



## Evolution and future trajectories of research on bank efficiency: A systematic review

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### ARTICLE INFO

#### Article history:

Received 29 July 2023

Received in revised form

2 November 2023

Accepted 9 November 2023

#### Keywords:

Bank efficiency

Bibliometric

Digital transformation

Scopus database

Systematic review

### ABSTRACT

This bibliometric study examines trends in bank efficiency research over the past three decades. Systematic database searches were used to identify 342 articles on bank efficiency published between 1991 and 2023. Bibliometric analysis techniques were used to analyze publication volume patterns, influential authors and journals, geographic distribution, and conceptual structure. Citation analysis and text mining shed light on the evolution of bank efficiency research. The publication rate increased between 2005 and 2016 before leveling off. Research output continues to be dominated by a handful of prolific authors and institutions, primarily in Malaysia. Recent studies have incorporated external determinants such as regulation, governance, and competition, while influential earlier works focused on internal operations. Despite the dominance of data envelopment analysis, new techniques such as machine learning are emerging. The focus of research has shifted from developed to emerging economies. Initial technical topics have expanded to include sustainability, governance, and inclusion. Differences exist in terms of qualitative factors, long-term performance, and new contexts. Future research should assess the impact of digital transformation, dynamics during economic downturns, climate-related risks, and competition from non-bank entrants based on identified trends and gaps. This study provides a quantitative analysis of the trends influencing bank efficiency research and identifies promising avenues for advancing knowledge.

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### 1. Introduction

Since the 1970s, bank efficiency has been an essential research topic in the banking and finance literature (Berger and Humphrey, 1997). Efficiency refers to how effectively a bank utilizes its financial and human resources to generate profits and provide banking services. Banks play a crucial role in allocating funds from savers to creditors as financial intermediaries. They incur costs for labor, capital, and technology infrastructure as a result. The effectiveness with which they mitigate these costs while engaging in lending and other activities is essential to their financial performance and continued existence (Pasiouras, 2008).

The study of bank efficiency also sheds light on the overall banking market structure and the

competitiveness of the financial industry (Fethi and Pasiouras, 2010). Policymakers have utilized bank efficiency estimates to identify merger and acquisition targets, evaluate bank restructuring programs, and devise regulations aimed at enhancing competitiveness. Since the 1980s, a large body of literature has applied frontier efficiency estimation techniques to measure bank efficiency in diverse country contexts (Paradi and Zhu, 2013).

This bibliometric study examines and evaluates the published literature on bank efficiency in depth. Bibliometric techniques permit the quantitative examination of patterns in scientific publications within a research domain in order to comprehend its structure and evolution (John et al., 2020). Despite the extensive literature on bank efficiency, few bibliometric studies have examined this research field. Those that do concentrate on narrow aspects, such as the context of a specific country. A systematic bibliometric analysis can reveal publication trends, influential authors and works, collaboration networks, and the topical structure of the literature on bank efficiency (Wanke and Barros, 2016). Using systematic database searches, this

study compiled over 342 published articles on bank efficiency between 1991 and 2023. Techniques of bibliometric analysis are used to investigate publication volume patterns, the most prolific authors and journals, geographic trends, and research topics. A recent bibliometric analysis of research on bank efficiency revealed that analyzing citation patterns and employing text-mining techniques cast light on the evolution of this field and the relationships between influential topics and works. By elucidating the conceptual framework of the literature on bank efficiency, this bibliometric study was able to identify research deficits and opportunities for expanding knowledge in this crucial area. The findings serve as a guide for researchers who wish to comprehend the current state of the literature and pursue fruitful future research avenues pertaining to bank efficiency.

## 2. Literature review

In the 1980s and 1990s, foundational studies employing frontier analysis appeared (Berger and Humphrey, 1997; Mester, 1996). These seminal works offered theoretical models differentiating technical and allocative efficiency, which stimulated extensive research employing parametric and nonparametric approaches. Extensive research has been conducted on the internal and external determinants of bank efficiency.

