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Financial institutions efficiency: a systematic literature review*

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Abstract

This study conducts a systematic literature review on the effect of risk management on financial institutions' efficiency. Using the PRISMA method, we analysed 173 studies published between 1990 and 2023 in journals ranked by Academic Journal Guide, issued by the Chartered Association of Business Schools in 2021. The results reveal that both parametric (Stochastic Frontier Approach) and non-parametric (Data Envelopment Analysis) models are equally utilized in estimating the efficiency of financial institutions. The limitations of these methodologies are discussed, while also indicating a lack of consensus on the classification of variables. Furthermore, the results show that recent studies mainly focus on the effects of mergers and acquisitions activities, regulation, and risk management on the efficiency of banks and insurance companies. Finally, a current trend towards developing composite indices in efficiency estimation is emphasized. Findings from this study will be useful to academics, researchers, financial institution managers, policymakers, and regulators interested in financial institutions' efficiency.

Keywords*: efficiency, risk management, financial institutions, composite indices*

JEL classifications*: C61, G21, G22*

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1. Introduction

Financial institutions are essential in providing financial services to the private and public sectors. They serve as financial intermediaries that enhance capital allocation, thereby fostering economic growth and development. Furthermore, these institutions enable effective risk management, hedging, and pricing. Efficient financial institutions reduce the costs and risks associated with goods and services, contributing to economic growth and development (Herring and Santomero, 1995), while simultaneously improving the competitiveness of the financial system for optimal resource allocation.

Financial institutions can fail due to internal mismanagement or external factors such as market shocks, regulatory changes, pandemics, wars, political crises, and democratic instability (Mousavi et al., 2015). Research indicates that robust risk management and effective corporate governance enhance institutional resilience, although this may come at the expense of performance (Stulz, 2023). Identifying institutions with strong risk management practices is essential for investors seeking to increase their wealth. The survival of banks is crucial for economic developments, as it ensures the efficient transfer of financial resources (Kocenda and Iwasaki, 2021). For managers, a thorough understanding of risk management is vital for maintaining institutional resilience.

Berger and DeYoung (1997) identified that risk management influences efficiency through internal factors, such as managerial skills or *bad management* as well as external factors like market uncertainty, often referred to as *bad luck*. Increased cost (and profit) efficiency can result in mixed performance during market shocks (Assaf et al., 2019). Regulators emphasize stability and fairness underscoring the importance of information sharing among institutions with varying risk management capabilities to enhance macroprudential policies (Kim and Santomero, 1988; Herring and Santomero, 1995; Assaf et al., 2019). The public values efficiency for its role in reducing transaction costs and risks, while relying on institutional stability to prevent financial losses and crises. Trust and reputation are crucial for maintaining a stable financial system (Adeabah et al., 2022; van der Cruijsen et al., 2023). Accurate bankruptcy prediction is essential for mitigating the impacts of crises, with survival analysis models demonstrating the most effective results, followed by linear probability and multivariate discriminant analysis models (Mousavi et al., 2015).

Since the survey conducted by Berger and Humphrey (1997), empirical studies on the efficiency of financial institutions have grown significantly, as noted in a recent review by Ardia et al. (2023). Bhatia et al. (2018) highlighted a growing focus on risk and uncertainty in bank efficiency, noting the most frequently employed methods as the Stochastic Frontier Approach (SFA) and the Data Envelopment Analysis (DEA). Recent studies by Elshandidy and Acheampong (2021), Bhatia

et al. (2018), and Ahmad et al. (2020) identified and examined various variables influencing efficiency and bank performance like risk and uncertainty, ownership, financial crisis, economics of scale, and failure to disclose risk information. The latest studies utilized composite indices as a tool for early warnings of systemic risks (Ellis et al., 2022; Gulati, 2022; Malafronte et al., 2018).

The main objective of this study is defined through the following research questions:

RQ1: What are the most used methods employed in studies on the efficiency of financial institutions?

RQ2: What are the most used variables for measuring the efficiency of financial institutions?

RQ3: What are the most used measures of risk and efficiency for evaluating the impact of risk management on operational efficiency? Are composite indices utilized in the efficiency assessment of financial institutions?

Our systematic literature review (SLR) is based on the Web of Science (WoS) database and adheres to the journal quality criteria implemented by de Abreu et al. (2018) focusing on the Chartered Association of Business Schools ABS (2021) journal list categories of 3, 4, and 4*. This SLR focuses on works that examine risk management and its impact on efficiency in banks and insurance companies. To our knowledge, this is the first review that explores risk management and composite indices within financial institutions efficiency. Additionally, we evaluate the strengths and weaknesses of parametric and non-parametric methods for estimating the efficiency of banks and insurance companies. Our findings aim to help improve decisions made by financial institutions, based on the interplay between risk management, efficiency, and stability.

This paper is structured as follows: Section 2 outlines the methodology and the search procedure. Section 3 presents the bibliometric analysis. Section 4 discusses the main findings, while Section 5 provides the conclusion.

