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ИЗЛЕЗЕ НАЈНОВИОТ БРОЈ НА НАШЕТО СПИСАНИЕ Economic Development year.28 No.1/2026, April 2026

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Skopje, April 2026

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FINTECH AND DATA ENVELOPMENT ANALYSIS: A BIBLIOMETRIC MAPPING OF EFFICIENCY EVALUATION STUDIES

Abstract: *Global financial services and markets have been thoroughly redefined with the emergence of FinTech. The integration of these new financial technologies into the financial services and financial products have improved the process through which the users' personal expectations are satisfied. On the one hand, these new technologies have the potential to enhance efficiency; on the other hand, they also present certain challenges. These challenges are particularly evident in the ability of regulatory bodies to promptly adapt to the rapidly changing fintech landscape. This paper presents a comprehensive bibliometric mapping of research at the intersection of Financial Technology (FinTech) and Data Envelopment Analysis (DEA), focusing on efficiency evaluation within financial innovation. Using the PRISMA framework and the Bibliometrix R-tool, 386 Scopus-indexed publications were systematically analyzed to identify intellectual structures, thematic trends, and key contributors in this emerging field. The results reveal that research on FinTech efficiency is growing in scope and methodological sophistication, with DEA serving as a dominant analytical approach for measuring productivity, performance, and sustainability. China emerges as the leading country in terms of publication output and citation impact, while core themes such as efficiency, productivity, technical efficiency, and sustainable development dominate the scholarly landscape. The analysis highlights a gradual shift from traditional efficiency assessments toward more integrated approaches that incorporate digital innova-*

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tion, environmental considerations, and policy relevance. By mapping research evolution and identifying knowledge gaps, this study offers valuable insights for academics, practitioners, and policymakers aiming to enhance the efficiency and resilience of FinTech ecosystems through data-driven methodologies.

Keywords: FinTech, financial technologies, Data Envelopment Analysis, DEA, bibliometric analysis

JEL Classification: G21, O33, C44

Introduction

The rapid advancement of digital technologies has transformed the global financial landscape, giving rise to a new era of innovation known as Financial Technology (FinTech). FinTech has redefined the way financial services are designed, delivered, and consumed—enhancing accessibility, reducing transaction costs, and promoting financial inclusion. However, this digital transformation also brings forth new challenges related to regulation, technological adaptation, and user engagement. Moreover, many customers struggle with limited digital literacy [1]. As mentioned in the paper of [2], digital finance is threatening the traditional financial service suppliers, because it offers opportunities that are more attractive for the younger clients.

In this evolving environment, understanding and evaluating the efficiency of FinTech institutions has become essential for ensuring sustainable growth, competitiveness, and long-term financial stability. Data Envelopment Analysis (DEA), as a leading non-parametric technique, provides a robust framework for measuring performance and benchmarking efficiency across financial organizations. Against this backdrop, the present study conducts a bibliometric mapping of research at the intersection of FinTech and DEA, aiming to identify key trends, methodological developments, and thematic directions that shape current and future efficiency evaluation studies. The intersection of financial technology (FinTech) and operational efficiency has become an increasingly significant research area within financial economics. The Data Envelopment Analysis (DEA), the leading non-parametric technique for evaluating the relative efficiency of homogeneous decision-making units (DMUs), has emerged as a powerful tool for assessing FinTech performance. DEA, which was originally developed by [3] and introduced by [4], has been most-

