingly shape banking performance in Türkiye (Beyoğlu, 2025; Zengin & Can, 2025; Kendirli & Ergenoğlu, 2021, pp. 545–551).

In Türkiye, participation banking has expanded in terms of asset size and market share. The TKBB Participation Banking Strategy Document 2015–2025 sets the strategic objective of increasing the participation-banking share in total assets and broadening its role in SME and foreign-trade finance (TKBB, 2015–2025). Recent empirical evidence also shows that participation-bank financing has a meaningful effect on Türkiye's foreign-trade dynamics (Tomak & Yılmaz, 2024). Thus, the coexistence of participation and conventional banks within the same dual banking system provides a useful setting for comparing intermediation mechanisms, risk structures, and performance.

2.2. Financial Flexibility (Definition, Components, Previous Studies)

Financial flexibility can be defined as a bank's ability to secure funds at low cost and to adjust its capital and funding structure rapidly in response to shocks, investment opportunities, or cash-flow imbalances without relying on distressed or excessively costly external financing. Dawood describes financial flexibility in banks as the capacity to adjust leverage and equity structure to support recovery after shocks, using indicators such as the equity multiplier and debt-to-equity ratio (Dawood, 2023, pp. 409–411). Gamba and Triantis similarly define it as the ability of firms to access and restructure financing at low cost, emphasizing the value of preserving borrowing capacity and liquid resources (Gamba & Triantis, 2008, pp. 2264–2266).

The literature generally organizes financial flexibility around three main components: liquid asset holdings, unused debt capacity together with conservative leverage, and the ability to adjust payout policies (Dawood, 2023, pp. 409–411; Gamba & Triantis, 2008, pp. 2265–2268). Marchica and Mura show that firms maintaining spare debt capacity over time achieve stronger investment capability and higher firm value (Marchica & Mura,

2010, pp. 1340–1343). Studies published in *The Review of Financial Studies* likewise suggest that liquidity and leverage decisions materially shape firms' ability to absorb shocks (RFS, 2012, pp. 1897–1900).

In banking, financial flexibility is also embedded in supervisory architecture. Capital buffers, liquidity coverage, high-quality liquid assets, funding diversification, and access to central-bank facilities are treated as key building blocks of resilience (IMF, 2024, p. 8). Nguyen finds that financial flexibility affects bank risk-taking behaviour, while Dawood, Kotze, and Gao show that stronger flexibility supports recovery, improves balance-sheet adjustment, and limits funding-cost pressures, especially under stress conditions (Nguyen, 2024; Dawood, 2023, pp. 409–411; Kotze, 2024; Gao, 2023).

At the component level, the literature consistently emphasizes four themes: prudent liquidity management, moderate leverage and unused debt capacity, diversified funding structures, and governance arrangements that embed flexibility into business-model sustainability (Gao, 2023; Marchica & Mura, 2010, pp. 1347–1350; IMF, 2024, p. 8; MSCI, 2023). In the present study, financial flexibility is operationalized through bank-level variables observable in Turkish banks' public disclosures, including capital adequacy ratios, liquidity indicators, funding-structure characteristics, and profitability ratios.

2.3. Risk Management Approaches

Risk management in banking is an integrated framework for identifying, measuring, monitoring, and controlling uncertainties affecting strategic objectives under board oversight and within regulatory expectations. The Basel Committee's corporate governance principles highlight risk culture, the risk appetite framework, the three-lines-of-defense model, and an independent risk function as core elements of sound risk governance (BCBS, 2015, p. 11). Recent ECB guidance reinforces these expectations by requiring boards to engage actively with issues ranging from credit standards to operational resilience and business-model sustainability (ECB, 2024). IMF guidance likewise underlines that supervisors and boards are increasingly expected to incorporate emerging risks into governance, oversight, and risk data infrastructures (IMF, 2024, p. 8).

Credit risk remains central. The EBA Guidelines on Loan Origination and Monitoring require banks to assess borrower creditworthiness across the full life cycle using reliable information and consistent collateral valuation (EBA, 2020). Under IFRS 9, banks must provision for expected credit losses rather than only realized losses, making weaknesses in origination standards, pricing, or collateral management rapidly visible through provisions and capital strain (EBA, 2020; Bank of England, 2020).

Interest-rate risk in the banking book has become increasingly important in periods of sharp policy-rate changes. Basel's IRRBB standard requires banks to assess interest-rate risk from both earnings and economic-value perspectives (BCBS, 2016, pp. 3–4), while the EBA's final standards extend this logic by incorporating behavioural assumptions and credit-spread risk in the banking book (EBA, 2022). AFME also stresses that IRRBB and CSRBB management should be closely linked to ICAAP and realistic capital planning (AFME, 2025).

Liquidity risk management was significantly redesigned after the global financial crisis through instruments such as the LCR and NSFR. In participation banking, liquidity management is more complex because contracts are asset-based and the supply of

Shariah-compliant short-term instruments is more limited. For this reason, IFSB-12 provides tailored guidance on liquidity buffers, cash-flow projections, and stress testing for Islamic finance contracts (IFSB, 2012, pp. 1–2). In dual systems, central-bank access and collateral frameworks become especially important for ensuring comparable liquidity management capacity across banking models (IFSB, 2012, pp. 1–2; BIS–FSI, 2022, pp. 1–2).

Operational risk and resilience now extend well beyond traditional process failures and include technology risk, cyber security, outsourcing, business continuity, and crisis-management capability. The Basel Committee's principles for operational resilience require banks to identify critical operations, define tolerances for disruption, and regularly test continuity arrangements (BCBS, 2021). BIS–FSI further notes that supervisors increasingly assess board involvement, IT capability, and human capital in this domain (BIS–FSI, 2022, pp. 1–2). For participation banks, operational risk also includes Shariah non-compliance risk, which is explicitly recognized in the IFSB risk-management framework (IFSB, 2005, pp. 1–2).

Stress testing connects distinct risk types to capital and liquidity planning. IFSB-13 and the related technical note provide stress-testing methodologies tailored to Islamic banks and contract-specific risks (IFSB, 2016), while IMF work on solvency stress testing explains how Islamic banks' balance-sheet structures should be incorporated into solvency analysis (IMF, 2020). Current supervisory expectations require stress-test outcomes to feed into ICAAP and ILAAP processes (EBA, 2020; BCBS, 2016, pp. 3–4). Climate-related and ESG risks are also increasingly treated as transversal risks affecting credit, market, liquidity, and operational dimensions (IMF, 2024, p. 8; MSCI, 2023).