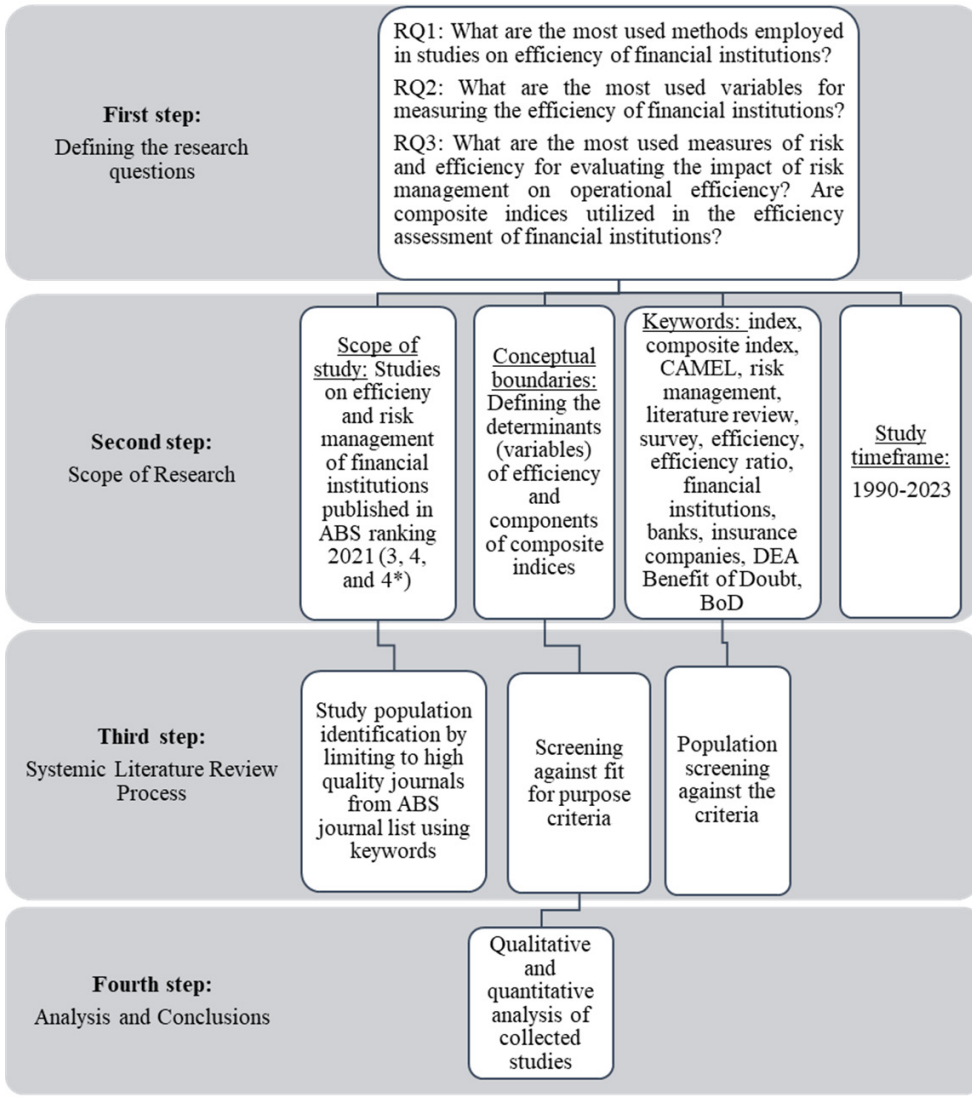
2. Methodology

In retrospect to traditional literature reviews, SLRs are superior due to their structured and objective methodology (Figure 1).

Page et al. (2021) claim that SLRs mitigate subjectivity, bias, and personal judgment through clearly defined search methods, research questions, and data extraction techniques. SLRs not only synthesize existing knowledge but also help identify research gaps and guide future studies. This paper adopts the

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. Following the work of Kuizinienė et al. (2022), Nazareth and Ramana Reddy (2023), and Shakeel et al. (2023), the authors apply the PRISMA stages: Identification, Screening, Eligibility, and Inclusion. This structured methodology enhances the review's transparency and replicability, ensuring a rigorous and high-quality analysis.

Figure 1: Stepwise process of a SLR



Source: Authors' construction according to the PRISMA framework by (Page et al., 2021)

2.1. Identification

To define a representative sample, authors in this study included published articles, reviews, and empirical studies in English from 1990 to 2023, while excluding conference proceedings, books, book chapters, working papers, early open-access publications, and unpublished studies. The focus on investigating only the WoS (Web of Science) database is based on studies by Martín-Martín et al. (2021), Visser et al. (2021), and Mongeon and Paul-Hus (2016) who reported a significant overlap of 80% to over 90% with the Scopus database. WoS is considered a gold standard for bibliometric studies (Birkle et al., 2020; Zhu and Liu, 2020). Following the guidelines established by Ali et al. (2023), Almeida and Gonçalves (2023), and de Abreu et al. (2019) our SLR focused on journals ranked 3, 4, and 4* in the ABS (2021) list, a common quality criterion among UK academics (Walker et al., 2019). This categorization allows for an objective measure of study quality by focusing on highly rated journals (Ali et al., 2023; Ali and Wilson, 2023; Almeida and Gonçalves, 2023; de Abreu et al., 2019).

In this SLR, we selected 454 journals rated 3, 4, and 4* from the ABS (2021) list. Followed by a manual search of the WoS database using a specific combination of keywords such as *index* OR *composite index* AND *CAMEL* (Capital Adequacy, Asset Quality, Management Efficiency, Earnings, Liquidity) AND *risk management literature review* OR *survey* AND *efficiency* OR *efficiency ratio* AND *financial institutions* OR *banks* OR *insurance companies*, as well as methodological terms *DEA* AND/OR *Benefit of Doubt* OR *BoD*. This search strategy yielded 19,383 results as of December 31st, 2023, with searches conducted between September and December 2023.

2.2. Screening

From the initial pool of 19,383 results, we used Excel's duplicate detection tool to eliminate 13,783 duplicate papers, which left us with 5,600 papers for the screening phase. The screening process, conducted alongside the identification phase, involved excluding papers beyond the scope of the study. By reviewing the titles and abstracts, 5,427 non-relevant studies were eliminated, resulting in a final sample of 173 studies, of which 120 (69%) are from rank 3 journals, 40 (23%) from rank 4, and 13 (8%) from rank 4* journals.

2.3. Eligibility

To evaluate the eligibility of the full-text articles sample we have applied specific inclusion and exclusion criteria:

Inclusion Criteria:

- Studies that focus on the risk-adjusted efficiency of financial institutions.
- Studies that incorporate composite indices to measure the efficiency of financial institutions.
- Studies that outline and compare various methods for estimating efficiency.

Exclusion Criteria:

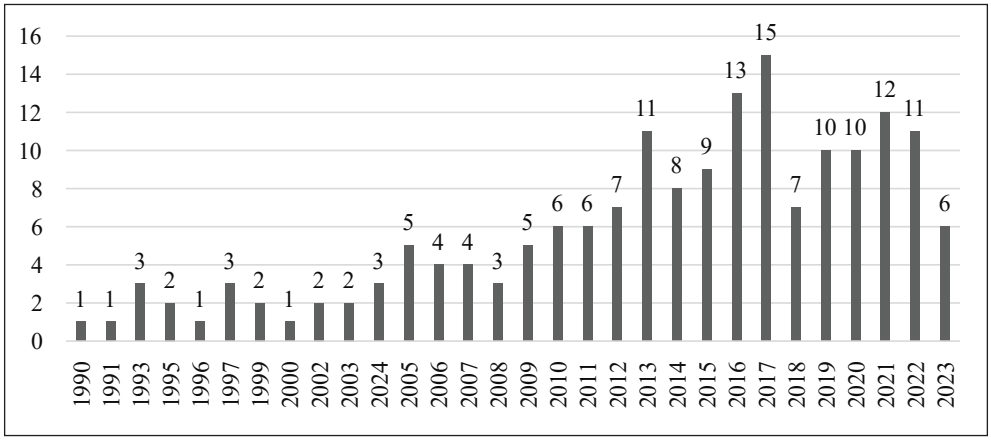
- Studies that have exclusively focused on the financial market from a macroeconomic perspective and deal with trading efficiency and stock price movements.
- Studies that do not focus on the efficiency of financial institutions, risk management, and composite indices in finance.
- Studies with unclear methodologies.

Among the 173 articles evaluated, 35 were identified as theoretical or conceptual, while 138 were classified as empirical studies and included in the bibliometric analysis (Figure A in the Appendix).

2.4. Inclusion

Bibliometric analysis involved the collection of author details, year of publication, journal, keywords, methods, variables, and results. Figure 2 illustrates the distribution of 173 published articles from 1990 to 2023. The highest number of articles was published in 2017 (15), followed by 2016 (13), 2021 (12), and both 2013 and 2022 with 11 alongside 2019 and 2020 with 10 articles.