Bank size, ownership, capitalization, risk management, governance, diversification, and economies of scale and scope are common internal factors studied (Fethi and Pasiouras, 2010). According to research, larger banks are frequently more efficient due to economies of scale but encounter diseconomies of scale beyond a certain threshold (Yin et al., 2013). Frequently, state-owned banks are less efficient than private or international banks (Barth et al., 2013). Capital provides a buffer against risk, so well-capitalized institutions are more efficient (Berger and Bouwman, 2013). Osei-Assibey and Asenso (2015) found that efficient risk management and governance structures, such as smaller, more independent committees, have a positive impact on efficiency. Diversification of income increases efficiency up to a certain point, after which volatile non-interest income decreases efficiency (Doan et al., 2018).

Among the external factors analyzed are competition, economic conditions, financial growth, and regulations. This relationship between competitive markets and efficiency remains complex (Banyen and Biekpe, 2020). Macroeconomic conditions that are favorable, such as higher GDP growth, boost productivity (Garza-García, 2012). Stricter regulations on bank activities decrease efficiency, whereas enhanced surveillance and supervision boost efficiency (Barth et al., 2013).

Earlier research centered on American and European banks. Banks in Asia (Wanke et al., 2016), Latin America (Jiménez-Hernández et al., 2019), and Africa (Blankson et al., 2022) are the subject of

emerging research. Due to contextual differences in regulations, development, and institutional integrity, efficiency levels vary by nation.

The widespread use of nonparametric DEA is due to its adaptability in incorporating multiple inputs and outputs. Statistical validity is strengthened by enhancements such as bootstrapping (Wanke et al., 2016). Statistical noise is accounted for in parametric SFA models (Berger et al., 2010). Approaches, such as dynamic network DEA models that incorporate undesirable outputs such as nonperforming loans (Kong et al., 2017), continue to evolve. Li et al. (2022) stated that machine learning techniques are being investigated for predicting bank distress based on efficiency.

The two primary conceptual models are production and intermediation. According to production models, banks are service providers. Banks serve as intermediaries between depositors and borrowers in intermediation models (Berger and Humphreys, 1997). Hybrid models that integrate both perspectives have emerged. The approach chosen influences the efficiency model's specification and results.

## 3. Methodology

This bibliometric study compiles a comprehensive database of academic articles related to bank efficiency research through a methodical search and screening procedure. Then, bibliometric analysis techniques are used to examine publication trends, influence, collaboration networks, and the conceptual structure of this research domain (John et al., 2020). Given its extensive coverage of business, finance, and economics scholarly literature, the Scopus database was selected as the primary source for article compilation (Harzing and Alakangas, 2016). Martín-Martín et al. (2018) conducted additional targeted searches on Web of Science and Google Scholar to identify any missing publications.

This article uses the Scopus database's "advanced search" feature using a query string: ((TITLE ("bank efficiency")) AND (LIMIT-TO (DOCTYPE,"ar"))) AND (LIMIT-TO (LANGUAGE,"English")) to look for every article indexed between 1991 and 2023 in the Scopus database. Scopus database search results for "bank efficiency" yielded 342 articles published between 1991 and 2023. The initial investigation yielded 342 articles. These were exported to Zotero and filtered based on the relevance of the titles and abstracts, limiting the results to journal articles employing quantitative frontier efficiency methods on banks (Paradi and Zhu, 2013). This filtering resulted in the retention of 342 articles for bibliometric analysis. The final database includes bibliographic information for each article, including authors, title, abstract, journal name, publication year, citations, and references.

Tortosa-Ausina (2002) analyzed the publication volume by year for the discipline as a whole, as well as for the leading journals and countries. Growth

curves illustrate the progression of research on bank efficiency. The author's productivity was evaluated by the number of publications and citations. The leading contributors were ranked according to their number of publications, citations, and h-index. Co-authorship network mapping illustrated authors who frequently collaborate (Newman, 2001).

The distribution of journal articles was analyzed by tallying the number of publications in each source title. The best journals were ranked based on their total number of articles and their impact factor to determine the leading publications (Garfield, 2006). Geographic Trends Publication output was aggregated based on author country affiliations in order to ascertain geographic contributions. Persson (2010) illustrated international collaboration through country co-authorship cartography. Text mining and clustering tools in VOSviewer analyzed the conceptual organization of research based on article titles, abstracts, and keywords (van Eck and Waltman, 2017). This demonstrates how bank efficiency-related topics cluster and their relationships.

