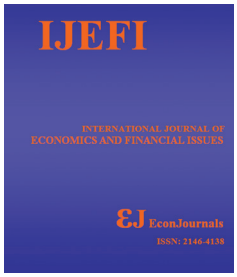

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The Rise of Open Banking: A Comprehensive Analysis of Research Trends and Collaborative Networks

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ABSTRACT

This study explores the changing landscape of Open Banking-a financial services model where third-party providers get access through APIs to banking data for further innovation and customer experience improvements. The analysis is based on Scopus bibliographic data and relies on Biblioshiny and Citespace for the analysis of trends from 1999 to 2024. The main indicators analyzed include the dynamics of the annual scientific production, which increased after 2018 by a factor driven by regulatory frameworks such as PSD2. The main contributors are leading authors and sources, among them the Journal of Payments Strategy and Systems, while country-specific analyses definitely point out the UK, India, and China as major Open Banking research hubs. Thematic and trend analyses show that themes like data sharing, fintech, and API regulation are well-developed, whereas API security and risk management are still underexplored. Co-citation network visualizations depicted clear collaboration networks between countries and then between key authors. Factorial analysis further identified clusters of research related to technologically integrated themes, such as machine learning and blockchain. Key research gaps were identified in areas such as security and risk management, which are considered critical, with Open Banking's continued expansion across the world. Practical implications include more robust API security frameworks and a deeper dive into the advanced technology-regulatory compliance link.

Keywords: Open Banking, Bibliometric Analysis, Biblioshiny, CiteSpace
JEL Classifications: G, O, K

1. INTRODUCTION

Open Banking is an innovative principle changing the conventional outlook toward banking worldwide. It allows TPPs to access customers' financial data securely through APIs. This opens up an entire new dimension in the relationship between banks and fintech in how innovative financial services are offered directly to customers (Odorovic, 2023). The roots of Open Banking are set amidst regulatory requirements and technical capabilities-literally changing the way corporate and individual customers have been traditionally interacting with the bank. It heralds a wider range of opportunities for personalization of financial services, greater inclusion of finances, and further continuing evolution of banking ecosystems by fostering transparency and competition (Nam, 2022). In this new paradigm, every customer has a bit more power, as they can manage their data and information on the services they can access. Open Banking invites innovation by allowing fintech companies to develop applications and services at the request of active consumers. The system brings problems on its own, most especially in relation to the security and privacy of data, a sensitive issue in the present setting when sensitive information about finance is exchanged between institutions (Packin, 2020).

Regulatory changes in the mid-2010s gave birth to Open Banking. In the UK, the Competition and Markets Authority carried out an investigation into the banking sector, which deduced that less

competition leads to worse deals for consumers and costlier ones at that. This made the UK introduce the Open Banking Standard in 2018 as a bid to raise competition and consumer choice in the market (Ziegler, 2021). At the same time, the European Union gave this a second with PSD2 in 2015, making a stipulation that required all banks to allow access to customer information by TPPs, on condition that appropriate consent was sought. These regulatory moves created a supportive environment wherein data that used to remain within banks became shared ammunition for better consumer finance (Dzhaparov, 2020). These regulations represented a pivotal moment for the global banking sector, shifting the paradigm from closed, proprietary systems into open ecosystems. The very foundation of Open Banking was based upon the premise that financial data could be used more effectively and innovatively if shared, provided that basic standards on data protection and security are strictly maintained (Dinçkol et al., 2023; Palmieri and Nazeraj, 2021). The beneficial ideas thus ushered in a new epoch in financial services that was truly customer-centric, with regulators posing no obstacle to progress.

At the very core, Open Banking relies on three basic components: Customer consent, security, and interoperability via APIs. Customer consent provides assurances that no data is disclosed until the consumer agrees upon this. This means control of data will remain with the consumers, who can potentially always keep track of who has what information about them and why. Open banking requires the sharing of financial data, so security and the protection of data are of prime importance. The fraudsters should not find points of intrusion or any unauthorized access to account information. So, regulatory frameworks such as PSD2 require requirements like strong customer authentication-SCA and encryption (Noctor, 2018). Among the three current principles of Open Banking, interoperability via APIs makes it technologically viable. APIs provide a secure and standardized infrastructure that gives seamless ways in which data should flow between banks and TPPs (Premchand and Choudhry, 2018). This is what interoperability means: creating a level playing field whereby even the small fintech companies can compete with established banks through offering innovative services without having to build their own banking infrastructure.