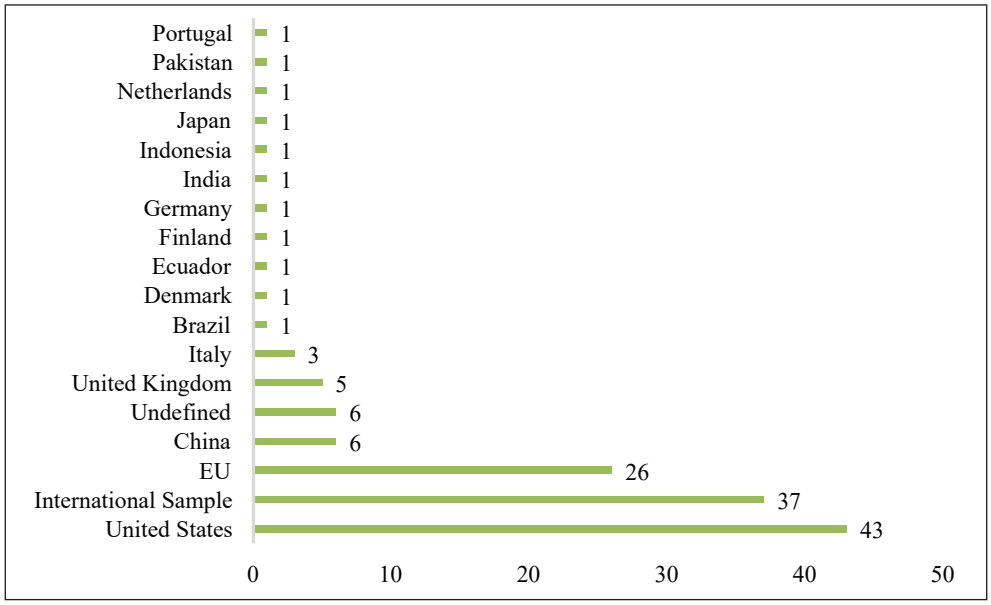
Figure 2: Temporal distribution of published articles



Source: Author's construction

Total of 541 authors contributed to these studies, with most papers co-authored by two authors (67 papers; 39%) or three authors (43 papers; 25%). Single-author studies accounted for 17% (30 papers), while 15% (26 papers) had four authors, and 3% (5 papers) had five authors. Only one study involved six (Babecký et al., 2014) and another seven authors (Mohsin et al., 2021). Figure 3 illustrates the geographical distribution of the 138 empirical studies reviewed. Among these, 43 studies (31%) focused on U.S. financial institutions, 37 studies (27%) utilized international samples, and 26 studies (19%) analysed data from European Union countries. Additionally, six studies (4%) concentrated on Chinese financial institutions, and five studies (4%) examined UK institutions, while the geographical area remained unidentified in six studies (4%).

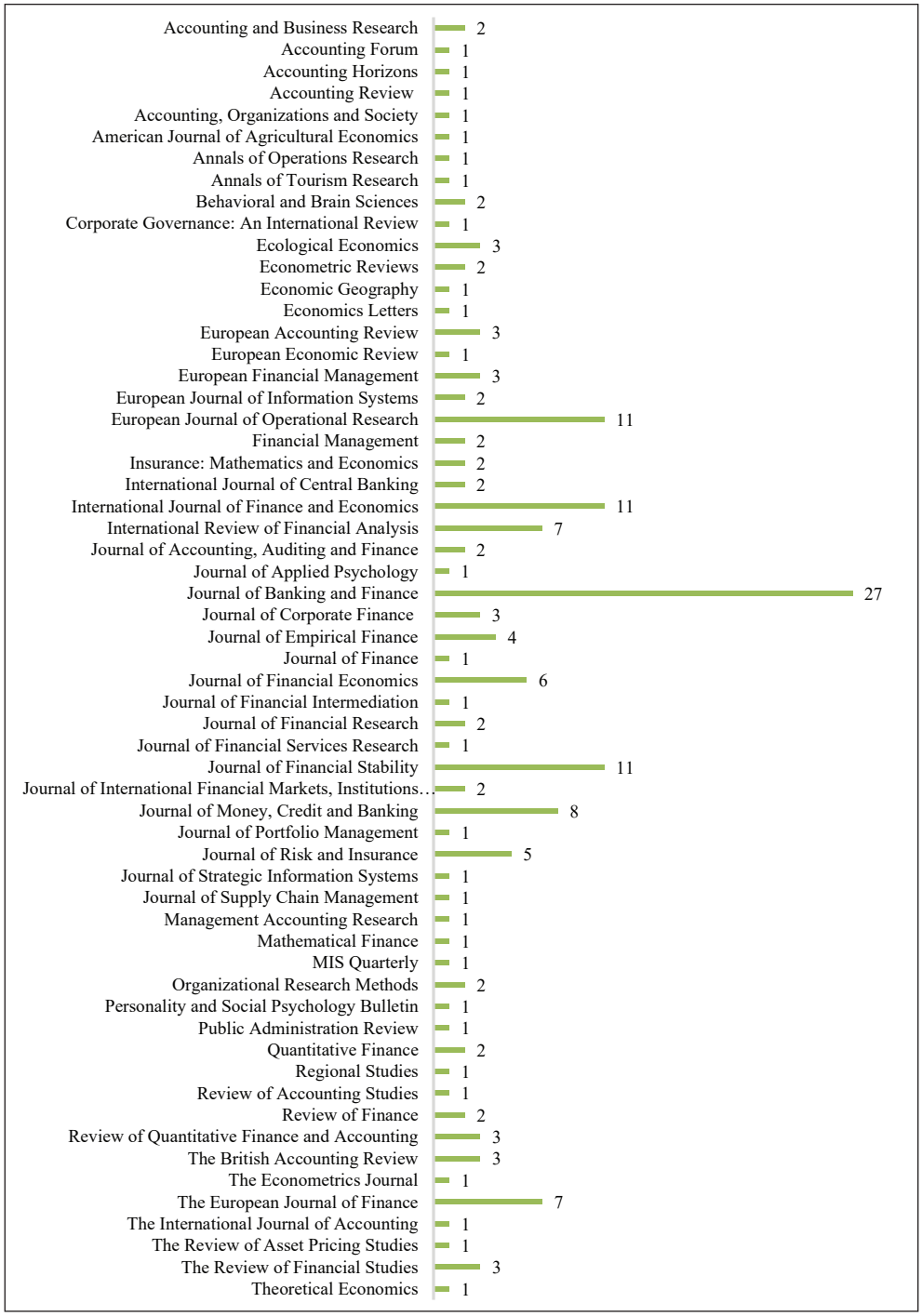
Figure 3: Geographical distribution of 138 empirical studies



Source: Author's construction

Out of the 173 studies, 59 were published at the top ranked journals according to the ABS (2021) list (Figure 4). *Journal of Banking and Finance* leads with 27 papers and boasts the highest citation count, followed by the *Journal of Financial Stability* (11 papers), the *International Journal of Finance and Economics* (11 papers), and the *European Journal of Operational Research* (11 papers). The *Journal of Money, Credit and Banking* published 8 papers, while both the *International Review of Financial Analysis* and the *European Journal of Finance* published 7 papers each.