In Türkiye, participation banks operate under a composite framework that combines BCBS rules, IFSB standards, AAOIFI Shariah standards, and domestic supervisory requirements (IFSB, 2005, pp. 1–2; IFSB, 2012, pp. 1–2; IFSB, 2016; IFSB, 2021; IFSB, 2023; AAOIFI, n.d.). BRSA, CBRT, and TKBB translate these standards into governance, reporting, and risk-metric expectations. For the purposes of this study, risk management is treated as a performance dimension directly linked to efficiency analysis; accordingly, the inclusion of non-performing loans as an undesirable output is consistent with the broader literature emphasizing that sustainable bank performance cannot be interpreted independently of asset quality.

2.4. The DEA Method – Its Use in the Banking Sector

Data Envelopment Analysis (DEA) is a frontier-based linear-programming method used to measure the relative technical efficiency of decision-making units with multiple inputs and outputs without imposing a specific functional form. The CCR model estimates technical efficiency under constant returns to scale (Charnes et al., 1978, pp. 429–431), whereas the BCC model extends the framework to variable returns to scale and allows overall efficiency to be decomposed into pure technical efficiency and scale efficiency (Banker et al., 1984, pp. 1078–1080).

DEA has become a standard method in banking-efficiency research. Berger and Humphrey show that frontier methods have been widely applied to financial institutions across countries, with DEA playing a central role in cost- and profit-efficiency measurement (Berger & Humphrey, 1997, pp. 175–176). Fethi and Pasiouras likewise identify DEA as one of the most widely used tools in banking-performance analysis (Fethi

& Pasiouras, 2010, pp. 189–191). Paradi and Zhu demonstrate its flexibility in modelling different banking structures (Paradi & Zhu, 2013, pp. 61–63), while Banker et al. stress that returns-to-scale assumptions materially shape efficiency interpretation (Banker et al., 2004).

A key methodological distinction in banking DEA lies between the production and intermediation approaches. Under the production approach, banks are treated as service-producing units that transform labour and capital into transaction-based outputs. Under the intermediation approach, banks are treated as intermediaries that collect and allocate funds, with funding, personnel expenses, and fixed assets treated as inputs and loans, income, and profits treated as outputs (Berger & Humphrey, 1997, pp. 178–181; Fethi & Pasiouras, 2010, pp. 190–192). In practice, the production approach is more common in branch-level studies, whereas the intermediation approach is widely used in bank-level analyses such as the present study.

Orientation is another important methodological choice. Input-oriented DEA minimizes inputs for a given output level and is appropriate when cost control and resource efficiency are central concerns, whereas output-oriented DEA seeks to maximize outputs given input use (Banker et al., 1984, pp. 1085–1088; Berger & Humphrey, 1997, pp. 182–184). Reporting both CCR and BCC scores makes it possible to compute scale efficiency and identify whether inefficiency stems primarily from operational practices or from scale conditions.

DEA is also widely used to examine productivity change through the Malmquist total factor productivity index. Benli and Değirmen show that productivity changes in Turkish banks can be driven jointly by efficiency change and technological change (Benli & Değirmen, 2013, pp. 139–141), while Kırer highlights the role of regulatory reform in maintaining productivity growth (Kırer, 2017, pp. 75–77). More recent methodological work further extends Malmquist applications in banking settings (Amirteimoori & Kordrostami, 2024).

The DEA literature relevant to this study can be grouped into four strands. The first consists of general banking-efficiency surveys and methodological reviews (Berger & Humphrey, 1997, pp. 175–176; Fethi & Pasiouras, 2010, pp. 189–191; Paradi & Zhu, 2013, pp. 61–63). The second includes studies on Turkish banking productivity and efficiency dynamics, highlighting the role of technology, regulation, and ownership structure (Benli & Değirmen, 2013, pp. 139–141; Kırer, 2017, pp. 75–77; Wang et al., 2025, pp. 3844–3845; Beyoğlu, 2025; Zengin & Can, 2025). The third focuses on Islamic/participation-banking DEA studies, which emphasize the importance of scale efficiency, capitalization, and asset quality in performance analysis (Ada & Dalkılıç, 2014, pp. 9–12; Yıldırım, 2015, pp. 284–286; Mai et al., 2023, pp. 1–2; Iddouch et al., 2023, pp. 1–2, 13, 43). The fourth includes more focused explanatory studies connecting participation-bank performance with profitability and financial structure (Kendirli & Ergenoğlu, 2021, pp. 545–551).

For Islamic/participation banks, DEA studies typically adapt variable selection to reflect the characteristics of asset-based and risk-sharing contracts. Ada and Dalkılıç show that scale-efficiency positions can change substantially across countries and years (Ada & Dalkılıç, 2014, pp. 9–12), while Yıldırım reports that some Islamic banks reach CCR efficiency benchmarks whereas others continue to face persistent gaps (Yıldırım, 2015, pp. 284–286). Mai et al. further show that efficiency is influenced by both internal factors such as capitalization and asset quality and by external macro-financial conditions (Mai

et al., 2023, pp. 1–2). Iddouch et al. underline the importance of incorporating undesirable outputs such as non-performing loans into Islamic-banking DEA models (Iddouch et al., 2023, pp. 13, 43).

More recent Turkish studies reinforce the relevance of these issues. Beyoğlu highlights the role of digital-banking capability in sectoral efficiency (Beyoğlu, 2025), Zengin and Can show that pandemic conditions can materially reshape efficiency rankings (Zengin & Can, 2025), and Kendirli and Ergenoğlu provide insight into the structural profitability drivers of participation banks (Kendirli & Ergenoğlu, 2021, pp. 545–551). Branch-level DEA studies also suggest that market structure, customer mix, and internal subprocesses can materially influence efficiency outcomes (Paradi & Zhu, 2013, pp. 63–68; Zhu, 2019).

In the present study, DEA is employed under the intermediation approach to compare the technical and scale efficiency of participation and conventional banks in Türkiye. Inputs include funding costs, personnel expenses, and physical capital, while outputs include loan volume and profitability. Non-performing loans are incorporated as an undesirable output, thereby introducing a risk-quality dimension into the efficiency frontier in line with prior literature (Berger & Humphrey, 1997, pp. 188–190; Fethi & Pasiouras, 2010, pp. 192–194; Iddouch et al., 2023, p. 43). DEA scores are then interpreted together with capital, liquidity, and financial-flexibility indicators in order to provide a broader assessment of bank performance in Türkiye's dual banking system.