#### 4. Results

##### 4.1. Overview of the literature collection: Trends in publication through time

The bibliographic database contains 342 relevant studies on bank efficiency published over the period 1991 to 2023. The collection comprises research applying frontier techniques like DEA, SFA, and related methods to assess bank efficiency across inputs, outputs, costs, and profits. The studies span top journals in finance, economics, operations research, and management science. Both foundational papers from the 1990s and recent works are included, providing a comprehensive overview. The sample encapsulates the diversity of techniques, focus areas, and geographic contexts

encompassing modern bank efficiency research. This expansive literature collection reflects the breadth of bank efficiency research.

The number of publications on bank efficiency has grown over time, indicating a developing research interest in this topic (Fig. 1). From 1991 to 1998, only one to four documents were published each year during the early 1990s. There was a modest increase in the number of publications in 2000, with five, followed by low publication rates from 2001 to 2003 (one to three per year). Four additional documents were produced in 2004. From 2005 to 2015, there was a period of sustained growth in the number of publications, with the number rising from 5 in 2005 to a zenith of 27 in 2016. This suggests that the research field became considerably more active during this period. After reaching a zenith in 2016, the average number of publications per year ranged from 15 to 22 from 2017 to 2019. This could suggest that the field has reached a stage of saturation. During the COVID-19 pandemic, there was likely a surge in interest in bank efficiency, which led to an increase of 21 documents in 2020. With 31 documents, 2021 maintained an upward trend. In 2022, there were 37 publications, the highest number ever recorded, demonstrating that bank efficiency remains a significant area of research. Nonetheless, as of July 2023, only 17 documents have been published, indicating that the publication rate may be decreasing again in comparison to the previous two years. Since the early 1990s, there has been a general upward trend in the number of publications, with a period of significant growth from 2005 to 2016, followed by a period of stabilization in 2020 and 2022. Uncertainty exists as to whether 2023 will maintain the high publication rate of the past three years or revert to a reduced rate. Additional analysis over the next few years will reveal more definitive long-term trends.

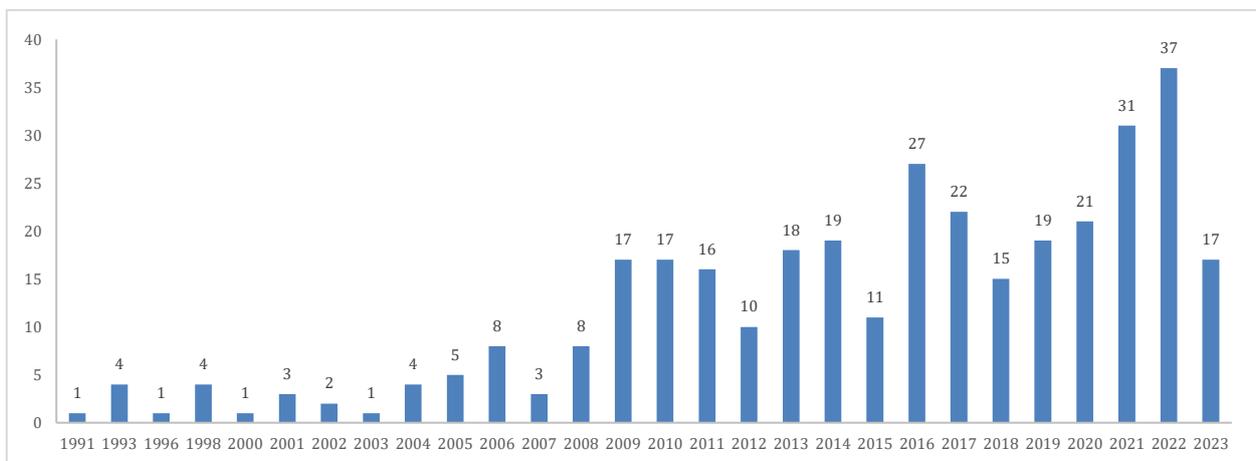


Fig. 1: Numerous publications are published annually

##### 4.2. Bank efficiency's most productive journals

The Journal of Banking and Finance published the greatest number of articles on bank efficiency, with

23 (Table 1). This prestigious finance journal published over three times as many articles on this topic as the next-highest journal. Clearly, it is the best venue for bank efficiency research. The top five

journals published a total of 66 documents or 27% of the total 242 documents published across all journals. The top 10 journals published 91 articles, or 38% of the total amount. This indicates that there

is a concentration of bank efficiency research in the leading journals but a reasonable distribution in other journals as well.