ly applied in banking and finance due to its ability to handle multiple inputs and outputs without requiring a predefined functional form. Its adoption in FinTech research reflects a broader trend toward quantitative and data-driven methods for evaluating firm-level performance in technologically dynamic environments. A growing body of literature has applied DEA methods to examine the efficiency of FinTech firms and their comparative performance against traditional financial institutions. For instance, [5] dive into the influence FinTech has on Asian banks, on a sample of 92 privatized commercial Asian banks in the period 2016-2022. Their findings reveal that FinTech had a significantly positive impact on bank efficiency. [6] in their paper evaluate the profitability, marketability and the overall efficiency performance of FinTech companies through two-stage DEA model for eight sub-sectors for the period 2010-2019. The results showed that profitability efficiency is higher than marketability efficiency, while the overall efficiency varies across sub-sectors. [7] analysed the efficiency of non-banking finance companies (NBFCs) in India through implementation of DEA on panel data for 2014-2018. The results showed that larger and smaller NBFCs have different efficiency and performance level, while the technical and efficiency shifts can be used as explanatory factors for productivity changes. Additionally, [8] examined the impact of fintech on regional innovation efficiency in China, using DEA method and spatial Durbin model. The findings indicate that fintech encourage the overall innovation and launching efficiency, with diminished effect on R&D efficiency. The overall conclusion is that the impact of fintech varies across the stages of innovation. Additionally, [9] in their paper used DEA model for analysing the operating efficiency of 55 listed fintech companies in China for the period 2014-2019. The results showed that older fintech companies have better efficiency than the younger ones and the non-state-owned companies have better performances than the state-owned. These results indicate that achieving sustainable growth of fintech will be only achieved through making overall improvements.

It is evident that there are many papers that analyse FinTech and DEA. In addition to the papers mentioned above are the papers of [10]; [11]; [12]; [13]; [14]. In the table presented below is provided detailed description for the papers of these authors.

Table 1 Literature review

Authors and Year of Publication	Sample and Observed Period	Methodology	Variables	Findings
Zhong et al. (2021) [10]	Rural commercial banks in China	DEA; black box theory and production function theory; regression model;	Inputs: staff, equipment, intermediate business cost Output: intermediate business income	Only through DEA were not detected the main inefficiencies in the operations of rural commercial banks, such as high reliance on human capital investment, the efficiency in the process of managing the business costs;
Camanho et al. (2024) [11]	Economic efficiency in various sectors; 1978-2020	DEA	Cost, profit, revenue	DEA studies mostly focus on cost efficiency; suggesting it should be expanded in broader areas;

Li and Xu (2021) [12]	848 publications on FinTech	Bibliometric analysis and science mapping	Publication metrics; citation metrics; collaboration metrics	Blockchain, AI and big data contributed to the grown interest of FinTech research
Alfawareh and Al-Kofahi (2023) [13]	Bibliometric analysis of FinTech research; 2008-2022	Bibliometric analysis conducted through Excel, VOSviewer, Harzing's Publish or Perish (citation metrics)	Publication and citation metrics	-Most active publisher: Bina Nusantara University (Indonesia) -Most active country: China -Most cited author: Buckley, R.P.; most publications: Rabbani, M.R.
Salem and Shahimi (2025) [14]	2760 articles; 1968-2025	Bibliometric analysis conducted through VOSviewer, Harzing's Publish or Perish	Publication and citation metrics	-growth in FinTech research, mainly in USA, England, China -areas of interest: blockchain, mobile and internet banking, crowdfunding;

1. METHOD

The bibliometric study is a result of a comprehensive literature review regarding the research subjects of FinTech and Data Envelopment Analysis and their intersection. The data for this study was extracted on June 30th 2025 from the Elsevier Scopus database, without any restrictions or limitations on the publication year, source, type of research, or period, as presented in Table 2.

Table 2 Database Search Criteria

Criteria	Inclusion of Sample	Exclusion of Sample
Search Scope	Scopus database	Other databases
Source	Peer-reviewed journal articles, book chapters, conference papers, and relevant online publications	Any other sources, e.g. books or dissertations
Type of Research	Empirical and conceptual papers	No exclusion
Time Period	No exclusion	No exclusion
Search Parameters + Subject Area	Search terms appear in the title, abstract, or keywords provided by the author(s)	Search terms do not appear in the title, abstract, or keywords provided by the author(s); or any other subject area
Language	English	Any other language