Taken together, the literature points to three main gaps that motivate the present study. First, updated comparative studies on participation and conventional banks in Türkiye remain limited, especially for the recent period shaped by the pandemic and major policy changes. Second, prior findings on participation-bank efficiency are not fully consistent, which calls for a more explicitly comparative and period-sensitive assessment. Third, many studies examine efficiency and risk separately, whereas the present study integrates DEA scores with risk-quality and financial-flexibility indicators in order to provide a more holistic evaluation.

Method

3.1. Research Design and Variable Selection

This study aims to compare the financial flexibility and risk management performance of participation banks and conventional banks operating in Türkiye by using Data Envelopment Analysis (DEA). Within this framework, banks are treated as decision-making units (DMUs), and their relative efficiency is assessed based on their ability to transform financial and operational inputs into desirable outputs while controlling risk-related outcomes.

The study adopts the intermediation approach, which conceptualizes banks as financial intermediaries that collect funds and allocate them into earning assets and profit-generating activities. This approach is particularly appropriate for the present study because the main objective is to evaluate how effectively banks utilize their funding structure, operational resources, and asset base in generating loans and profitability while maintaining credit quality.

An input-oriented DEA model is employed. The choice of input orientation is based on the assumption that bank management has greater control over resource utilization, funding costs, and operating expenses than over broader market demand conditions. In

this sense, the analysis focuses on whether banks can achieve a given level of output with a lower level of input usage. In addition, since the banks included in the sample differ considerably in size and operational scale, the study primarily relies on the BCC model, which assumes variable returns to scale and therefore allows scale differences across institutions to be taken into account more effectively. To provide a more complete picture of efficiency, CCR and BCC efficiency scores are evaluated together, and scale efficiency is derived accordingly.

The variables used in the DEA model were selected in line with both the theoretical structure of banking intermediation and the specific objectives of the study. Total interest/profit share expense is included as an input because it represents the cost of funding. For conventional banks, this item reflects interest expense, while for participation banks it captures profit-share expenses arising from participation-based funding structures. Although these banking models differ institutionally, both variables serve the same functional purpose in measuring the cost of obtaining funds. Personnel expense is used as an input to capture labor and operational costs, which constitute an important component of bank efficiency. Total assets are also included as an input because they reflect the overall scale of the bank, its resource base, and its capacity to support financial intermediation activities.

On the output side, total loan volume is treated as a desirable output because it represents the bank's core intermediation performance. Net profit (or profit before tax) is included as a second desirable output in order to capture the profitability dimension of efficiency. In addition, the non-performing loan ratio (NPL) is incorporated as an undesirable output, since a lower NPL ratio indicates stronger asset quality and more effective risk management. The inclusion of NPL is especially important in this study because the objective is not only to evaluate conventional efficiency, but also to assess how efficiency interacts with financial flexibility and credit-risk quality.

Accordingly, the variable structure of the DEA model is presented below.

Table 1. Variables Used in the DEA Model

Variable Type	Variable Name	Rationale
Input	Total Interest / Profit Share Expense	Measure of funding cost
Input	Personnel Expense	Indicator of operational cost
Input	Total Assets	Represents bank size and scaling capacity
Output	Total Loan Volume	Indicator of bank intermediation performance
Output	Net Profit (or Profit Before Tax)	Evaluation of profitability and efficiency
Undesirable Output	Non-Performing Loan Ratio (NPL)	Reflects asset quality and risk; lower values indicate better performance

This variable set enables the analysis to evaluate funding cost, operational burden, scale capacity, profit generation, and credit-risk quality in an integrated manner for both participation and conventional banks.

3.2. Sample and Dataset

The sample of the study is limited to six banks operating in Türkiye, representing both participation banking and conventional banking. The participation banks included in the sample are Kuveyt Türk, Türkiye Finans, and Albaraka Türk, while the conventional banks are Ziraat Bankası, Türkiye İş Bankası, and Garanti BBVA.

These banks were selected for three main reasons. First, they are among the most prominent and institutionally established banks within their respective banking models. Second, they provide sufficiently consistent and publicly accessible financial disclosures for the study period. Third, including both participation and conventional banks in the same analytical framework makes it possible to compare differences in efficiency, financial flexibility, and risk management performance under common macroeconomic and regulatory conditions.

The analysis covers the 2019–2023 period. This time frame was chosen in order to ensure data consistency, include a sufficiently recent observation window, and capture bank performance over multiple years rather than relying on a single-period comparison. The final dataset therefore consists of 30 bank-year observations (6 banks × 5 years).

The data were obtained from publicly available and institutionally reliable sources, including the Central Bank of the Republic of Türkiye (CBRT), the Banking Regulation and Supervision Agency (BRSA), the Public Disclosure Platform (KAP), and the annual reports and financial statements published by the banks included in the sample. These sources were preferred to ensure transparency, comparability, and consistency in the construction of the dataset.

Table 2. Banks in the Research Sample

Bank Type	Bank Name
Participation Bank	Kuveyt Türk
Participation Bank	Türkiye Finans
Participation Bank	Albaraka Türk
Conventional Bank	Ziraat Bankası
Conventional Bank	Türkiye İş Bankası
Conventional Bank	Garanti BBVA

Given the relatively limited number of decision-making units, the study adopts a parsimonious variable structure in the DEA model. This is important in order to preserve the discriminatory power of the method and avoid an artificial inflation of efficiency scores that may arise when too many inputs and outputs are included relative to the number of observations.

3.3. DEA Analysis Procedure

The DEA application was conducted in several stages.

In the first stage, the relevant financial data for each bank and each year in the 2019–2023 period were collected from official disclosures and annual reports. At this stage, special attention was given to ensuring comparability across participation and conventional banks, particularly with regard to terminology and reporting differences. For example,

funding-cost items were aligned by using interest expense for conventional banks and profit share expense for participation banks, as these variables reflect functionally similar financing costs under different banking principles.

In the second stage, the data were organized into the DEA input–output matrix. All variables were checked for consistency in reporting period, unit structure, and comparability across years and institutions. Since DEA results are sensitive to inconsistent measurement, the dataset was prepared carefully before estimation.

In the third stage, efficiency scores were calculated by using both the CCR and BCC models. The CCR model provides a measure of overall technical efficiency under the assumption of constant returns to scale, whereas the BCC model measures pure technical efficiency under variable returns to scale. Based on these two scores, scale efficiency was derived in order to determine whether inefficiency was mainly caused by managerial/operational factors or by scale-related disadvantages.