**Table 1: The leading 20 journals by the number of articles published**

Rank	Journal	Documents	Rank	Journal	Documents
1	Journal of Banking and Finance	23	11	Banks and Bank Systems	4
2	Applied Economics	9	12	Global Finance Journal	4
3	International Review of Economics and Finance	8	13	International Journal of Finance and Economics	4
4	European Journal of Operational Research	7	14	Journal of Asian Finance Economics and Business	4
5	Journal of International Financial Markets Institutions and Money	7	15	Journal of Islamic Monetary Economics and Finance	4
6	Research in International Business and Finance	7	16	Romanian Journal of Economic Forecasting	4
7	Managerial Finance	6	17	Service Industries Journal	4
8	Economic Modelling	5	18	Applied Economics Letters	3
9	Annals of Operations Research	4	19	Cogent Economics and Finance	3
10	Applied Financial Economics	4	20	Corporate Ownership and Control	3

Comparing the top five to the leading ten journals: (i) Journal of Banking and Finance, the leading publication, published 23 articles, substantially more than any other journal. (ii) Journals ranked 2 through 5 (Applied Economics, International Review of Economics and Finance, European Journal of Operational Research, and Journal of International Financial Markets, Institutions, and Money) published between 7 and 9 articles per volume. (iii) Journals ranked 6-10 published between four and six articles per issue.

**4.3. The best institutions research subject bank efficiency**

The data indicates that research on bank efficiency is concentrated in a small number of institutions worldwide, with Malaysian universities dominating the field. Universiti Putra Malaysia has published the most documents in this research field, a total of 18, establishing it as the distinct leader (Table 2). It is followed by another Malaysian institution, Universiti Utara Malaysia, which has 14 documents demonstrating Malaysia's expertise in

bank efficiency. In fact, Malaysia is home to the preponderance of the top ten and top five universities, with four and five universities, respectively.

The output of the two leading Malaysian institutions is substantially higher than that of all others, demonstrating their unparalleled productivity. While countries like the Netherlands, the United Kingdom, Vietnam, and Ghana rank among the top 10 and top 5, their output is significantly lower. Rijksuniversiteit Groningen in the Netherlands is the only non-Malaysian university in the top five. Overall, the sharp decline after the Malaysian leaders demonstrates that global research interest remains concentrated in a small number of critical institutions. Primarily in Malaysia, the extended tail of single-publication universities reinforces the concentration of research. However, increasing representation from developing regions indicates a growing global focus on bank efficiency research. There are still ample opportunities for additional nations and institutions to establish themselves as leaders in this vital area of research.

**Table 2: The top 20 institutions ranked by notable outputs**

Rank	Institutions	Documents	Rank	Institutions	Documents
1	Universiti Putra Malaysia	18	11	University of Essex	5
2	Universiti Utara Malaysia	14	12	Charles University	5
3	Universiti Malaya	9	13	International Islamic University Malaysia	5
4	Rijksuniversiteit Groningen	7	14	University of Sussex	5
5	University of Economics Ho Chi Minh City	7	15	Soochow University, Taipei	5
6	University of Ghana Business School	7	16	Bangor University	5
7	Universidade Federal do Rio de Janeiro	6	17	Universitas Padjadjaran	5
8	University of Kent	6	18	Kent Business School	5
9	University of Nottingham	6	19	University of Cape Town	4
10	Taylor's University Malaysia	6	20	Bank of Finland	4

**4.4. The most significant study on the subject of bank efficiency**

Mester's (1996) study on bank efficiency has received the most citations, at 397 (Table 3). This study examines bank efficiency while taking into consideration output quality and risk preferences using a stochastic cost frontier technique. The

findings demonstrate that banks use inputs inefficiently while operating at cost-effective output levels. With 345 citations, Berger et al. (1993) is the second-most cited work. This study's stochastic frontier analysis reveals that rather than high input costs, almost half of the potential variable profits are lost to inefficiency, mostly due to low output revenues. Greater banks' efficiency outperformed

that of smaller ones. Pi and Timme (1993), with 312 citations, are third on the list. This study uses data envelopment analysis to demonstrate that banks with a combined CEO and chairman have lower cost-effectiveness and return on assets than banks with separate positions, demonstrating that combined decision management and control exacerbate principal-agent conflicts. Barth et al.'s (2013) paper is the fourth-most cited study, with 276 citations. Sturm and Williams (2004), which has 206 citations, rounds out the top 5 most cited articles.