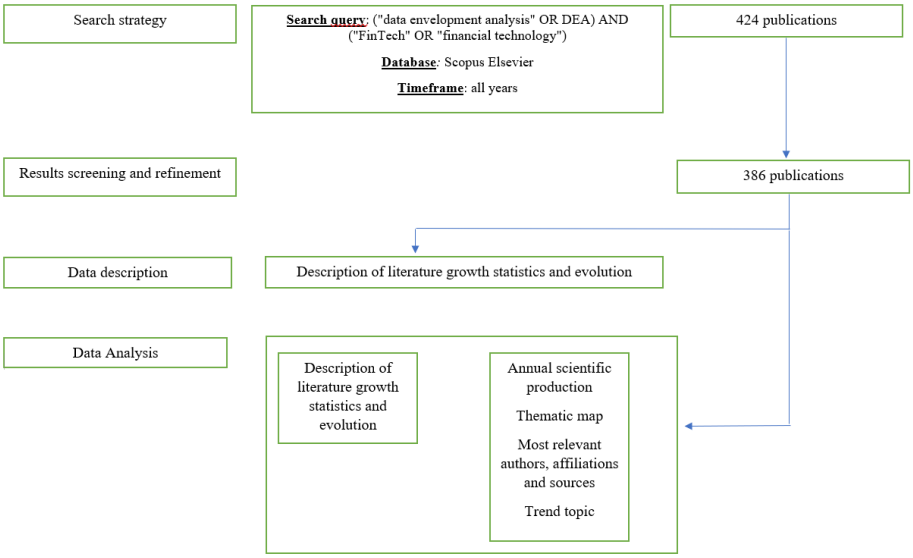
Source: Authors work

The search criteria applied in this study are summarized in Table 2. For the analysis, only one of the most widely recognized international scientific databases, Scopus, was used; no other databases were considered. The search was limited to journal articles, book chapters, conference papers, and other relevant online publications, while sources such as books and dissertations were excluded. Only publications written in English were included, with no restrictions on publication period or research type.

The search focused on publications containing keywords such as "FinTech" OR "Financial Technology" AND "DEA"/ "Data Envelopment Analysis". The PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines were implemented in the literature review, and the R studio's Bibliometrix tool was applied.

In this context, PRISMA method was created to assist reviewers to clearly explain why the review was done, what the authors did and to present the finding they obtained [15]. Additionally, Bibliometrics refers to the application of quantitative analysis of academic literature, which results in quantitative evaluation of the publications. It is mostly used for evaluating growth, maturity, leading authors, conceptual and intellectual maps and trends of a scientific community. The PRISMA steps are presented in Figure 1.

Figure 1. PRISMA diagram flow



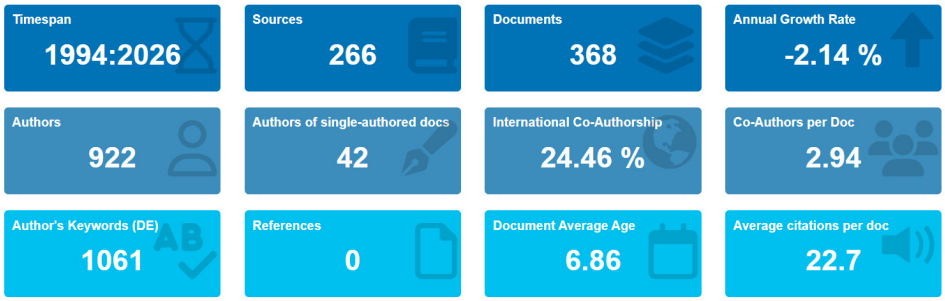
Source: Authors work

2. RESULTS

A rigorous search and screening of the Scopus scientific database identified 386 articles for analysis. The authors perform a bibliometric analysis using this data set of peer-reviewed articles and map the intellectual structure, research trends, and thematic evolution of this emerging field. As shown in

Figure 2, the papers included in this bibliometric study have been published in the period from 1994 to 2026, in 266 sources (i.e. journals), by 922 authors, with a 24.24% international co-authorship. There are 42 single-authored papers. Interestingly, the annual growth rate for this whole period is -2.14%, which reveals the slow publication growth in this area.