Open Banking basically works ensconced in a series of steps which are well-coordinated with one another. It initiates when the customer gives consent to share financial data with a third-party provider, say a personal finance management application or a payment processor (Ramdani et al., 2020). Once the consent of the customer is given, the TPP sends a request to the API of the bank. It validates the request and takes care of the consent of the customer with the bank, before securely transferring the data to the TPP. Information may include but is not restricted to, sensitive information like balance, transaction histories, spending habits, etc. (Xie and Hu, 2024). The TPP will then utilize it to offer various services to the customer, ranging from the complete overview of the customer's financial accounts to personalized recommendations regarding investments or budgeting tools (Gogia and Chakraborty, 2022). Therefore, Open Banking nurtures an innovative breed of financial offerings and services that are in tune with the actual needs of the customers. The system ensures that sensitive financial information is protected by basing reliance on secure data sharing through APIs and is effectively used by TPPs to improve user experience (Xu et al., 2020).

Among other benefits, Open Banking provides an all-engulfing range for consumers, banks, and third-party providers. To the consumer, Open Banking allows them to have much better control of their data and financial life by allowing choice in the selection of services they want to use and whom to share their data with (Junior et al., 2024). This sort of control is made complimentary with customized financial services; for example, more precise loan offers, tools for budgeting, and investment advice which will be personalized in regard to their unique financial circumstances (Nam, 2022). Moreover, Open Banking also supports financial inclusions because various services can be provided by fintech and extended to communities that perhaps would not be reached by local banking systems. To the banks themselves, Open Banking represents an opportunity for innovation but without having to build everything in-house. They are partnering with fintechs in the manufacturing of new services that increase customer engagement through bespoke product offers (Chan et al., 2022). This also allows them to collect new revenues from data partnerships and value-added services enabled. Third-party providers benefit from the fact that previously restricted financial data is going to be available to them and can be used for the development of innovative financial products (Odorovic, 2023). Such a market opportunity may therefore also spur further competition and innovation in the financial services market, making it more dynamic with even startups and fintechs.

1.1. Challenges and Concerns

On the other hand, however, at the same time as there are quite a few potential benefits from Open Banking, quite a few challenges have to be overcome by it for its successful working. Data security and privacy are major issues since sharing sensitive financial data increases risk related to cyber attacks and unauthorized access (Ma et al., 2018). Despite strong regulatory frameworks like PSD2, securing data is still an ongoing challenge. Another challenge is customer trust. Clearly, many consumers remain uncomfortable with the concept of sharing their financial information with third-party providers they may neither know nor trust. This underlines the need for banks and TPPs to develop transparent, trustworthy relationships with their customers (Chen, 2023). Open Banking also has to deal with regulatory complexity. Different regions have taken different regulatory approaches toward Open Banking, and this makes it hard for banks and fintechs to understand the situation, especially those operating across borders. Perversely, of course, the legacy systems often get in the way, and the thinking of incumbent banks might be against sharing data with other potential competitors (Remolina, 2019). Such challenges put a spotlight on the need for ongoing innovation and adaptation as the Open Banking ecosystem matures.

In the longer run, Open Banking will emerge to an even broader concept: Open Finance, where openness reaches beyond banking into insurance, pensions, and investment management (Pascalis, 2022). On this platform, open finance will provide a wider array of financial data for more products to TPPs. Further opportunities both

for personal finance and greater competition would be unleashed. Open Banking could also, finally, serve to make the financial system more inclusive since the pace at which different solutions are sought outside of traditional banking systems helps democratize access to financial services (Bernards, 2023). Long-term consequences may well change not just how the financial industry works but how individuals manage all aspects of their financial lives. As the ecosystem is increasingly interconnected to, and oriented toward, consumers, the financial future will likely be typified by integrated, transparent, and more accessible financial services. For this future to become a reality, however, the many barriers to this future do need to be overcome: Issues of security, regulation, and collaboration, while continuing to innovate (Gekhaeva et al., 2023).