The primary focus of bank efficiency research has primarily revolved around the examination of internal operations within banks. However, the broader body of literature has broadened its scope to encompass external macroeconomic factors, the business environment, and the overall economy. This observation illustrates a growing inclination to conduct a more comprehensive analysis of bank efficiency that extends beyond internal factors.

**4.5. The most significant authors on bank efficiency**

Sufian, F., is the author with the most publications on bank efficiency, with 16 (Table 4). This demonstrates that Sufian, F. has been one of the most influential bank efficiency researchers over time. Matousek, R. is in second place with eight publications, which is less than half of Sufian's output. The best five authors, including Sufian, Matousek, Chan, Wanke, and Girardone, have published a total of 39 documents on this topic, constituting a sizeable portion of the available

research. The overwhelming majority of the 163 authors on the full list have only one to three publications on bank efficiency. Over a third of the total number of publications are produced by the leading ten journals. This demonstrates that the research on bank efficiency has been driven by a comparatively small number of prolific authors whose primary focus has been on this topic. As interest in bank efficiency persists, the concentration at the top likely indicates opportunities for new researchers to make significant contributions to the literature. The data reveals a pattern of inequality in research output, with a handful of prominent authors such as Sufian, Matousek, and Chan dominating the discussion.

**4.6. Countries that study bank efficiency most**

The United Kingdom and the United States are shown as having the most research on bank efficiency, with 50 and 47 documents, respectively, demonstrating their advanced banking systems and significant research capacity (Table 5). China and Malaysia, two emerging Asian economies with fast-growing banking sectors and a need to increase efficiency, are closely behind with 46 and 35 studies, respectively. The emphasis is on implementing best practices and technologies while maximizing cost, profit, revenue, and risk efficiency. In order to offer Malaysia and China global expertise and frameworks to identify and diagnose problems, sophisticated economies like the UK and the US collaborate extensively with both countries.

**Table 3:** The 20 most influential and frequently cited articles

Rank	Article	Cited by	Rank	Article	Cited by
1	Mester (1996)	397	11	Sufian (2009)	180
2	Berger et al. (1993)	345	12	Lozano-Vivas and Pasiouras (2010)	171
3	Pi and Timme (1993)	312	13	Chortareas et al. (2013)	170
4	Barth et al. (2013)	276	14	Girardone et al. (2004)	169
5	Lensink et al. (2008)	245	15	Fujii et al. (2014)	160
6	Drake et al. (2006)	234	16	Holod and Lewis (2011)	136
7	Bonin et al. (2005)	206	17	Ataullah et al. (2004)	131
8	Sturm and Williams (2004)	206	18	Hasan et al. (2009)	128
9	Staub et al. (2010)	203	19	Ataullah and Le (2006)	119
10	Berger and DeYoung (2001)	187	20	Sun and Chang (2011)	113

**Table 4:** The 20 most influential authors on bank efficiency

Rank	Author	Documents	Rank	Author	Documents
1	Sufian, F.	16	11	Kamarudin, F.	4
2	Matousek, R.	8	12	Komara, R.	4
3	Chan, S. G.	7	13	Liang, L. W.	4
4	Wanke, P.	6	14	Molyneux, P.	4
5	Girardone, C.	5	15	Pasiouras, F.	4
6	Habibullah, M. S.	5	16	Alhassan, A. L.	3
7	Tan, Y.	5	17	Azad, M. A. K.	3
8	Anwar, M.	4	18	Bos, J. W. B.	3
9	Chen, T. Y.	4	19	Harimaya, K.	3
10	Hasan, I.	4	20	Havranek, T.	3

The US and the UK, Malaysia, China, and Taiwan are collaborating on a number of projects and joint publications. The aim is to learn about and implement international best practices for banking sector reform. International research networks focusing on bank efficiency are expanding, enabling the pooling of international knowledge.