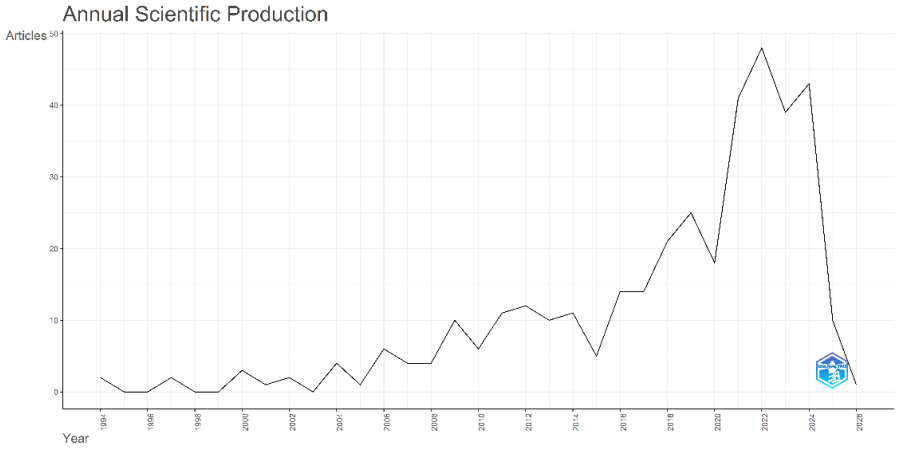
Figure 2. Main information regarding the bibliometric study.



Source: Authors work

The annual scientific production is presented in Figure 3, and it reveals relatively modest publication trends until 2016. Thereafter, there is a publication upward trend until 2020, and thereafter, one more upward trend is obvious. The sharp decline shown in Figure 3 (for year 2025) is the result of considering only papers published until June 30th 2025.

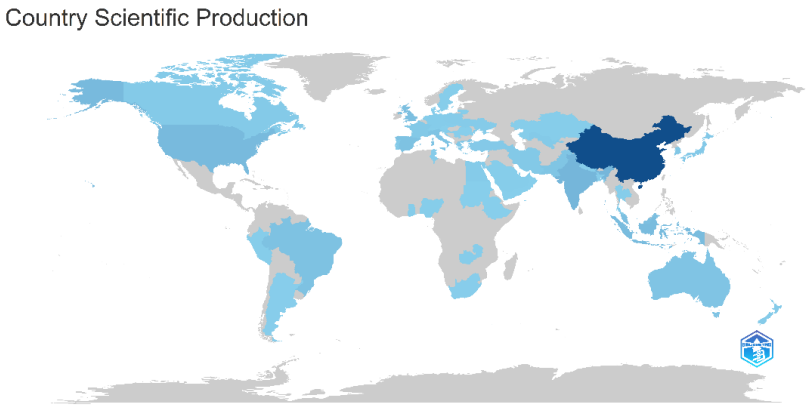
Figure 3. Annual scientific production



Source: Authors work

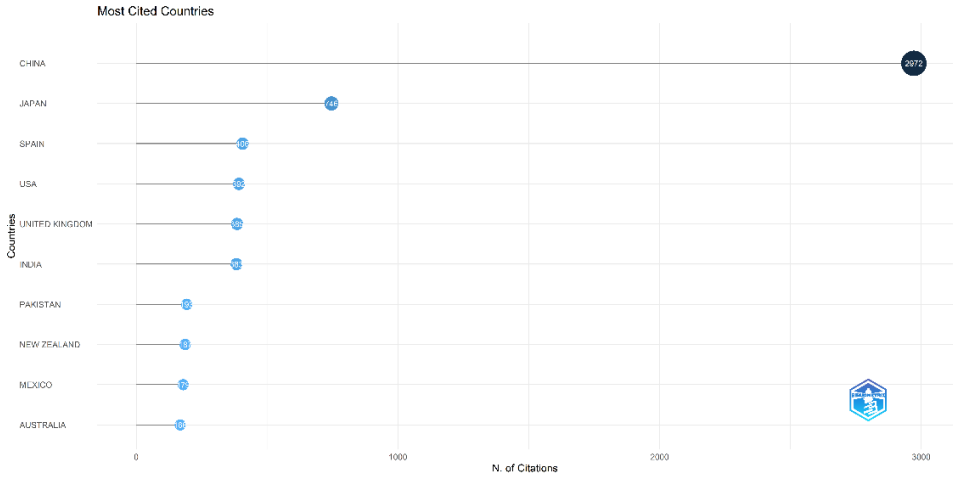
Figure 4 and Figure 5 show the country specific production and the most cited countries in the bibliometric study, i.e. in the papers included in the study. These graphs reveal that China is the most productive country in this research area, as well as the country with most citations (with 2972 citations), which is far greater citation than Japan (746 citations) and Spain (406 citations), USA (392 citations) and UK (385 citations).