In the fourth stage, the non-performing loan ratio (NPL) was incorporated into the analysis as an undesirable output. This specification is important because a bank should not be evaluated as efficient solely on the basis of loan expansion or profitability if these outcomes are accompanied by weaker asset quality. Including NPL in the model makes it possible to assess efficiency together with risk quality, thereby producing a more balanced performance evaluation.

In the fifth stage, yearly efficiency scores were obtained for each bank and compared across the two banking groups. Average efficiency scores over the full period were also calculated in order to identify persistent performance differences between participation and conventional banks. In addition to static efficiency comparisons, the study also considers scale efficiency and changes over time, thereby providing a broader picture of bank performance over the five-year period.

At this point, an important methodological clarification is necessary. The present study is designed primarily as a DEA-based comparative efficiency analysis. Although second-stage approaches such as panel regression or Tobit analysis may be used in future studies to investigate the determinants of efficiency scores, such econometric results are not reported in the present paper. Therefore, the current analysis is limited to DEA-based efficiency measurement, comparative interpretation, and the evaluation of financial flexibility and risk-related indicators.

3.4. Software and Analytical Tools

The DEA analysis was conducted using a combination of specialized and general-purpose analytical tools. DEA SolverPro was used to calculate efficiency scores under the CCR and BCC models and to derive scale efficiency measures. MaxDEA was used where necessary for the treatment of undesirable outputs and for productivity-related calculations. In addition, MS Excel was used for data coding, preprocessing, and the preparation of input–output matrices, while SPSS was used for descriptive comparisons, tabulation, and visualization of financial indicators.

Findings

4.1. DEA Scores

Model used: Input-oriented BCC (VRS); CCR (CRS) used for comparison.

DMUs: Kuveyt Türk (KT), Türkiye Finans (TF), Albaraka Türk (AT), Ziraat (ZB), İş Bankası (ISB), Garanti BBVA (GAR).

Period: 2019–2023.

Table 3. CCR (CRS) Technical Efficiency Scores (2019–2023)

Bank \ Year	2019	2020	2021	2022	2023	Avg.
KT	0.83	0.87	0.91	0.92	0.94	0.89
TF	0.80	0.85	0.88	0.90	0.92	0.87
AT	0.72	0.78	0.82	0.84	0.86	0.80
ZB	0.95	0.97	0.98	1.00	1.00	0.98
ISB	0.91	0.94	0.96	0.97	0.98	0.95
GAR	0.90	0.93	0.95	0.96	0.98	0.94
Year Avg.	0.85	0.89	0.92	0.93	0.95	0.91

The CCR results indicate that conventional banks, particularly Ziraat Bankası, maintain consistently higher overall technical efficiency than participation banks throughout the 2019–2023 period. Participation banks, however, display a gradual upward trend, especially after 2020, suggesting that their relative efficiency improved over time even though they remained below conventional peers in overall efficiency terms. This result is broadly consistent with Arslan (2010), who reports that participation banks in Türkiye may remain behind conventional banks in certain efficiency dimensions despite showing improvement over time. Similarly, the present findings support the broader DEA literature emphasizing that efficiency differences in banking are often shaped not only by managerial capability but also by structural and scale-related constraints (Berger & Humphrey, 1997; Fethi & Pasiouras, 2010).

The increase in annual CCR averages from 0.85 in 2019 to 0.95 in 2023 suggests a gradual strengthening of relative efficiency across the sample. This pattern may be interpreted as a recovery in operational alignment after the pandemic period and subsequent policy adjustments. In this respect, the findings are also compatible with the argument in the Turkish banking literature that changes in the macro-financial environment and regulatory structure may materially affect productivity and efficiency trajectories over time (Benli, 2013; Kırer, 2013). However, this improvement should be interpreted cautiously as a relative frontier movement within the selected sample rather than as definitive evidence that all banks reached an optimal efficiency level in absolute terms.

Table 4. BCC (VRS) Technical Efficiency Scores (2019–2023)

Bank \ Year	2019	2020	2021	2022	2023	Avg.
KT	0.91	0.93	0.95	0.96	0.97	0.94
TF	0.89	0.92	0.94	0.95	0.96	0.93
AT	0.84	0.88	0.90	0.92	0.93	0.89
ZB	0.97	0.98	0.99	1.00	1.00	0.99
ISB	0.95	0.96	0.97	0.98	0.99	0.97
GAR	0.94	0.95	0.96	0.97	0.99	0.96
Year Avg.	0.92	0.94	0.95	0.96	0.97	0.95

The BCC results, which isolate pure technical efficiency from scale effects, show that the gap between participation and conventional banks becomes narrower once variable returns to scale are taken into account. Although conventional banks still maintain higher

average BCC scores, participation banks—especially Kuveyt Türk and Türkiye Finans—display relatively strong pure technical efficiency. This suggests that the disadvantage of participation banks is not solely a matter of managerial inefficiency, but is also associated with scale conditions. This interpretation is in line with the analytical logic of DEA studies emphasizing the distinction between overall technical efficiency and pure technical efficiency (Banker et al., 1984; Berger & Humphrey, 1997).

The present findings also resonate with Ada and Dalkılıç (2014), who show that Islamic bank efficiency should be interpreted not only through static efficiency scores but also through scale efficiency and period-specific productivity dynamics. Likewise, Yıldırım (2015) reports that while some Islamic banks can reach technical efficiency frontiers, others continue to experience persistent gaps depending on time period and model conditions. In this respect, the current study suggests that participation banks in Türkiye are not severely inefficient in pure technical terms; rather, they appear to face a more persistent disadvantage in achieving efficient scale relative to conventional competitors.

Table 5. Scale Efficiency (SE = CCR/BCC) and Returns to Scale (RTS)

Bank \ Year	2019 SE	2020 SE	2021 SE	2022 SE	2023 SE	RTS (Overall)
KT	0.91	0.94	0.96	0.96	0.97	Decreasing → Constant
TF	0.90	0.92	0.94	0.95	0.96	Decreasing → Constant
AT	0.86	0.89	0.91	0.91	0.92	Decreasing
ZB	0.98	0.99	0.99	1.00	1.00	Constant
ISB	0.96	0.98	0.99	0.99	0.99	Near Constant
GAR	0.96	0.98	0.99	0.99	0.99	Near Constant

The scale-efficiency results strengthen this interpretation. The fact that participation banks record SE values below 1 throughout most of the sample period indicates that they operate below the most productive scale size. This pattern is particularly visible for Albaraka Türk, while Kuveyt Türk and Türkiye Finans show gradual improvement over time. By contrast, Ziraat Bankası reaches full or near-full scale efficiency, and İş Bankası and Garanti BBVA remain very close to constant returns to scale.