**4.7. Keyword analysis**

Bank Efficiency, Data Envelopment Analysis, Efficiency, Banking, and DEA are the five most frequently occurring search terms (Table 6). These top keywords indicate a significant research emphasis on bank efficiency and methods for

measuring it. Bank Efficiency appears 112 times, emphasizing its significance as a subject of study. Data Envelopment Analysis, DEA, and Efficiency are

also prominently featured, indicating that these are essential techniques for evaluating bank efficiency.

**Table 5:** The 20 nations with the most papers published

Rank	Country	Documents	Rank	Country	Documents
1	United Kingdom	50	11	Spain	13
2	United States	47	12	Netherlands	12
3	Malaysia	46	13	South Africa	12
4	China	35	14	India	11
5	Taiwan	21	15	Brazil	10
6	Greece	19	16	Germany	10
7	Viet Nam	18	17	Ghana	10
8	Australia	17	18	Italy	9
9	Indonesia	17	19	Czech Republic	8
10	France	14	20	Japan	8

**Table 6:** The top 20 keywords utilized in academic articles about bank efficiency

Rank	Keyword	Frequency	Rank	Keyword	Frequency
1	Bank efficiency	112	11	Efficiency measurement	14
2	Data envelopment analysis	89	12	Regression analysis	14
3	Efficiency	84	13	Europe	13
4	Banking	65	14	Corporate governance	12
5	DEA	35	15	Malaysia	11
6	Banks	32	16	Data envelopment analysis (DEA)	10
7	Cost efficiency	24	17	Financial crisis	10
8	Stochastic frontier analysis	23	18	Eurasia	9
9	Technical efficiency	20	19	Finance	9
10	China	15	20	Productivity	9

The emphasis remains on bank efficiency, DEA, and related methodologies, such as Stochastic Frontier Analysis, when expanding to the top 20 keywords. This demonstrates a focused research interest in these particular areas. Nonetheless, the top 20 keywords introduce new themes. China, Europe, Malaysia, and India are mentioned, demonstrating the geographical diversity of the research. Also discussed are corporate governance, the financial crisis, and bank ownership. This indicates that bank efficiency research should also consider the influence of governance, economic conditions, and bank structure. However, bank efficiency and the DEA continue to be of paramount importance.

The top five and twenty keywords indicate a research emphasis on bank efficiency as measured by data envelopment analysis and related techniques. While the top twenty introduce some peripheral topics, bank efficiency, DEA, and efficiency measurement continue to dominate. This indicates a narrowly focused research interest, with DEA-evaluated bank efficiency representing the primary themes. Increasing the number of keywords from five to twenty provides some additional context but does not substantially alter the emphasis of the most prevalent keywords.

## 5. Thematic evolution and future research directions

### 5.1. Thematic evolution

Despite a large body of literature, there are still voids in our understanding of qualitative factors that influence efficiency, such as management quality and bank culture. The relationship between efficacy and long-term profitability and stability requires more

research. It would be advantageous to conduct additional research on emerging markets and novel techniques for measuring efficiency, such as machine learning. Conceptually, methodologically, and geographically, the research on bank efficiency continues to develop and mature. The key themes and methods in bank efficiency research have substantially expanded over time, pointing to an evolution from relatively narrow investigations of efficiency measurement to a much broader investigation of internal and external drivers of bank efficiency globally, using more sophisticated techniques.

The field continues to rapidly develop along new dimensions like technology, competition, and sustainability. The 1991–2023 bank efficiency research subjects are grouped into six categories: (i) Technical and Cost Efficiency (1991–early 2000s): Early 1990s research quantified bank efficiency using stochastic frontier and data envelopment analysis. US, Germany, Croatia, and Taiwan banks were examined for technological and cost efficiency. (ii) Alternative Banking Practices (early 2000s): Researchers examined how off-balance sheet items and fee-based services affected cost and profit efficiency assessments in the early 2000s. (iii) Mid-2000s: Regulation and Macroeconomic Factors Research focused on how financial crises and regulation affected bank efficiency midway through the 21st century. Global and national bank efficiency was reviewed after the 1997 Asian financial crisis, the 2008 global crisis, and Basel standards. (iv) Bank Risk and Stability (Late 2000s to Early 2010s): Research examined the relationship between bank risk-taking, stability, and efficiency. Researchers explored how credit and market risk affect cost and profit effectiveness. (v) 2010–2019: Governance, Competition, and Development Governance elements

like board structure, ownership type, and CEO power affected bank efficiency in early 2010s research. (vi) 2020–2023: Governance, Competition, and Development: Governance, competition, institutional quality, and efficacy were assessed after 2020.