Figure 4. Country scientific production



Source: Authors work

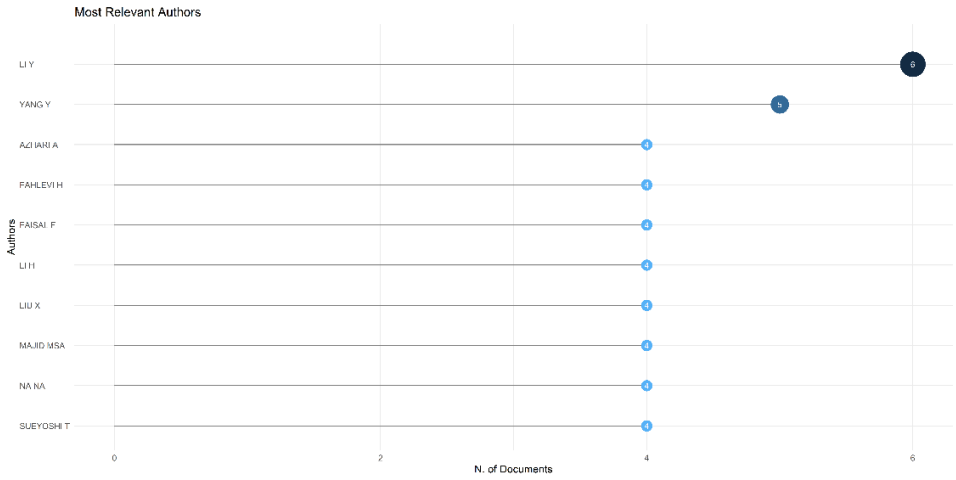
Figure 5. Most cited countries



Source: Authors work

The most relevant (and productive) authors in the intersection between DEA and FinTech are Li, Y., Yang, Y. and Azhari A. The rest of the authors are shown in Figure 6.

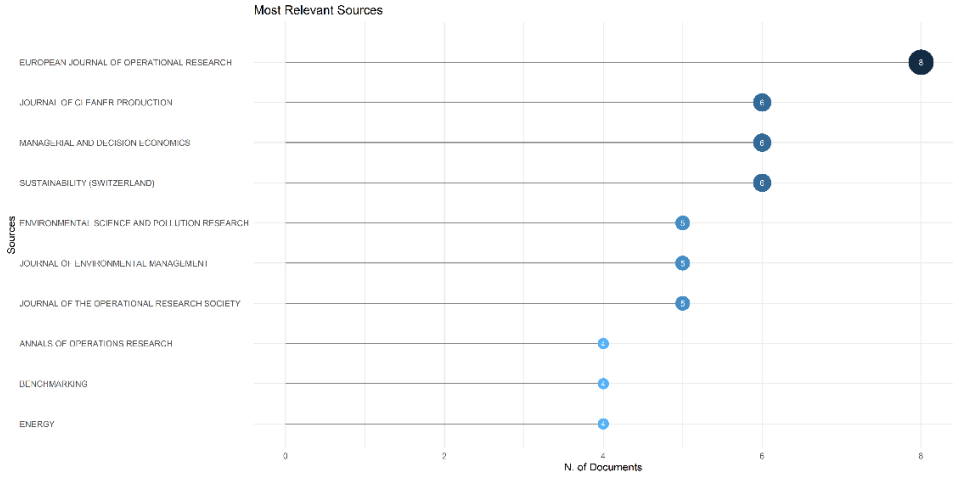
Figure 6. Most relevant authors



Source: Authors work

In Figure 7, the most relevant sources are revealed, in terms of venues/ journals were most relevant and most frequently work in this research area was published. These are European Journal of Operational Research (with 8 published papers), Journal of Cleaner Production, Managerial and Decision Economics and Sustainability (each with 6 published papers), and Environmental Science and Pollution Research, Journal of Environmental Management and Journal of the Operational Research Society (each with 5 published papers).