A bibliometric review of open banking studies will go a long way in providing useful insights into the development, trends, and knowledge structure of research in this area. Using Biblioshiny and CiteSpace for their analysis, the authors are able to review a broad array of scholarly outputs, identify patterns of collaboration, key authors, and influential papers, and map the intellectual structure of Open Banking Studies. First, biblioshiny is used for descriptive analysis, which is very user-friendly in providing a descriptive overview of the bibliographic data (Devaki et al., 2024; Thangavel and Chandra, 2023). Second, network visualization, advanced forms of citation analysis, will be performed using CiteSpace (Niazi, 2016; Sun et al., 2022). Both are complementary tools that will comprehensively outline Open Banking research.

Such tools could provide a bibliometric analysis to enable researchers to look into metrics such as citation trends, co-citation networks, and keyword analysis in order to tease out the most influential topics and emerging areas within Open Banking. These will be of essence in framing how the academic discourse on Open Banking has fared, indicating the break in the literature and guiding future research. This might also reveal the interdisciplinary nature of Open Banking research, which connects the dots between finance, technology, and many other areas of regulation, and stress how this revolutionary concept was brought about through academic-industry collaborative work.

Some of the major objectives of the bibliometric analysis on open banking include observing research output and growth trends, locating the influence of articles, authors, and journals, and studying the collaboration patterns of authors, institutions, and countries. This study will further look into the thematic evolution and current research hotspots in open banking to gain a comprehensive view of how this particular field has evolved over time. From this, the researchers also outline the literature gaps to further explore future directions. For instance, issues not investigated as yet, emerging technologies, or new regulatory frameworks. This research does not only provide a snapshot of the current state of research in open banking, but it also serves to direct further research effort in open banking.

2. LITERATURE REVIEW

The attention of academia and industry towards the concept of Open Banking has recently been very high, both due to regulatory developments and because of rapid digital transformation in the financial services sector. Some of the recurring themes that emerge from the literature review are issues of regulatory frameworks guiding Open Banking, potential impacts on financial inclusions and economic development, the integration of emergent technologies linked to Open Banking, and challenges related to consumer trust and data privacy (Chen, 2023; Remolina, 2019). This thematic review synthesises key studies and points out research gaps that are in need of more investigation.

Regulation has been the key driver for shaping the vista that is Open Banking. As Babin and Smith say, clear rules, industry coordination, and technical standards regarding Open Banking are thought of as increasingly important in North America. They support the idea of only a balanced model between government and private sector being able to make successful the initiatives on Open Banking (Babin and Smith, 2022). Similarly, Pascalis (2022) touches upon how the Open Banking regulation in Europe, via PSD2, forms a basis for a wider Open Finance (Pascalis, 2022). These studies bring to light that regulatory frameworks are important enablers of innovation and competition within the banking sector, but at the same time, there are concerns regarding the fragmentation of standards across jurisdictions (Dzhaparov, 2020). It is also a very specific research gap, namely the need for uniformity within regulations, most especially regarding the role of government and private sector collaboration across varied regions.

Most of the literature advocates for financial inclusion in general and, more importantly, in developing countries through the use of Open Banking. For example, several studies identify the opportunities for Open Banking in India in the field of financial inclusion around UPI (Chinoda and Kapingura, 2023). Their results indicated that financial literacy acts as a partial mediator in the relationship between Open Banking and financial inclusions, which is further influenced by economic growth (Singh and Naik, 2017). Along the line, others investigate the impacts of Open Banking on traditional lending in BRICS countries, showing that consumers borrow less from traditional banks as Open Banking increases competitiveness (Khatun and Bist, 2019). These studies therefore show that Open Banking can boost access to finance, but more research needs to be conducted about its long-term effect on economic development and interplay with general socio-economic factors.

This is evidenced by the reliance on the integration of APIs and cloud computing technologies to realize the implementation of Open Banking. Farrow reports on the trends of adopting platform-based Open Banking models instead of more traditional banking systems. As such, cloud technologies ensure that the solutions are secure and scalable (Farrow, 2020). Premchand and Choudhry go further to present APIs at the heart of Open Banking, since this will enable banks to securely share data with other banks and third-party providers (Premchand and Choudhry, 2018). At the same time, some other works illustrate how blockchain might be a stepping stone to the resolution of some of the prominent concerns related to both trust and privacy within Open Banking (Li, 2019). However, further investigation is required in terms of interoperability issues between these technologies and how

such technologies could be standardized across separate banking ecosystems.