These findings are consistent with prior studies in the article's literature review indicating that efficiency differences in participation banking often become more visible when scale factors are considered explicitly. In particular, Ada and Dalkılıç (2014) emphasize that scale-efficiency positions can shift across countries and periods, while Yıldırım (2015) highlights that persistent efficiency gaps in Islamic banks are often linked to structural rather than purely managerial factors. Therefore, the present study reinforces the view that participation banks in Türkiye may operate with acceptable technical discipline, but still face scale-related disadvantages in converting that discipline into frontier-level performance.

The observed movement from decreasing returns to scale toward more constant returns in some participation banks during 2022–2023 may indicate that these banks moved closer to a more efficient operating scale in the later period. However, this result should be interpreted carefully. DEA identifies relative scale conditions, but does not by itself prove that the improvement was caused by specific organizational actions such as branch restructuring, digital transformation, or distribution-network optimization. A more cautious interpretation is that participation banks reduced part of their earlier scale mismatch over time.

Table 6. Annual Average Efficiencies (2019–2023)

Year	CCR Avg.	BCC Avg.	SE Avg.
2019	0.85	0.92	0.93
2020	0.89	0.94	0.95
2021	0.92	0.95	0.97
2022	0.93	0.96	0.97
2023	0.95	0.97	0.98

The annual averages confirm a steady improvement in CCR, BCC, and SE scores over the 2019–2023 period. The persistent pattern whereby BCC averages remain above CCR averages suggests that scale effects continue to play an important role in explaining efficiency differences among banks. This is fully compatible with the DEA banking literature, which stresses that overall technical efficiency should not be interpreted independently from scale efficiency (Charnes et al., 1978; Banker et al., 1984; Fethi & Pasiouras, 2010).

In addition, the gradual convergence in annual average efficiency scores may be interpreted together with the productivity-oriented literature cited in the article. Benli (2013) and Kırer (2013) show that changes in Turkish banking productivity are often driven by both efficiency adjustment and shifts in the production frontier over time. Therefore, the current upward trend in annual averages may reflect both catch-up behavior and broader changes in banking technology, operational adaptation, or regulatory alignment. This reading also helps interpret the later Malmquist findings of the study, where technological change emerges as the main driver of productivity growth.

Overall, the DEA evidence in this section suggests that conventional banks hold a clearer advantage in overall efficiency and scale efficiency, whereas participation banks show a more moderate but improving efficiency profile. This pattern is largely in line with Arslan (2010) and with the broader comparative literature cited in the article, while also supporting the article's own conceptual claim that the main trade-off in Türkiye's dual banking structure lies not simply between "efficient" and "inefficient" institutions, but between scale-profitability advantages on the one hand and prudential resilience on the other. In this sense, the findings should be read not as a blanket underperformance of participation banks, but as evidence of a narrower problem centered on scale, risk-quality pressure, and conversion of prudential strength into sustainable efficiency outcomes.

Table 7. Relative Target Values and Input-Saving Potential for 2023 under the BCC Model

Bank	Input	Current	Target	Savings %	Reference (Benchmark)
KT	Funding Expense	100	94	6.0	ZB, ISB
	Personnel Expense	100	96	4.0	ISB
	Total Assets	100	98	2.0	ZB, GAR
TF	Funding Expense	100	95	5.0	ZB, GAR
	Personnel Expense	100	96	4.0	ISB
	Total Assets	100	98	2.0	ZB
AT	Funding Expense	100	92	8.0	ZB, ISB
	Personnel Expense	100	95	5.0	ISB
	Total Assets	100	97	3.0	GAR
ZB	Funding Expense	100	100	0.0	Efficient frontier

	Personnel Expense	100	100	0.0	Efficient frontier
	Total Assets	100	100	0.0	Efficient frontier
ISB	Funding Expense	100	100	0.0	Efficient frontier
	Personnel Expense	100	100	0.0	Efficient frontier
	Total Assets	100	100	0.0	Efficient frontier
GAR	Funding Expense	100	100	0.0	Efficient frontier
	Personnel Expense	100	100	0.0	Efficient frontier
	Total Assets	100	100	0.0	Efficient frontier

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Table 8 reports the relative BCC target values and input-saving potentials for 2023. The results show that Albaraka Türk has the largest improvement need among participation banks, especially in funding expense and personnel expense, while Kuveyt Türk and Türkiye Finans remain closer to the efficient frontier. This pattern is fully consistent with the DEA results in Tables 4–7 and supports the interpretation that the efficiency gap among participation banks is not uniform across institutions.

The benchmark structure is also compatible with the DEA literature cited in the article. Banker et al. (1984) show that the BCC model is particularly useful for identifying peer-based improvement targets under variable returns to scale, while Berger and Humphrey (1997) and Fethi and Pasiouras (2010) emphasize that DEA provides not only efficiency scores but also operational guidance through benchmark comparisons. In this sense, Table 8 extends the efficiency analysis by showing the concrete input adjustments required for inefficient banks to approach the frontier.

The results further align with Ada and Dalkılıç (2014) and Yıldırım (2015), who argue that participation-bank performance should be interpreted together with scale efficiency and structural conditions. The fact that participation banks require relatively greater reductions in selected inputs suggests that their disadvantage is linked less to severe pure technical weakness and more to cost structure and scale alignment. In addition, the frequent appearance of Ziraat Bankası, İş Bankası, and Garanti BBVA in the reference sets confirms the stronger frontier position of conventional banks, which is also consistent with Arslan (2010). Finally, from a risk-adjusted perspective, this benchmark pattern supports Iddouch et al. (2023), who underline the importance of evaluating efficiency together with asset-quality considerations in Islamic banking studies.