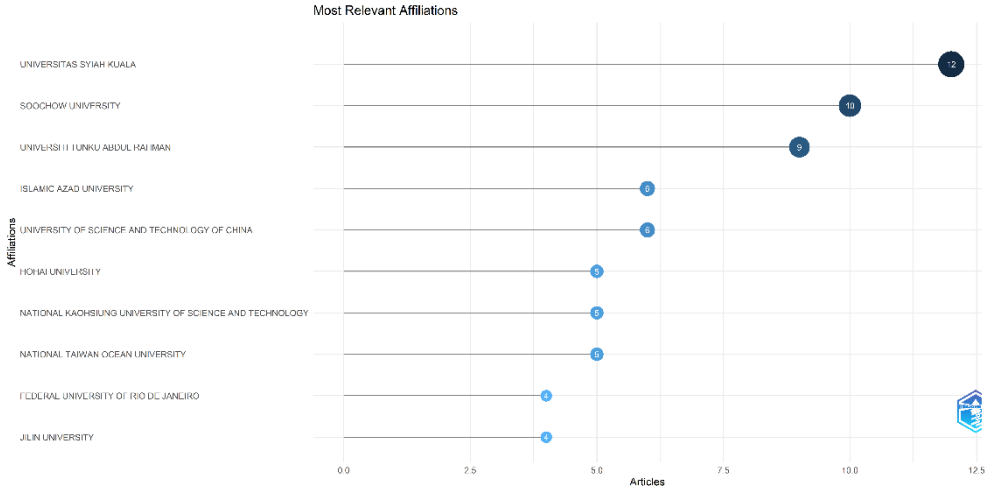
Figure 7. Most relevant sources



Source: Authors work

As for the most relevant affiliations, the findings reveal the Universitas Siyah Kuala (Indonesia) as the most relevant affiliation, followed by Soochow University (Taiwan) and University Tunku Abdul Rahman (Malaysia).

Figure 8. Most relevant affiliations



Source: Authors work

The analysis reveals key authors, influential publications, core journals, and dominant countries contributing to the literature. Co-citation and keyword co-occurrence analyses identify distinct research clusters, highlighting the growing interest in performance measurement, technological disruption in finance, and the application of non-parametric methods such as DEA.

The most relevant and mostly applied keywords in these papers are presented visually in the word cloud in Figure 9. A word cloud is a visual representation of the most frequently occurring terms within a dataset, such as research publications, reports, or articles. In this visualization, the size of each word reflects its frequency or prominence—the larger the word appears, the more often it occurs in the dataset, signaling its importance or centrality within the body of literature. Word clouds provide a quick and intuitive overview of dominant themes and concepts, allowing researchers to identify key areas of focus and recurring topics at a glance. However, while they highlight frequency, they do not capture the context or depth of how terms are used, meaning that further analysis is required to understand relationships, meanings, and thematic connections. In research studies, word clouds serve as a useful starting point for exploring core ideas, guiding thematic mapping, and identifying potential directions for deeper investigation. In this case, words "efficiency", "China", "productivity", "finance" and "sustainable development" are most frequently used.

Key concepts such as *technical efficiency*, *energy efficiency*, and *total factor productivity* indicate a strong methodological focus on quantitative assessment tools like Data Envelopment Analysis (DEA). The prominence of *sustainable development*, *economic development*, and *finance* underscores the interdisciplinary nature of efficiency research, linking environmental, financial, and industrial perspectives. Furthermore, emerging topics such as *investments*, *decision making*, and *innovation* suggest that fintech applications are increasingly integrated into efficiency analyses, driving advancements in *resource allocation* and *information technology*–based performance measurement. Overall, the thematic structure reflects the convergence of sustainability, digital finance, and analytical modeling in shaping the future trajectory of efficiency research.