Consumer confidence is the recurring problem in the application of Open Banking. The work of Alhawamdeh et al. (2024) focuses on the imperatives that will render effective implementation: Trust, transparency, and solidity of security. Deriving from their work, it is evident that increasing awareness of the benefits derived from Open Banking will minimize privacy concerns and enhance consumption. Similarly, Podder explains how Open Banking can fight against financial crimes. He says that a framework of sharing data can increase the efficiency of anti-money laundering, which again is constrained because explicit consent is needed from customers (Podder, 2022). That therefore begets an important question of how to balance consumer control over data and the need for broader financial security. Further research is necessary on ways in which the level of awareness and trust of the consumer can be improved and sustained, especially under various conditions of culture and regulation.

These changing roles of traditional banks and those of FinTech companies in the Open Banking ecosystem create room for both risks and opportunities. Gozman et al. (2018) differentiate between a bank's role as an integrator, producer, distributor, and platform by describing several related risks, such as those of disintermediation and reputational damages, but also opportunities that enable service innovation. Meanwhile, in a similar vein, Aytas et al. indicate six parameters that are important for the successful implementation of Open Banking, underlining the importance of regulatory engagement and shared infrastructure (Aytaş et al., 2021). These studies have shown great avenues of growth for the fintech segment through Open Banking but have also highlighted difficulties that traditional banks face in such competition. What this suggests is that in the literature today, there is a dire need for further analysis into how banks can hedge against risks while leveraging the opportunities brought forth by Open Banking.

Recent research has also pursued the prospects of Open Banking in areas concerning less financial crime. For example, Podder discusses how shared data in Open Banking may further help improve anti-money laundering by flagging suspicious transactions with ease (Podder, 2022). However, full application is still limited due to shortfalls in the existing regulatory frameworks, for example, explicit consent by a customer to share data. In a similar direction, Behbehani et al. introduce Bayesian attack graphs for API security threats detection in Open Banking (Behbehani et al., 2022; Behbehani et al., 2023). These clearly indicate the dual role played by Open Banking: exposing or mitigating financial risks, although research in this direction is at its very inception, especially when one considers the security challenges linked with data-sharing protocols.

The literature on Open Banking covers a wide range of themes, including regulatory frameworks, financial inclusion, technological integration, consumer trust, and financial security. While existing research provides valuable insights into the benefits and challenges of Open Banking, significant gaps remain, particularly in understanding the long-term socio-economic impacts and the role of emerging technologies like blockchain. Future studies should focus on cross-jurisdictional analyses of regulatory frameworks, the interplay between financial inclusion and economic growth, and strategies to build consumer trust in an increasingly digital financial landscape.

3. MATERIALS AND METHODS

Scopus was selected as the primary database for data collection due to its extensive coverage of peer-reviewed literature across multiple disciplines, including business, finance, technology, and regulation. Scopus is known for its comprehensive indexing of journals, conference proceedings, and book chapters, making it an ideal source for conducting a thorough bibliometric analysis. To retrieve relevant documents, the query TITLE-ABS-KEY ("open banking") was used, targeting documents where "Open Banking" appeared in the title, abstract, or keywords. This search yielded a total of 225 documents. After removing duplicates and documents that did not meet the criteria for analysis a total of 206 documents were identified for the final analysis. The inclusion criteria allowed for peer-reviewed articles, conference proceedings, and book chapters without any language restrictions, ensuring a comprehensive overview of global research on Open Banking. The extracted documents were downloaded in CSV format from Scopus for further bibliometric analysis.