Figure 4: Distribution of sampled empirical studies by publications in journals



Source: Author's construction

Most cited studies are Landis et al. (2000) on composite measures (849 citations), Berger and DeYoung (1997) on problem loans and cost efficiency (828 citations), and Acharya et al. (2017) on systemic risk (741 citations). Followed by Berger et al. (2009) with 529, beside Bonin et al. (2005) with 514, and Abedifar et al. (2013) with 356 citations. Recently, studies on risk and financial stability such as Benoit et al. (2017), Schaeck and Cihák (2014), Altunbas et al. (2007) and Crook et al. (2007) each amassed over 200 citations.

Recent topics in literature concentrate on determinants of risk and its effects on financial institutions' efficiency and stability. Furthermore, the development and comparison of composite indices yield equal or greater insights than individual financial indicators, as noted by the OECD (2008). Composite indices are invaluable for policymakers and stakeholders, as they distil complex, multidimensional concepts into more comprehensible formats. Ghosh (2015) and Gambacorta and Shin (2018) examined the determinants of non-performing loans (NPLs) and the role of capital in monetary policy. Based on findings from this SLR, the most frequently cited authors are Allen Berger (Berger et al., 2009; Berger and Bonaccorsi di Patti, 2006; Berger and DeYoung, 1997; Berger and Humphrey, 1997 Berger et al., 1993) and Mamatzakis (Mamatzakis et al., 2023; Mamatzakis, 2015; Kalyvas and Mamatzakis, 2014; Mamatzakis and Bermpei, 2014), followed by Rogge (Rogge, 2018; Van Puyenbroeck and Rogge, 2018; Verbunt and Rogge, 2018).

3. Review of the sampled literature

The primary advantage of employing PRISMA framework in a SLR is its focus on quality and transparency (Page et al., 2021). This framework guarantees a comprehensive presentation of commonly utilized methods, variables, and performance or efficiency metrics within the field, thereby enhancing the reliability and replicability of the research findings.

3.1. Overview of the methods in financial institutions' efficiency estimation

Financial institutions' efficiency is traditionally assessed using financial data from balance sheet and profit/loss statements, with a focus on profitability ratios such as return on assets (ROA) and return on equity (ROE). However, the efficiency ratio, which compares non-interest costs (overhead) to gross income, is a more suitable measure of efficiency (Fukuyama and Tan, 2022; Hays et al., 2009; Forster and Shaffer, 2005). Although financial indicators are widely accessible and relatively straightforward to interpret, they can sometimes be misleading. To mitigate this issue, parametric (SFA) and non-parametric (DEA) models are frequently employed (Murillo-Zamorano, 2004; Berger and Humphrey, 1997). Recent discussions by Učkar and Petrović (2021b) highlight that the efficiency of financial institutions is

influenced by various economic theories, including microeconomic theory, agency theory, and financial intermediation theory. Demsetz's (1973) efficient structure hypothesis suggests that institutions that operate more efficiently are likely to be more profitable and capture a larger market share. Both parametric and non-parametric methods are employed almost equally in efficiency estimation (Učkar and Petrović, 2021b; Berger and Humphrey, 1997).

The 138 empirical studies can be categorized into two groups (Table 1) based on frontier analysis: parametric studies (SFA) with 22 (15.94%) articles and 32 (23.19%) non-parametric studies (DEA). Additionally, econometric methods, such as OLS and panel regression were employed in most studies 84 (60,87%). Many studies, regardless of the model, conducted robustness tests on efficiency results through both static (OLS) and dynamic (GMM) panel data analyses. Studies using SFA and econometric models focus on the effects of regulation on bank performance (Barra et al., 2022; Ayadi et al., 2016; Kalyvas and Mamatzakis, 2014; Dimitras et al., 2018), on the effect of regulatory capital and bank failure (Abou-El-Sood, 2015), and the implementation of International Financial Reporting Standards (IFRS) by Kyiu and Tawiah (2023). SFA is also used to evaluate the impact of corporate governance on efficiency (Chen et al., 2021; Abedifar et al., 2013; Leventis et al., 2013), transparency and competition (Andrievskaya and Semenova, 2016). A major topic of SFA studies is the effect of mergers and acquisitions (M&A) on efficiency (Mamatzakis et al., 2023; Gang et al., 2018; Altunbas et al., 2007; Choi and Weiss, 2005: Williams and Gardener, 2003; Shaffer; 1993) that support Demsetz's (1973) efficient structure hypothesis. Nonetheless, studies by Mühlnickel and Weiss (2015), Amel et al. (2004), Cummins et al. (1999), and Fixler and Zieschang (1993) report contradictory results. Similar studies on M&A employ DEA methodology (Proaño-Rivera et al., 2023; Nippani and Ling, 2021; Učkar and Petrović, 2021a; McKee and Kagan, 2018; Pessarossi and Weill, 2015; Hadad et al., 2011). Followed by studies on regulation (Mohsin et al., 2021; Chortareas et al., 2016) and on the impact of risk on efficiency. Positive effects from adequate risk management on efficiency are reported by Stulz (2023), Lartey et al. (2021), Eling and Jia (2018), Mamatzakis and Bermpei (2014), and Chan et al. (2013) while Boussemart et al. (2019) reports negative effects.

Table 1: Parametric and non-parametric models

Model	Number of studies	Definition	Banks	Insurance Companies	Context
SFA	22/138 (15.94%)	SFA is the most widely used parametric method for estimating efficiency. Described by Berger and Humphrey (1997) as an econometric frontier approach it was introduced by Aigner et al. (1977), Battese and Corra (1977), and Meeusen and van Den Broeck (1977). This method is frequently modelled using a Cobb-Douglas production function (Williams and Gardener, 2003)	Agliardi et al. (2012) Altunbas et al. (2007), Barra et al. (2022), Berger et al. (2009), Bolt and Humphrey (2010), Bonin et al. (2005), Bos and Kool (2006), Dong et al. (2017), Fries and Taci (2005) Gang et al. (2018) Kalyvas and Mamatzakis (2014), Mamatzakis (2015), Mamatzakis and Bermpei (2014), Maudos et al. (2002), Mester (1996), Safiullah and Shamsuddin (2019), Shamshur and Weill, (2019), Sun and Chang (2011), Williams, (2004), Williams and Gardener (2003), Zamore et al. (2023).	Mamatzakis et al. (2023)	The primary limitation of SFA is the necessity of a functional form and the relationships involving costs, profits, or production in relation to inputs, outputs, and environmental factors (Berger and Humphrey, 1997). Defining these relationships is relatively straightforward for goods producers, it becomes more complex for service providers, particularly in the financial sector. Depending on the model employed, variables such as deposits in banking or incurred claims in insurance may be classified as inputs, outputs, or both (Učkar and Petrović, 2021b). SFA necessitates compliance with sample size and distribution axioms due to its stochastic nature.
DEA	32/138 (23.19%)	DEA is a linear programming approach designed to optimize input-output efficiency. First introduced by Charnes et al. (1978) under the assumption of constant returns to scale (CRS), known as the CCR model. Banker et al. (1984) extended the model to account for variable returns to scale (VRS), also known as the BCC model.	Asmild and Zhu, (2016), Ayadi et al. (2016), Barth et al. (2013), Boussemart et al. (2019), Canhoto and Dermine (2003), Chan et al. (2013), Chang (1999), Chortareas et al. (2016), Chortareas et al. (2012), Eling and Jia (2018), Fukuyama and Tan (2022), Gaganis et al. (2021), González(2009), Hadad et al. (2011), Lartey et al. (2021) Maudos et al. (2002), McKee and Kagan (2018), Mohsin et al. (2021), Nippani and Ling (2021) Pessarossi and Weill (2015), Proaño-Rivera et al. (2023), Spokeviciute et al. (2019).	Cummins et al. (1999), Eling and Jia, (2018), Huang et al. (2011)	DEA methodology is widely utilized across various disciplines, including finance, due to its simplicity, versatility, and minimal assumptions regarding the inputs and outputs of decision-making units (DMUs). It is particularly well-suited for smaller sample sizes (Emrouznejad and Yang, 2018). Its primary limitation is the absence of a random error term, making it highly sensitive to inaccurate data. Inaccuracies are classified as DMU inefficiency rather than statistical noise. Consequently, studies typically employ a two-stage procedure or an econometric approach to further validate their results.