Figure 9. Word cloud

Source: Authors work

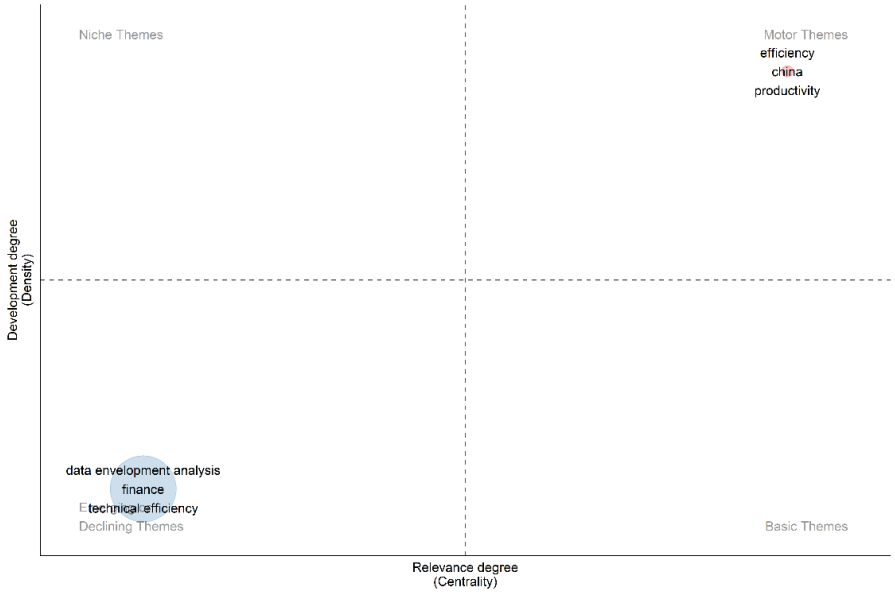
3. DISCUSSION / POLICY IMPLICATIONS

The study emphasizes the need for continued research and capacity building in the field of FinTech efficiency. Public institutions, especially those concerned with economic development and digital transformation, should support further academic-industry collaboration. Encouraging the use of advanced analytical tools like DEA in academic curricula and regulatory training programs will help build the technical capacity required to evaluate and guide FinTech innovation effectively.

The thematic map in Figure 10 highlights how different research topics are positioned within the field in terms of both development (density) and relevance (centrality). The motor themes quadrant, where "efficiency," "China," and "productivity" are located, indicates that these topics are not only well developed but also central to the broader research domain, serving as driving forces in current scholarship. In contrast, themes such as "data envelopment analysis," "finance," and "technical efficiency" are clustered in the declining themes quadrant, suggesting that while these areas have been studied in the

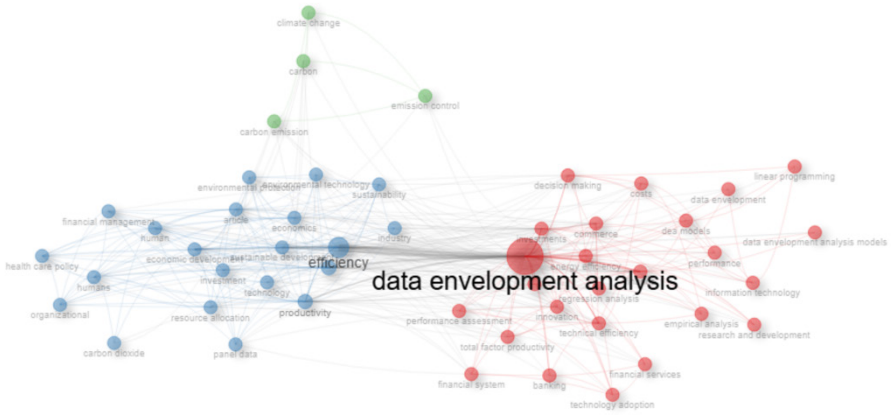
past, their influence and development have diminished, and they currently occupy a peripheral position. Interestingly, the absence of themes in the niche and basic quadrants reveals a lack of emerging specialized areas or foundational topics under development, pointing to a research landscape that is strongly concentrated around established and mature themes. This distribution implies that future studies may continue to focus on refining and expanding motor themes, while opportunities for innovation may lie in rethinking or revitalizing declining areas.