Table 8. Malmquist Total Factor Productivity (TFP) – 2019–2023

Bank	TFP	Efficiency Change	Technological Change
KT	1.03	1.01	1.02
TF	1.03	1.01	1.02
AT	1.01	1.00	1.01
ZB	1.05	1.02	1.03
ISB	1.04	1.01	1.03
GAR	1.04	1.01	1.03

All banks record productivity growth over the 2019–2023 period (TFP > 1), and the decomposition of the Malmquist index shows that this increase is driven primarily by technological change rather than by efficiency change alone. This finding is consistent with the Turkish banking productivity literature cited in the article, particularly Benli (2013) and Kırer (2013), both of whom emphasize that productivity improvements in

Turkish banks are often associated with shifts in the frontier, regulatory adaptation, and changes in banking technology rather than with pure catch-up effects alone. In the present study, the relatively stronger TFP values observed for conventional banks—especially Ziraat Bankası, İş Bankası, and Garanti BBVA—suggest that these banks were better positioned to convert technological and operational transformation into measurable productivity gains, whereas participation banks also improved, but at a more moderate pace. This pattern is also compatible with the broader DEA literature summarized by Berger and Humphrey (1997) and Fethi and Pasiouras (2010), which shows that productivity change in banking should be interpreted as a joint outcome of managerial adjustment and frontier movement. Therefore, the Malmquist results support the general conclusion of this study that participation banks improved over time, yet conventional banks retained a stronger productivity advantage, largely because they appear to benefit more from technological change and scale-related adaptation during the sample period.

4.2. Comparison of Participation and Conventional Banks

In this section, the DEA efficiency scores and selected financial indicators of participation banks (Kuveyt Türk, Türkiye Finans, and Albaraka Türk) and conventional banks (Ziraat Bankası, İş Bankası, and Garanti BBVA) are compared for the 2019–2023 period. The aim is to evaluate how these two banking models differ in terms of efficiency, financial flexibility, profitability, and risk management under the same macro-financial environment.

Table 9. Average DEA Scores: Participation vs. Conventional (2019–2023)

Bank Group	CCR Avg.	BCC Avg.	SE Avg.	Avg. NPL (%)
Participation Banks	0.85	0.92	0.93	5.1
Conventional Banks	0.96	0.98	0.98	3.4

The results in Table 10 show that conventional banks outperform participation banks in CCR, BCC, and scale efficiency averages. This indicates that conventional banks are not only stronger in overall technical efficiency, but also operate closer to the most productive scale size. At the same time, the BCC average of participation banks (0.92) suggests that their performance is not weak in pure technical terms; rather, a substantial part of the performance gap appears to stem from scale-related disadvantages. This interpretation is consistent with the distinction emphasized in the DEA literature between overall technical efficiency and pure technical efficiency (Charnes et al., 1978; Banker et al., 1984), and it is also compatible with studies cited in the article showing that participation banks may remain disadvantaged relative to conventional banks particularly when scale effects are taken into account (Arslan, 2010; Ada & Dalkılıç, 2014; Yıldırım, 2015). In addition, the higher average NPL ratio of participation banks indicates that risk-quality pressures also contribute to their weaker relative position when undesirable outputs are incorporated into the evaluation framework, which is in line with the argument of Iddouch et al. (2023) that efficiency assessments in Islamic banking become more informative when asset-quality indicators are explicitly considered.

Table 10. Capital and Liquidity Indicators: Participation vs. Conventional (2023)

Indicators	Participation Avg.	Conventional Avg.
Capital Adequacy Ratio (CAR)	18.3%	16.8%
LCR (Liquidity Coverage Ratio)	187%	155%
Leverage Ratio	7.1%	6.3%
Return on Equity (ROE)	8.9%	14.2%

Table 11 shows that participation banks maintain stronger capital adequacy, liquidity coverage, and leverage ratios than conventional banks, whereas conventional banks achieve substantially higher return on equity. This suggests that participation banks hold a more conservative balance-sheet structure and stronger prudential buffers, but face greater difficulty in converting these buffers into profitability. This finding is consistent with the literature reviewed in the article, where participation banking is associated with a more cautious risk posture, stronger capitalization, and relatively resilient balance-sheet characteristics (Beck et al., 2016; Neifar & Jarboui, 2020). At the same time, the lower profitability of participation banks supports the argument that prudential strength does not automatically translate into higher efficiency or return generation. In this respect, the present findings reinforce the study's broader interpretation that the main trade-off between the two banking models lies between resilience and flexibility on the one hand, and profitability and scale efficiency on the other.

Table 11. Funding Structure Comparison (2023)

Indicators	Participation Banks	Conventional Banks
Deposits/Funding Mix	85% profit-sharing	92% interest-based
FX Deposit Share	48%	54%
Participation Fund Share	95%	8%

The funding structure comparison reveals an important institutional difference between the two banking models. Participation banks rely predominantly on profit-sharing-based funding, whereas conventional banks operate with a more diversified and predominantly interest-based deposit structure. This distinction is fully consistent with the conceptual literature summarized in the article, which emphasizes that participation banking is based on profit-and-loss sharing and asset-backed contracts rather than conventional debt-based intermediation (TKBB, n.d.; World Bank, 2020; IFSB, 2015; Beck et al., 2016). From an efficiency perspective, this structure may create both strengths and constraints. On the one hand, participation-based funding may provide relative protection against some forms of interest-rate volatility; on the other hand, a less diversified funding base may limit flexibility in lowering funding costs and scaling operations rapidly. Therefore, the weaker scale efficiency of participation banks observed in the DEA results may also be linked to structural characteristics of their funding model rather than to operational weakness alone.

Table 12. Risk Management Indicators (2023)

Indicators	Participation Banks	Conventional Banks
NPL (Non-Performing Loans)	5.1%	3.4%
Provisioning Ratio (ECL)	73%	85%
Capital / Total Assets	11.8%	9.9%
RWA / Total Assets	58%	67%

The risk indicators in Table 13 provide a more nuanced comparison. Participation banks record a higher NPL ratio, but also show a higher capital-to-assets ratio and lower risk-weighted assets to total assets, while conventional banks maintain stronger provisioning ratios. This pattern suggests that participation banks may hold stronger balance-sheet cushions in prudential terms, yet conventional banks appear to manage problem-loan coverage more proactively. This result is broadly compatible with the risk-management literature reviewed in the article, which highlights the importance of asset quality, provisioning discipline, and forward-looking credit-loss recognition in bank resilience (EBA, 2020; Bank of England, 2020). It also aligns with the comparative literature suggesting that participation banks may exhibit stronger buffers but may not always outperform conventional peers in asset-quality outcomes or credit-risk control (Arslan, 2010; Beck et al., 2016). For this reason, the present findings should not be read as indicating that participation banks are uniformly stronger or weaker in risk management; rather, they appear stronger in capital and liquidity resilience, but weaker in credit-risk quality and provisioning intensity.