Source: Author's construction

Studies by Zamore et al. (2023), Tan and Tsionas (2022), Baule and Tallau (2021), Nippani and Ling (2021), Simper et al. (2019), and Marton and Runesson (2017) used NPLs, loan loss provisions (LLPs) and loan loss reserves (LLRs) as credit risk proxies and reported a positive relationship between risk management and efficiency. Furthermore, Alzayed et al. (2023) and Kumar et al. (2022) utilized the CAMEL framework to study the effect of corporate governance and risk management on efficiency. Abendschein and Grundke (2022) and Acharya et al. (2017) report that bank-specific variables are more relevant in less volatile markets. Bernard et al. (2019), Bohnert et al. (2018), and Lechner and Gatzert (2018) state that enterprise risk management is positively influenced by firm size and diversification (Lee and Li, 2012), therefore enhancing efficiency. Fredriksson and Moro (2014), Zhang et al. (2013), and Brewer and Jackson (2006) find that incorporating bank-specific risk variables diminishes the significance of the negative relationship between market concentration and performance, where lower-risk banks perform better.

3.2. Input and output data in efficiency estimation

The selection of methods and variables for efficiency estimation is critical, as it significantly influences the reliability of results. Due to the absence of a consensus on the most effective approaches, efficiency studies yield varied outcomes (Aiello and Bonanno, 2018). Učkar and Petrović (2021b) highlighted the importance of evaluating key variables, particularly in sectors such as banking and insurance, where inadequate variable selection (e.g., deposits or incurred losses) can adversely affect empirical findings. Consequently, choosing appropriate variables is essential to prevent misleading conclusions.

Although there is no consensus, studies indicate some overlap in variables used in efficiency estimation as shown in Table 2 (Ahmad et al., 2020; Bhatia et al., 2018; de Abreu et al., 2018; Berger and Humphrey, 1997).

Table 2: Most common input and output variables

Model	Studies	Inputs	Outputs
SFA	Altunbas et al. (2007), Barra et al. (2022), Gang et al. (2018), Kalyvas and Mamatzakis (2014), Mamatzakis et al. (2023), Mamatzakis and Bermpei (2014), Pessarossi and Weill (2015), Williams and Gardener (2003), Zamore et al. (2023), Bolt and Humphrey (2010), Bos and Kool (2006), Mester (1996), Ruinan (2019), Safiullah and Shamsuddin (2019), Shamshur and Weill (2019), Srairi (2010), Williams (2004).	*Banks:* Loan-loss reserves; interest rate spread/3-year government bonds; operating expenses/total assets; number of employees; number of branches; loan loss reserves/ gross loans (as proxy for risk); nonperforming loans; labour expenses; administrative expenses; interest expenses; non-interest expenses; total cost; administration expenses/ total assets; net technical provisions/total assets; equity; assets; personnel expenses/total assets; total earning assets, total operating expenses/fixed assets; interest expenses/total assets; book value of equity/total assets; operating costs or overhead *Insurance companies:* Total equity, total investments, operating costs, investment costs, claims incurred	*Banks:* ROA; ROE; current assets/ current liabilities; loans (differentiated by type); services; securities; net claims paid; total investments; customer deposits; non-interest income; ordinary profits/sum of equity and reserves; net loans/total assets; ln (total assets); *Insurance companies:* ROA; ROE; Earned premiums, investment income
DEA	Boussemart et al. (2019), Chan et al. (2013), Chortareas et al. (2016), Chortareas et al. (2012), Eling and Jia (2018), Hadad et al. (2011), Lartey et al. (2021), McKee and Kagan (2018), Mohsin et al. (2021), Nippani and Ling (2021), Pessarossi and Weill (2015), Proaño-Rivera et al. (2023), Barth et al. (2013), Canhoto and Dermine (2003), Chang (1999), Cummins et al. (1999), González (2009), Huang et al. (2011), Ruinan (2019), Spokeviciute et al. (2019)		

Source: Author's construction

The main approaches are the *intermediation approach*, which emphasizes the transfer of funds through deposits and premiums, and the *operating approach*, which focuses on financial operations. Inputs and outputs typically encompass balance sheet components such as total assets, loans, equity, and deposits, with income and expenses categorized by type (e.g., interest, non-interest, or incurred claims for insurance). Recent studies also use environmental factors (Breitenstein et al., 2021; Lozano-Vivas et al., 2002; Pastor et al., 1997), control variables for GDP, inflation, ownership and bank size (Barth et al., 2013; Sun and Chang, 2011; Srairi, 2010), and financial indicators such as ROA, ROE, and NPLs, LLRs and LLPs to account for credit risk (Bischof et al., 2022; Bhat et al., 2021; Chen et al., 2021; Afzal et al., 2020; Dong et al., 2017; Ghosh, 2015; Matousek et al., 2015; Leventis et al., 2013). For instance, Safiullah and Shamsuddin (2019) utilized common inputs and outputs and introduced risk proxies for operational risk (standard deviation of ROA), insolvency

risk (Altman's Z-score), credit risk (LLRs), and liquidity risk (liquidity ratios). Ferro and León (2018) report on a consensus on inputs (labour and capital) for insurance companies but note a lack of agreement on methodologies and variable combinations across studies (Aiello and Bonanno, 2018). Consequently, the results between studies vary significantly (de Abreu et al., 2019; Bhatia et al., 2018), thus complicating cross-study comparisons (Henriques et al., 2020).

3.3. Measures of risk and efficiency

From our study, we may conclude that the effect of risk management on financial institutions has become a central focus of numerous studies. Mester (1996) noted that neglecting the influence of risk on efficiency could lead to misleading conclusions. Building on the work of Hughes and Mester (2008), Berger and DeYoung (1997), and Berger and Mester (1997), many studies have investigated risk-adjusted efficiency. Brewer and Jackson (2006) discovered that banks with lower NPLs tend to offer lower deposit rates. Sun and Chang (2011) and Chang (1999) demonstrated that risk measures (such as NPLs) significantly influence bank efficiency. Berger and DeYoung (1997) argued that cost efficiency during stable periods mitigates the risk of failure during crises, a viewpoint supported by Assaf et al. (2019), who emphasized the importance of cost efficiency over profit efficiency due to riskier investments.