Figure 10. Thematic map



Source: Authors work

Figure 11. Co-occurrence network



Source: Authors work

The co-occurrence network map in Figure 11 reveals the centrality of "data envelopment analysis" as the dominant research theme, shown by its large node size and strong connections across different clusters. Closely linked to this core concept are themes such as "efficiency," "productivity," and "technical efficiency," which highlight the method's application in measuring performance and resource allocation. The red cluster primarily reflects methodological and technical aspects, including "DEA models," "regression analysis," and "linear programming," indicating a strong focus on analytical tools and model development. The blue cluster is more interdisciplinary, connecting data envelopment analysis to areas like "sustainable development," "finance," "economics," and "health care policy," showing its broader relevance in policy and organizational studies. Meanwhile, the green cluster points to emerging environmental concerns, with terms like "climate change," "carbon emissions," and "emission control," suggesting a growing application of the methodology in sustainability and environmental efficiency studies. Overall, the map illustrates how data envelopment analysis operates as a methodological hub that bridges technical modeling with applied fields in economics, pol-

icy, and environmental studies, highlighting both its maturity and expanding influence across disciplines.

Conclusion:

This study provides a comprehensive bibliometric analysis of the intersection between Financial Technology (FinTech) and Data Envelopment Analysis (DEA), offering an in-depth understanding of the evolution, structure, and dynamics of efficiency evaluation research in the FinTech domain. By applying PRISMA guidelines and the Bibliometrix R-tool to a Scopus-indexed dataset, the study identified 386 relevant publications spanning more than three decades. The findings demonstrate that the integration of DEA into FinTech research has grown steadily, reflecting the increasing demand for quantitative, data-driven methods to assess performance, productivity, and technological innovation. China emerged as the leading contributor in terms of both publication volume and citation impact, underscoring its pivotal role in advancing efficiency studies within financial technology and banking sectors.

The thematic and co-occurrence analyses reveal that "efficiency," "China," and "productivity" are central and well-developed themes driving current scholarship, while "technical efficiency," "finance," and "data envelopment analysis" represent mature but declining topics. Moreover, emerging areas such as sustainability, environmental efficiency, and innovation efficiency highlight the expanding application of DEA beyond traditional financial performance measurement toward broader socio-economic and environmental dimensions. These findings point to a clear research shift from isolated efficiency assessments toward integrated frameworks that connect financial innovation, sustainability, and policy.

From a policy perspective, the results suggest that regulators and financial institutions should leverage DEA and similar analytical tools to better understand efficiency dynamics within FinTech ecosystems. Encouraging methodological rigor, interdisciplinary collaboration, and data transparency will be crucial for developing evidence-based strategies that foster innovation while ensuring financial stability and inclusiveness. Future research should explore hybrid approaches that combine DEA with machine learning, big data analytics, and network efficiency models to better capture the complexity and scalability of digital finance. Overall, this bibliometric mapping contributes to both academic and practical discourse by delineating key trends, identifying

research gaps, and providing a roadmap for advancing efficiency evaluation in the rapidly evolving FinTech landscape. In conclusion, this bibliometric review also equips policymakers with actionable insights. By embracing data-driven tools like DEA, governments and regulators can ensure that FinTech developments align with broader economic goals, enhance efficiency, and ultimately deliver inclusive, sustainable financial services. Moreover, this bibliometric review's findings underscore the increasing relevance of efficiency analysis in FinTech, and offer strategic insights for future research directions in financial innovation, performance evaluation, and operational benchmarking.

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