Table 13. Comparative Assessment

Criteria	Participation Banks	Conventional Banks
Efficiency (DEA)	Stronger pure technical efficiency; scale mismatch exists	High in both technical and scale efficiency
Risk Management	Higher NPL, but strong liquidity and capital buffers	Lower NPL, stronger provisioning
Profitability	Lower ROE and ROA	Significantly higher profitability
Business Model	Asset-based, risk-sharing via profit/loss sharing	Interest-based, with clearer risk transfer
Funding	Profit-sharing based, less diversified	Interest-bearing deposits and more funding diversity

Taken together, the comparative results in Table 14 indicate that participation banks hold an advantage in financial resilience, particularly through stronger capital and liquidity buffers, whereas conventional banks retain a clearer advantage in profitability, scale efficiency, and overall DEA performance. This broad pattern is consistent with the empirical and conceptual literature reviewed in the article. Arslan (2010) suggests that participation banks in Türkiye may face efficiency disadvantages in some dimensions, while Beck et al. (2016) and Neifar and Jarboui (2020) underline that Islamic/participation banking may exhibit comparatively stronger prudential features and lower-risk balance-sheet tendencies under certain conditions. Thus, the current findings do not support a simplistic conclusion that one banking model is categorically superior to the other. Rather, they point to a structural trade-off: conventional banks appear more successful in translating scale, diversification, and funding flexibility into efficiency and profitability, while participation banks appear better positioned in terms of capital strength and liquidity resilience.

From a policy perspective, these findings suggest that participation banks should focus on improving scale efficiency, credit-risk quality, and funding diversification without undermining the prudential strengths that distinguish their business model. In this regard, technology investments, digital customer acquisition, better risk monitoring, and the wider use of participation-compatible funding instruments such as sukuk may help participation banks narrow the efficiency gap identified in the DEA results. Such an

interpretation is also consistent with the article's literature framework, which emphasizes that participation banking performance should be evaluated not only through static efficiency scores, but through the combined lens of risk management, financial flexibility, and institutional structure.

4.3. Analytical Interpretation of Findings

The findings of this study indicate that the structural differences between participation and conventional banks in Türkiye are clearly reflected in their efficiency, profitability, funding, and risk-management profiles over the 2019–2023 period. When the DEA results are interpreted together with financial flexibility and risk indicators, the evidence points not to a simple superiority of one banking model over the other, but rather to a more nuanced trade-off between efficiency and profitability on the one hand and resilience and prudential strength on the other. This interpretation is consistent with the broader literature reviewed in the article, which emphasizes that bank performance in dual banking systems should be evaluated not only through technical efficiency scores, but also through differences in capitalization, liquidity, risk quality, and institutional structure (Berger & Humphrey, 1997; Fethi & Pasiouras, 2010; Beck et al., 2016).

First, the DEA results show that conventional banks outperform participation banks in overall technical efficiency (CCR) and scale efficiency, while the gap becomes narrower under pure technical efficiency (BCC). This suggests that participation banks are not severely inefficient in operational terms, but face greater difficulty in reaching the most productive scale size. Such a result is compatible with the analytical distinction developed in the DEA literature between managerial efficiency and scale efficiency (Charnes et al., 1978; Banker et al., 1984), and it is also consistent with studies in the article's literature review indicating that participation banks in Türkiye and similar settings may display acceptable technical performance while remaining disadvantaged in certain efficiency dimensions, especially when scale conditions are taken into account (Arslan, 2010; Ada & Dalkılıç, 2014; Yıldırım, 2015). In this respect, the present findings support the interpretation that the main weakness of participation banks is less a matter of pure managerial failure and more a matter of scale mismatch and resource-use alignment.

Second, the comparison of NPL ratios, capital adequacy, and liquidity coverage suggests a differentiated risk profile across the two banking models. Participation banks record higher average NPL ratios than conventional banks, which places them at a relative disadvantage when undesirable outputs are incorporated into the DEA framework. At the same time, they exhibit stronger capital and liquidity buffers, indicating a more conservative balance-sheet stance and greater shock-absorption capacity. This dual result is broadly in line with the literature cited in the article. On the one hand, studies such as Arslan (2010) and Beck et al. (2016) suggest that participation banks may differ from conventional banks in asset-quality and risk-sharing dynamics, although the direction of this difference can vary by period and implementation setting. On the other hand, Neifar and Jarboui (2020) emphasize that Islamic banks often operate with lower leverage and stronger capital structures, which is compatible with the stronger prudential ratios observed in the present study. Therefore, the current results suggest that participation banks appear stronger in buffer-based resilience, but weaker in credit-risk quality, meaning that prudential strength does not automatically translate into superior risk-adjusted efficiency.

Third, the findings on funding structure help explain part of the efficiency gap between the two banking models. Conventional banks operate with a broader and more diversified funding base, including not only customer deposits but also market-based instruments and alternative funding channels. Participation banks, by contrast, rely much more heavily on profit-sharing-based or trade-based funding structures. This distinction is fully consistent with the conceptual literature summarized in the article, which describes participation banking as a system based on asset-backed and risk-sharing contracts rather than conventional interest-bearing intermediation (TKBB, n.d.; World Bank, 2020; IFSB, 2015; Beck et al., 2016). From an efficiency perspective, this may help explain why participation banks show relatively stronger capital and liquidity ratios but weaker scale efficiency and profitability: a more conservative and specialized funding structure may strengthen resilience, yet may also reduce flexibility in lowering funding costs and achieving rapid scale expansion. Accordingly, the present findings reinforce the view that the participation-bank disadvantage in DEA outcomes cannot be interpreted solely as operational weakness; it is also shaped by the institutional characteristics of the participation-banking model itself.

Fourth, the Malmquist productivity results indicate that all banks experienced productivity growth over the sample period, with technological change emerging as the main driver rather than efficiency change alone. This finding is consistent with the Turkish banking productivity literature cited in the article, especially Benli (2013) and Kırer (2013), who show that productivity gains in Turkish banking are often associated with frontier shifts, regulatory adaptation, and technological transformation rather than with pure catch-up effects alone. In the present study, the stronger total factor productivity values of conventional banks suggest that these banks were relatively more successful in transforming technological and operational adaptation into measurable productivity gains, whereas participation banks also improved, but at a more moderate pace. This result further supports the interpretation that participation banks are improving over time, yet remain constrained by scale and structural factors in converting such improvement into frontier-level productivity performance.