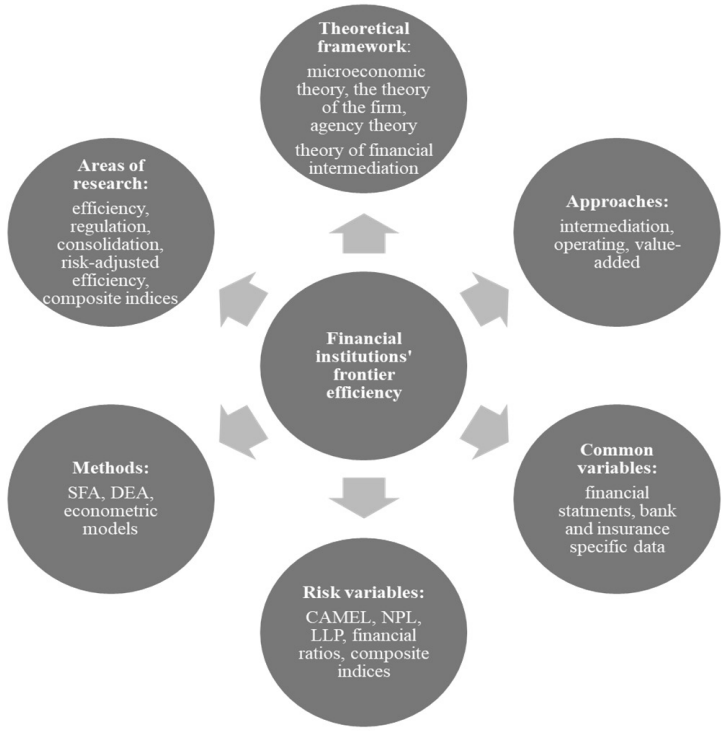
The results from our SLR show an uptake in the use of composite indices in efficiency estimation. When constructed properly, composite indices can effectively inform government policy. Unlike financial ratios, composite indices incorporate multiple components to summarize multidimensional concepts without sacrificing essential information (Purvis and Genovese, 2023). The PRISMA framework used in this SLR has identified several studies that utilized composite indices (Pinto et al., 2020; Rogge, 2018; Verbunt and Rogge, 2018; Acharya et al., 2017; Babecký et al., 2014; Schaeck and Cihák, 2014; Foster et al., 2013; Leventis et al, 2013; Groh et al., 2010; Sahoo and Acharya, 2010). Composite indices must be constructed with care, following the 10-step framework outlined in the OECD (2008) Handbook. A common challenge in constructing composite indices is determining the weight of each component (Foster et al., 2013). Some studies assign equal weights, while others base the weights on professional opinion, employing questionnaires to rank the importance of each component (Hatefi and Torabi, 2018). Paruolo et al. (2013) recommended utilizing Pearson's correlation coefficient to address issues related to weighting and aggregation while Choi (2023) proposed projected principal component analysis. To mitigate the limitations of equal weighting, more sophisticated methods have been employed, such as the ASW algorithm used by Elshandidy et al. (2024). The Benefit of Doubt (BoD) DEA model, introduced by Melyn and Moesen (1991), is frequently applied to minimize bias in the allocation of component weights (Gulati, 2023; Gulati et al., 2023; Maricic and Jeremic, 2023; Gulati et al., 2020; Färe et al., 2019; Rogge,

2018; Verbunt and Rogge, 2018; Van Puyenbroeck and Rogge, 2018; Cherchye et al., 2008). CAMEL framework has been adopted as a risk proxy in various studies (Alzayed et al., 2023; Kumar et al., 2022; Chen et al., 2021; Nippani and Ling, 2021; Afzal et al., 2020; Hwa et al., 2018; Beltratti and Paladino, 2016). Williams and O'Boyle (2011) and Landis et al. (2000) found that composite indices generally enhance model fit in structural equation models.

4. Discussion

Utilizing the PRISMA framework, this study's results indicate that DEA and SFA are the most frequently used methods for assessing efficiency in financial institutions, providing valuable insights for academics, investors, policymakers, managers, regulators, and the general public. The study focuses on identifying key input and output variables and explores the use of composite indices in constructing risk management indices and estimating risk-adjusted efficiency. Our findings, summarized in Figure 5, identify six key determinants of financial institutions' efficiency.