The focus of bank efficiency research has changed from technical metrics to firm-specific, institutional, and macro-financial issues over the past 30 years. A recent study shows that bank efficiency, stability, governance, competitiveness, and development are interdependent.

### 5.2. Future research directions

Based on a thorough analysis of 342 scholarly articles on bank efficiency, this study recommends five specific areas for additional research beyond

2023 (Table 7). First, as sustainability becomes imperative, future research should examine the impact of environmental, social, and governance (ESG) factors on bank efficiency. Second, academics must analyze the impact of digital transformation, including innovations in financial technology, on bank efficiency. Thirdly, research should investigate the relationship between macroeconomic conditions and bank performance in a global economy in decline. Given the intensifying risks associated with climate change, it is necessary to conduct research on how weather events, transition risks, and climate policies affect bank efficiency. Lastly, the new competitive landscape created by non-bank entrants necessitates research into the effect of increasing competition on bank efficiency.

**Table 7:** Proposed directions for future research on the topic of bank efficiency

Research topic	Research questions	reference
Impact of ESG factors on bank efficiency	<ul style="list-style-type: none"> <li>- How does a bank's ESG performance affect its efficiency?</li> <li>- What ESG factors have the biggest impact on bank efficiency?</li> <li>- Does ESG integration improve or reduce efficiency?</li> <li>- How can banks balance profitability and sustainability?</li> <li>- Which banks are leading in integrating ESG factors?</li> </ul>	Osei-Tutu (2022) and Salim et al. (2017)
Digital transformation and bank efficiency	<ul style="list-style-type: none"> <li>- How does digitalization affect bank efficiency and productivity?</li> <li>- Can AI and automation improve efficiency?</li> <li>- What is the optimal level of fintech adoption?</li> <li>- How to balance digital innovation and cybersecurity?</li> <li>- What new business models and capabilities are required?</li> </ul>	Chen et al. (2022), Lee et al. (2023), and Diallo (2018)
Declining global economy and bank efficiency	<ul style="list-style-type: none"> <li>- How will a recession affect bank efficiency?</li> <li>- What strategies can improve efficiency in downturn?</li> <li>- How to manage higher NPLs and credit risks?</li> <li>- What is the impact on cost-to-income and profitability?</li> <li>- How to balance efficiency and stability?</li> </ul>	Le et al. (2022), Mamatzakis et al. (2016), and Fujii et al. (2018)
Impact of Climate change risks on bank efficiency	<ul style="list-style-type: none"> <li>- How does climate risk exposure affect bank efficiency?</li> <li>- What is the impact of financing green transition?</li> <li>- How to accurately measure climate-related financial risks?</li> <li>- What climate stress testing approaches are most useful?</li> <li>- How to set science-based climate targets?</li> </ul>	Galán and Tan (2022), Forgione et al. (2020), and Degl'Innocenti et al. (2017)
New competitive landscape and bank efficiency	<ul style="list-style-type: none"> <li>- How will new competition from Big Tech affect efficiency?</li> <li>- What is the optimal business model to compete with neo-banks?</li> <li>- How to leverage collaborative partnerships and ecosystems?</li> <li>- What new capabilities are needed to stay competitive?</li> <li>- How to retain talent in the new landscape?</li> </ul>	Chen et al. (2022) and Banyen and Biekpe (2020)

### 6. Discussion

The literature review reveals several significant research trends in the field of bank efficiency over the past few decades. Since the 1990s, there has been an upward trend in the number of publications, which accelerated between 2005 and 2016 before leveling off in recent years. This indicates a growing interest in research, and as publication rates stabilize, there will be opportunities for new contributions.

The majority of research is published in a small number of influential finance and economics journals, particularly the Journal of Banking and Finance. Despite being advantageous for visibility, this concentration suggests opportunities for interdisciplinary expansion of bank efficiency studies.

A limited number of institutions dominate research productivity, with Malaysian universities in the lead. As an emerging economy with a growing finance sector, Malaysia's emphasis on research is

understandable; however, more geographically diverse perspectives would enrich the discourse.