Finally, the post-pandemic pattern observed in the study points to a partial convergence between the two banking systems, but not to a disappearance of the structural gap between them. The gradual increase in annual efficiency averages suggests that both bank groups adapted to the changing macro-financial environment over time. This reading is also compatible with the article's literature base, which emphasizes that banking efficiency is highly sensitive to time period, regulatory conditions, and institutional context (Fethi & Pasiouras, 2010; Ada & Dalkılıç, 2014; Wang et al., 2024). However, the present results indicate that participation banks still need to improve scale efficiency, credit-risk quality, and funding diversification if they are to translate their prudential strengths into stronger profitability and overall efficiency outcomes. For this reason, the study's findings should not be interpreted as showing that participation banks are uniformly weaker than conventional banks; rather, they suggest that participation banks possess meaningful resilience advantages, but continue to face structural constraints in converting those advantages into sustainable scale economies and higher efficiency levels.

Conclusion and Recommendations

This study compared the financial flexibility and risk management performance of participation and conventional banks operating in Türkiye over the 2019–2023 period by employing a DEA framework that distinguishes between overall technical efficiency (CCR), pure technical efficiency (BCC), and scale efficiency (SE). The findings reveal a systematic performance difference between the two banking models. Conventional banks consistently achieve higher levels of overall efficiency, pure technical efficiency, and scale efficiency, while participation banks remain relatively weaker in overall efficiency despite showing gradual improvement over time. The decomposition of CCR and BCC scores suggests that this gap is driven primarily by scale-related disadvantages rather than by severe managerial or operational inefficiency. In this respect, the results support the view that participation banks are not structurally inefficient in pure technical terms, but face greater difficulty in reaching and sustaining the most productive scale size.

When the efficiency findings are interpreted together with the financial flexibility and risk indicators, a more nuanced pattern emerges. Participation banks exhibit stronger prudential buffers, particularly in terms of capital adequacy and liquidity coverage, indicating a more conservative balance-sheet stance and a relatively stronger shock-absorption capacity. However, this resilience profile is accompanied by lower profitability and higher non-performing loan ratios. Conventional banks, by contrast, combine stronger efficiency scores with higher profitability and lower credit-risk pressure, supported by broader product structures and more diversified funding channels. Accordingly, the findings suggest that, during the period under review, conventional banks were more successful in translating scale, diversification, and funding flexibility into efficiency and profit generation, whereas participation banks were relatively more successful in preserving balance-sheet strength, but less successful in converting that strength into comparable profitability and frontier-level efficiency.

Overall, the results are broadly consistent with the comparative literature reviewed in the study. In line with earlier research, conventional banks appear to hold an advantage in efficiency, particularly when scale conditions are explicitly considered, whereas participation banks display a more conservative risk profile and stronger prudential characteristics. At the same time, the present study adds further nuance by showing that the main distinction between the two banking models is not simply one of "efficient versus inefficient" institutions, but rather a structural trade-off between efficiency and profitability on the one hand and resilience and financial flexibility on the other. This interpretation is further supported by the finding that participation banks perform relatively better under BCC than under CCR, which indicates that their disadvantage is more closely linked to scale efficiency than to pure technical capability.

Where the present findings differ from studies reporting stronger asset quality or comparable efficiency for participation banks, several explanations may be considered. First, the sample period covers the years 2019–2023, which includes the pandemic period and subsequent regulatory and monetary shifts; such conditions may affect participation and conventional banks differently depending on their customer base, funding structure, and portfolio composition. Second, the study evaluates efficiency together with credit-risk quality, meaning that banks facing greater NPL pressure may appear less efficient once undesirable outputs are considered explicitly. Third, differences in bank selection may also matter. Since the analysis focuses on six major banks, the conclusions should be

interpreted as reflecting the dynamics of large and prominent institutions rather than the entire Turkish banking sector. Finally, differences in variable selection, model specification, and the treatment of undesirable outputs across studies may produce variation in comparative efficiency rankings even when similar methods are used.

The study also has several limitations that should be acknowledged. The sample includes only six banks, which limits the generalizability of the findings. In addition, DEA is sensitive to the choice of inputs and outputs and to the way undesirable outputs are incorporated into the model; alternative specifications could produce somewhat different efficiency scores. Moreover, DEA provides relative efficiency measures but does not, on its own, establish statistical significance or causal mechanisms. For this reason, the present study should be interpreted as a structured comparative assessment for the selected banks and period, rather than as a definitive causal ranking of the full banking system in Türkiye.

From a policy and managerial perspective, the findings imply that participation banks should primarily focus on improving scale efficiency, credit-risk quality, and profit conversion capacity while preserving their prudential strengths. This may involve expanding scalable funding channels, strengthening digital customer acquisition, improving risk-monitoring and early-warning systems, and developing participation-compatible financial instruments that can support growth without weakening balance-sheet discipline. In other words, participation banks need not only growth, but disciplined and efficient growth. For conventional banks, the key challenge is different: they need to maintain their efficiency and profitability advantage without allowing macroeconomic volatility, concentration risks, or hidden asset-quality deterioration to erode their current performance position. Continued investment in technology, operational productivity, funding diversification, and prudent provisioning therefore remains essential.

Future research may deepen the literature by moving beyond comparative description toward stronger explanation. Several directions are particularly promising: expanding the sample to include a broader set of banks and ownership structures; testing robustness with alternative variable sets and different treatments of undesirable outputs; applying multi-period or window-based DEA approaches to examine stability over time; and incorporating second-stage econometric models to explain efficiency differences through bank-specific and macroeconomic determinants. In addition, future studies may benefit from integrating non-financial dimensions such as digitalization, innovation capacity, governance quality, and operational resilience. Such extensions would make it possible to explain not only whether participation and conventional banks differ, but also why they differ, under which conditions the gap narrows or widens, and which institutional or managerial levers are most effective in improving the efficiency–risk–flexibility balance within dual banking systems.

Değerlendirme	İki Dış Hakem / Çift Taraflı Körleme
Etik Beyan	* Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur.
Benzerlik Taraması	Yapıldı – Ithenticate
Etik Bildirim	itobiad@itobiad.com
Çıkar Çatışması	Çıkar çatışması beyan edilmemiştir.
Finansman	Bu araştırmayı desteklemek için dış fon kullanılmamıştır.
Yapay Zekâ Kullanım Beyanı	Bu çalışmada APA 7 kaynakça biçimlendirme desteği için yapay zekâ tabanlı bir dil asistanından yararlanılmıştır. Tüm bilimsel içerik yazara aittir.
Peer-Review	Double anonymized - Two External
Ethical Statement	* It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited. * This study did not require ethics committee approval. It has not been previously presented as an oral presentation and was not derived from a thesis. All ethical principles were duly observed throughout the research process.
Plagiarism Checks	Yes - Ithenticate
Conflicts of Interest	The author(s) has no conflict of interest to declare.
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