Figure 5: Financial institutions' frontier efficiency estimation framework

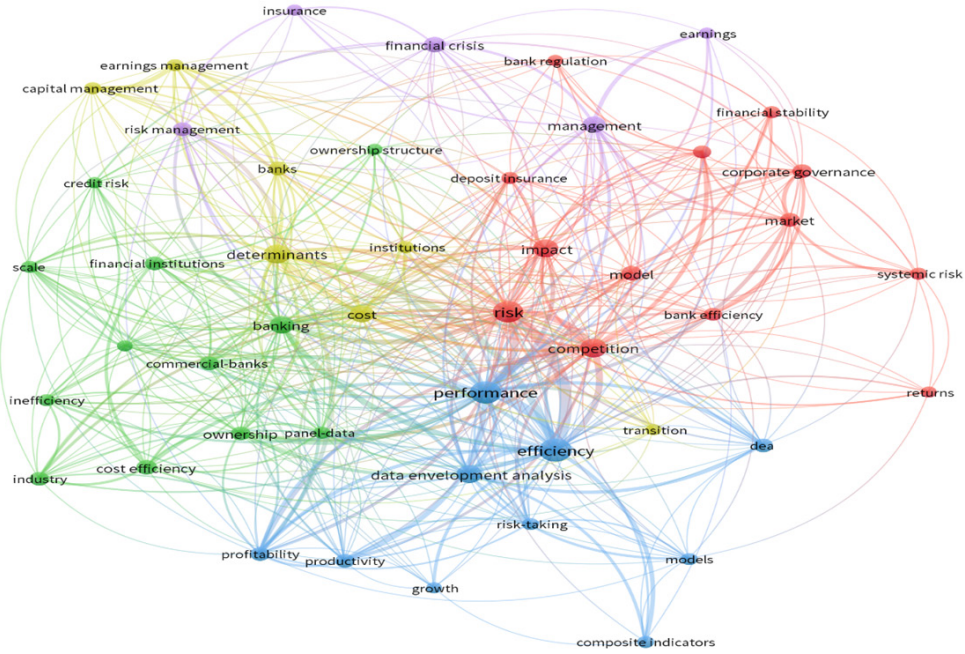


Source: Authors' construction

Depending on whether the intermediation or operating approach is employed, data is sourced from either the balance sheet or the income statement. Studies also incorporate bank and insurance company's specific data (such as ownership, employee count, and risk measures), macroeconomic indicators (including inflation and GDP), and environmental variables. The choice between a parametric and nonparametric model is contextual, as both have distinct advantages and limitations (Ahmad et al., 2020; Aiello and Bonanno, 2018; Bhatia et al., 2018; de Abreu et al., 2018; Murillo-Zamorano, 2004; Berger and Humphrey, 1997). Our SLR categorizes studies focusing on *efficiency* (Proaño-Rivera et al., 2023; Kumar et al., 2022; Nippani and Ling, 2021; Shamshur and Weill, 2019; Eling and Jia, 2018), the impact of *regulation* on efficiency (Kyiu and Tawiah, 2023; Mohsin et al., 2021; Gambacorta and Shin, 2018; Pessarossi and Weill, 2015; Kalyvas and Mamatzakis, 2014; Barth et al., 2013), the effects of *consolidation* (Andrievskaya and Semenova, 2016; Mühlnickel and Weiss, 2015; Bolt and Humphrey, 2010; Amel et al., 2004; Cummins et al., 1999; Fixler and Zieschang, 1993), the role of *risk management* (Mies 2024, Sen, 2023; Zamore et al., 2023; Bhat et al., 2021; Boussemart et al., 2019; Lechner and Gatzert, 2018; Lee and Li, 2012), and the application of *composite indices* (Choi, 2023; Abendschein and Grundke, 2022; Gaganis et al., 2021; Gang et al., 2018; Mohanram et al., 2018; Acharya et al., 2017; Babecký et al., 2014; Schaeck and Cihák, 2014; Islami and Kurz-Kim, 2013; Hu et al., 2012). The diversity of financial institutions' efficiency is evident in the thematic map shown in Figure 6, which shows multiple connections between the 773 keywords used in 138 empirical studies.

Figure 6 not only provides a snapshot of the thematic diversity in financial institutions' studies but also highlights critical areas requiring further exploration. The largest cluster (red) is on risk and its impact on bank efficiency, competition, returns and financial stability which indicates the rising interest in risk-adjusted efficiency of financial institutions. The green cluster specifically focuses on technical efficiency, scale, cost efficiency and the effect of ownership on bank efficiency and other financial institutions. The blue cluster focuses on efficiency and performance of financial institutions including risk-taking, identifying DEA as one of the most important methods for efficiency estimation and composite indicators as a new avenue for efficiency studies. Methodological advancements in these areas could support the development of standardised metrics in efficiency estimation, allowing for direct ranking and comparability between financial institutions. The fourth cluster is denoted as yellow and outlines keywords such as determinants of bank efficiency, financial institutions, capital, earnings and cost management as the main topics of several empirical studies. The last cluster is purple and focuses on risk management, insurance, financial crisis and earnings which encompasses the consequences of inadequate risk management during the great financial crisis and more recently the collapse of Silicon Valley Bank.

Figure 6: Thematic map based on the keywords co-occurrence between 138 empirical studies



Source: Keyword co-occurrence network of 138 empirical studies using the VOSviewer software 1.6.20 (2024)

By analysing these clusters, researchers can identify leading trends such as the effect of risk management, and emerging methodologies such as DEA BoD model for composite indices construction, paving the way for more comprehensive and comparative research. This thematic map underscores the need for cross-regional studies especially in underrepresented regions (Africa and Latin America) to bridge gaps and achieve a more comprehensive understanding of financial institutions' efficiency.

We emphasize the necessity for further research to refine risk measures and their influence on efficiency. While there is no consensus on approaches for estimating efficiency, most common are the intermediation and operating approach. In our SLR, we have identified frequently used variables in accordance with Radojicic et al. (2018). However, debates persist regarding the classification of deposits in banking and claims in insurance. Our final insight is the increasing application of DEA BoD models in developing composite indices for risk management, aimed at evaluating risk-adjusted efficiency. These indices have the potential to yield more accurate results and improve internal assessments of risk management practices.

5. Conclusion

Although numerous studies have synthesized the extensive literature on the efficiency of financial institutions, significant gaps remain in understanding the most utilized theories, methodologies, variables, and research domains. This systematic review further investigates risk-adjusted efficiency and expands comprehension of composite risk management indices, simultaneously elucidating new evidence on precise efficiency estimations. Ongoing challenges, such as the lack of consensus on approaches, methods, and variables, contribute to the heterogeneity observed within the literature. This review determines that parametric (SFA) and non-parametric (DEA) methods are the predominant techniques utilized for efficiency estimation (RQ1). Furthermore, it is anticipated that future developments will increasingly incorporate machine learning (ML) and artificial intelligence (AI) to overcome existing methodological limitations. Although significant progress has been made in the field, numerous challenges remain unresolved, including inconsistencies in the classification of variables, along with insufficient practices and broader considerations such as macroeconomic, environmental, and governance factors. Proxies, including non-performing loans (NPLs), loan loss provisions (LLPs), loan loss reserves (LLRs), capital ratios, and profitability ratios, have gained prominence in financial institutions efficiency studies (RQ2). However, further research is required to explore the practical implementation of these proxies. The growing use of composite indices shows potential for synthesizing complex multidimensional data into accessible metrics that assess risk-adjusted efficiency (RQ3).

This study provides several innovative contributions. First, it identifies the most commonly employed theories, methodologies, and variables in efficiency estimation, providing valuable insights into the current state of the field. Moreover, the focus on risk-adjusted efficiency and composite indicators makes this SLR unique in its approach to synthesise the large body of knowledge provided by studies on financial institutions efficiency. Secondly, this SLR not only outlines the current state of financial institutions efficiency but also highlights areas for improvement, including the integration of risk-adjusted efficiency measures and the formulation of composite indicators to enhance risk management quality ranking and comparability among financial institutions. The importance of this area of study cannot be overstated. The efficiency of financial institutions is fundamental for maintaining financial stability, fostering economic growth and enhancing institutional resilience. In an era marked by rising risks and systemic shocks such as war conflicts, trade wars, biohazard threats and technological disruptions, a deeper understanding of the risk-adjusted efficiency of financial institutions is more important than ever. Additionally, the growing significance of cryptocurrencies and blockchain technology adds to this complexity. This study lays a foundation for addressing future challenges and provides valuable insights for both researchers and policyholders.

Future research should prioritize illuminating the existing lack of consensus concerning key variables, specifically deposits in the banking sector and incurred claims in the insurance industry. Additionally, further studies are encouraged to explore the influence of risk management practices in conjunction with environmental, social, and governance (ESG) factors on the efficiency of financial institutions. The methodological limitations of DEA and SFA outlined in this study can be improved by integrating ML and AI techniques to incorporate an error term in nonparametric models and specify an adequate production function specifically tailored to financial institutions. It is vital for future studies to prioritize the implementation of composite indices in efficiency estimation, particularly the development of Risk Management Indices (RMI). These indices could significantly enhance decision-making processes by providing standardized measures of risk management quality and facilitating comparability across institutions. The findings from this study are valuable to regulators as the advancements in risk-adjusted efficiency could refine regulatory frameworks, including Basel IV and Solvency II. These improvements could also strengthen early warning systems and support macroprudential objectives aimed at ensuring financial stability, thus supporting policyholders macroprudential goals. An understanding of risk-adjusted efficiency provides managers with valuable insights into best practices in risk management, thereby facilitating the identification of critical areas for improving operational performance. The RMI could provide a basis for practical insights in identifying institutions that possess a competitive advantage in cost management and financial stability. By addressing these priorities, future research has the potential to bridge the gaps identified in this review, stimulate the development of innovative methodologies, and provide guidance to stakeholders in their pursuit of more accurate and meaningful efficiency estimations within financial institutions.