Early influential research, such as Mester (1996), focused on internal bank operations, whereas more recent studies incorporated external macroeconomic factors. This modification recognizes that internal capabilities, as well as broader contextual forces, play a role in bank efficiency.

A handful of prolific authors, such as Sufian, have made substantial contributions to literature. While this is beneficial for the advancement of knowledge, there are opportunities for new researchers to leave their mark and contribute new perspectives.

The focus of research has been on advanced economies such as the United Kingdom and the United States collaborating with emergent nations such as Malaysia and China. Continuing these collaborative endeavors capitalizes on complementary strengths to generate insights.

Keyword analysis validates the research emphasis on DEA-based bank efficiency measurement. Although fundamental, efficiency measurement techniques are only one component.

Expanding the scope of techniques and subjects may reveal new research avenues.

The thematic evolution of bank efficiency research over the past three decades highlights the field's progression from narrow technical assessments to investigating a diverse range of internal and external drivers of bank performance. As Osei-Tutu (2022) found, early research in the 1990s focused predominantly on quantifying the cost and technical efficiency of banks using frontier analysis techniques. By the 2000s, studies began assessing how non-traditional banking activities and macroeconomic factors like financial crises impacted efficiency measurements (Lee et al., 2023). During the 2010s, governance attributes, competition dynamics, and institutional quality became prominent research foci, elucidating their complex relationships with bank productivity. Most recently, emerging topics include environmental, social, and governance (ESG) factors, digital transformation, and new competitive landscapes (Galán and Tan, 2022).

Based on the analysis of research trends, the authors recommend five fruitful directions for future inquiry. Firstly, assessing the impact of ESG initiatives on bank efficiency will provide actionable insights, given the growing prominence of sustainability (Osei-Tutu, 2022). Secondly, rapid digitalization necessitates researching how financial technologies are transforming operations, products, and distribution channels to affect bank productivity. Thirdly, with rising recession risks, examining how macroeconomic downturns influence bank efficiency will be beneficial. Fourthly, quantifying climate-related physical and transition risks for banks could uncover channels impacting efficiency and stability. Finally, understanding how banks can leverage partnerships and technologies to compete amidst new non-bank entrants will be increasingly important.

## 7. Conclusion

This bibliometric study provides a thorough quantitative analysis of research trends and patterns in the academic literature on bank efficiency over the past three decades. The findings demonstrate a growing interest in research, with publication rates increasing between 2005 and 2016 before leveling off in recent years. Research output continues to be concentrated among a sprinkling of prolific authors and institutions, primarily in Malaysia, indicating opportunities for participation from a broader geographic region. Early influential research centered on internal operations, while more recent works include external performance determinants such as regulation, governance, and competition. In spite of the dominance of data envelopment analysis, new methodologies such as machine learning are emerging. The geographic emphasis has transferred from advanced economies to emerging markets. The thematic scope now includes governance, competition, regulation, sustainability, and financial inclusion alongside technical factors. Regarding the

relationship between efficiency and long-term sustainability, the role of qualitative variables, and research contexts outside of major economies, however, gaps remain.

This study has limitations, including its reliance on the Scopus database and English-language publications, which may have led to the omission of some literature. It's possible that the search terms excluded some relevant articles. Citation analysis is susceptible to field size and article age. The adoption of a systematic, multifaceted methodology that integrates exhaustive literature compilation, descriptive statistical analyses, visualization techniques, and text mining mitigates limitations and provides valuable insights into the intellectual structure and evolution of this academic field.

Based on identified trends and voids, the following five directions for future research are recommended: (i) Assessing the influence of digital transformation on bank productivity; (ii) Examining bank efficiency dynamics during economic downturns; (iv) Quantifying the transmission channels from climate-related risks to bank efficiency; and (v) Understanding how banks can increase efficiency in the face of competition from non-bank entrants.

The research field of bank efficiency continues to be active and multidimensional, with ample room for ongoing innovation in techniques, contexts, and research questions. Regular quantitative reviews can aid the academic community in directing future research toward plausible avenues that address contemporary banking industry challenges. Maintaining a variety of geographical perspectives and expanding beyond the technical measurement of efficacy will enrich the discussion.

## Acknowledgment

The author received financial assistance from Ho Chi Minh University of Banking in Vietnam. This study was made possible by the generous assistance of all stakeholders involved.

## Compliance with ethical standards

## Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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