The findings of this study provide several practical implications for policymakers and regulators by providing insights into the most important methodologies in efficiency estimation, as well as new trends in estimating risk-adjusted efficiency and the use of composite indices. The advancements in risk-adjusted efficiency indices, including the development of RMIs, can advise the refinement of regulatory frameworks such as Basel IV and Solvency II. The development of standardized measures of risk management quality, such as the proposed RMIs could be of support to policymakers in achieving their macroprudential objectives of an efficient and stable financial system by enhancing early warning systems and reducing the probability of financial institutions failures. On a similar note, financial institution managers could be motivated by the insights provided in this study to estimate risk-adjusted efficiency and leverage insights from studies to identify best practices in risk management and operational performance. Thus, the development of RMIs would serve as benchmarks for assessing and improving cost management and financial stability.

While this study provides valuable insights, it is not without limitations. By focusing exclusively on risk-adjusted efficiency of financial institutions, it excludes studies on the efficiency of entire financial systems and those examining ESG factors. Although this exclusion was intentional to maintain a clear scope, it highlights areas for improvement in future studies. Additionally, the reliance on studies published in high-quality journals, as identified by the ABS journal guide, and the sole focus on the WoS database may have excluded relevant studies from other sources, such as Scopus. Limitations of this study, also, could be identified in its geographical scope, as regions such as Africa and Latin America remain underrepresented. Despite the outlined limitations, we believe that this SLR contributes to the understanding of financial institutions efficiency while defining new research paths for future scholars.

Finally, this study contributes to a deeper understanding of financial institutions' efficiency and offers a novel area for future research. By addressing the identified gaps, researchers can develop more standardised and innovative approaches to efficiency estimation. Policymakers, in turn, can leverage these advancements to design more effective regulatory frameworks, ensuring the resilience and stability of financial systems. The integration of risk-adjusted efficiency metrics into decision-making processes represents a crucial step forward, fostering a more robust and sustainable financial system.

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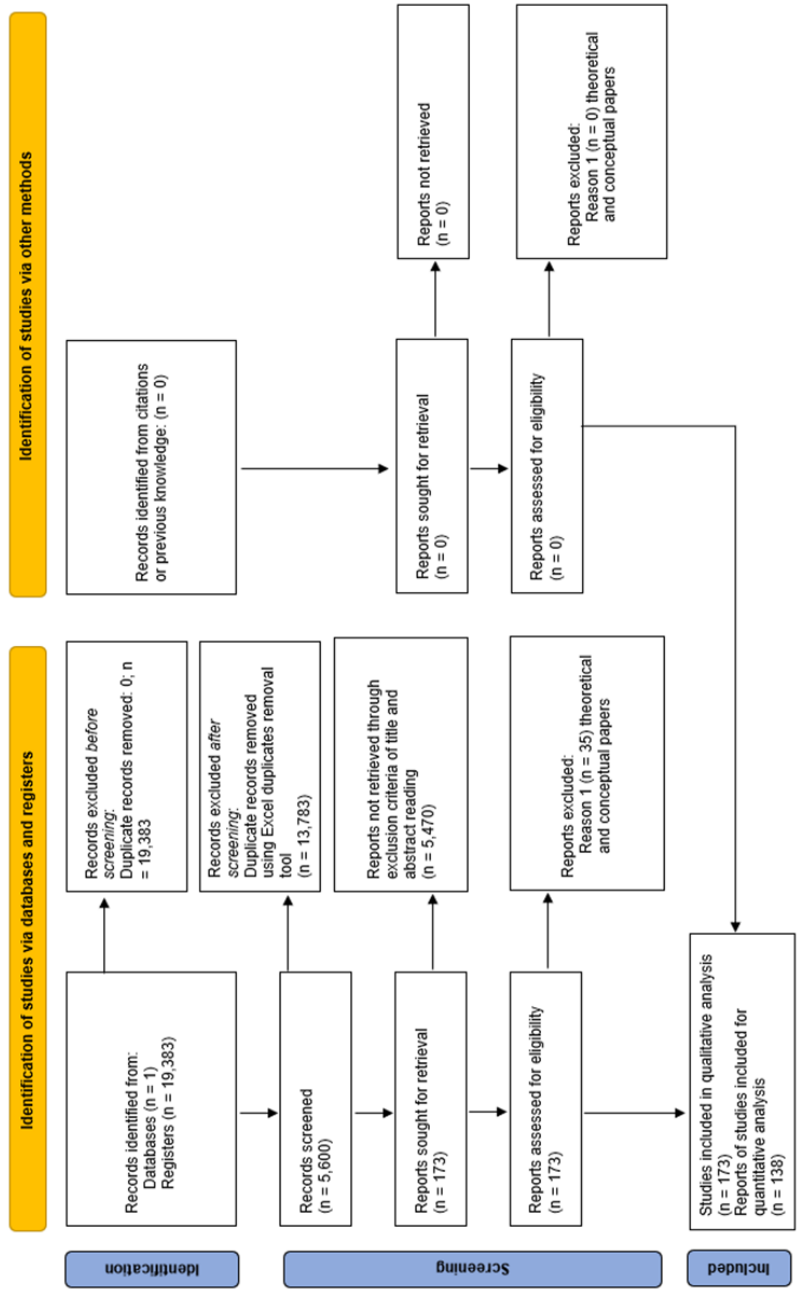
Appendix

Figure A: PRISMA Flow Diagram



Source: Author's construction based on Page et al. (2021)

Efikasnost financijskih institucija: Sistematski pregled literature

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Sažetak

U ovom istraživanju provodi se sistematski pregled literature utjecaja upravljanja rizicima na efikasnost financijskih institucija. Koristeći se PRISMA metodom, analizirano je 173 članaka objavljenih u razdoblju od 1990. do 2023. godine i to u časopisima rangiranim prema Akademskom vodiču časopisa objavljenom od strane Udruge poslovnih škola u 2021. godini. Rezultati pokazuju kako se parametarski i ne parametarski modeli podjednako koriste u procjeni efikasnosti financijskih institucija. Rezultati istraživanja ističu ograničenja spomenutih metodologija, kako i nedostatak konsenzusa u klasifikaciji varijabli. Rezultati također pokazuju kako se recentna empirijska istraživanja prvenstveno usmjeravaju na efekte spajanja i pripajanja, regulaciju i upravljanje rizicima na efikasnost banaka i osiguravajućih društava. Analizom recentnih empirijskih istraživanja ističe se trend razvijanja i uporabe kompozitnih indeksa u procjeni efikasnosti. Rezultati ovog istraživanja mogu biti od koristi akademicima, istraživačima, menadžerima financijskih institucija, regulatorima i kreatorima monetarne politike čiji je interes efikasnost financijskih institucija.

Ključne riječi*: efikasnost, upravljanje rizicima, financijske institucije, kompozitni indeksi*

JEL klasifikacija*: C61, G21, G22*

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