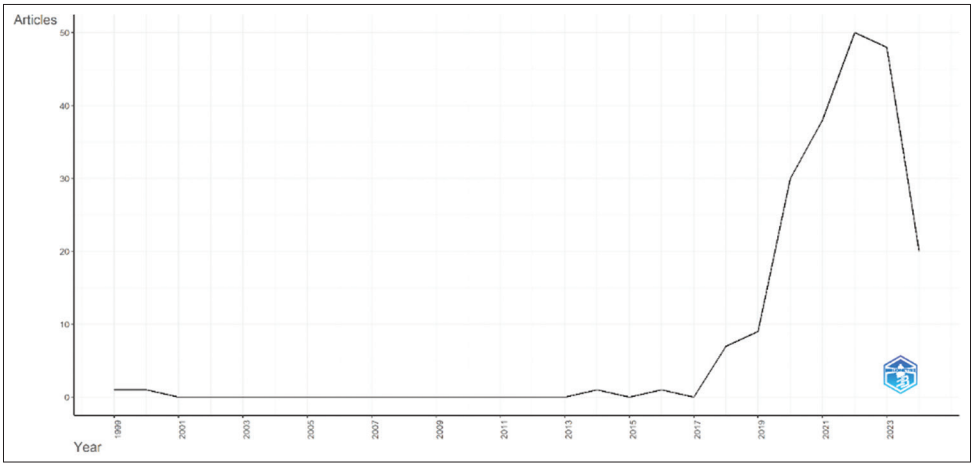
4. RESULTS

The results of this study provide a comprehensive overview of the academic and professional landscape surrounding Open Banking. This section highlights the rapid growth and multidisciplinary nature of Open Banking research, shedding light on its evolution, primary areas of focus, and emerging themes within the field.

Table 1: Main information about the dataset

Description	Results
Main information about data	
Timespan	1999:2024
Sources (Journals, Books, etc)	156
Documents	206
Annual growth rate %	12.73
Document average age	2.6
Average citations per doc	6.35
References	7482
Document contents	
Keywords plus (ID)	630
Author's Keywords (DE)	581
Authors	
Authors	485
Authors of single-authored docs	47
Authors collaboration	
Single-authored docs	51
Co-Authors per Doc	2.63
International co-authorships %	15.53
Document types	
Article	124
Book chapter	31
Conference paper	51

Figure 1: Annual scientific production



4.1. Main Information of the Investigation

Table 1 illustrates the main information about the dataset. The bibliometric analysis on Open Banking covers publications from 1999 to 2024, with data extracted from 206 documents across 156 sources, indicating a diverse range of scholarly and professional contributions. The field is experiencing a robust annual growth rate of 12.73%, and the relatively young document age of 2.6 years reflects its recent surge in academic attention. On average, each document receives 6.35 citations, suggesting moderate academic impact. The analysis identifies 485 authors, with an average of 2.63 co-authors per document, indicating a collaborative research environment, though 51 single-authored documents are also present. Approximately 15.53% of the publications involve international co-authorship, reflecting a degree of cross-border collaboration. The dataset comprises 124 journal articles, 31 book chapters, and 51 conference papers, illustrating that Open Banking research is widely disseminated through journals, books, and conferences, while drawing on a rich set of 7,482 references and diverse keywords to explore its evolving themes.

4.2. Annual Scientific Production

Figure 1 illustrates the annual scientific production of research articles on Open Banking from 1999 to August 2024. The early years, from 1999 to 2017, show very limited academic activity, with only a few articles published sporadically (one article each in 1999, 2000, 2014, and 2016). However, from 2018 onwards, there is a noticeable and consistent rise in the number of publications, signaling increased academic interest. In 2018, there were 7 articles, followed by 9 in 2019, marking the beginning of a steep upward trend. The year 2020 saw a significant jump with 30 articles, which continued to rise in subsequent years: 38 in 2021, 50 in 2022, and 48 in 2023. As of August 2024, 20 articles have already been published, suggesting that this year will also witness substantial academic contributions. This trend reflects the growing importance of Open Banking in financial services and academia, likely driven by the adoption of regulatory frameworks like PSD2 and technological advancements.

4.3. Most Relevant Authors

Table 2 highlights the most relevant authors contributing to research on Open Banking based on the number of articles they have published. Borgogno O, Colangelo G, and Hjelkrem LO are the top contributors, each having published 3 articles on the subject. This suggests that these authors are key figures in the academic discourse on Open Banking. Following them, a group of authors, including Al-Begain K, Alves PH, Arner DW, Barros Pena B, Behbehani D, Boegelund C, and Brataas G, have each published 2 articles, indicating their substantial contributions to the field as well. The data suggests that Open Banking research is relatively collaborative, with several authors contributing multiple works, further solidifying the field's growing importance in academic and professional settings.

Table 2: Most relevant authors

Authors	Articles
Borgogno O	3
Colangelo G	3
Hjelkrem LO	3
Al-Begain K	2
Alves PH	2
Arner DW	2
Barros Pena B	2
Behbehani D	2
Boegelund C	2
Brataas G	2

Table 3: Most relevant sources

Sources	Articles
Journal of payments strategy and systems	15
Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)	5
ACM international conference proceeding series	4
Journal of risk and financial management	4
Communications in computer and information science	3
European business law review	3
Lecture notes in networks and systems	3
Advances in intelligent systems and computing	2
Applied sciences (Switzerland)	2
Banking law journal	2

4.4. Most Relevant Sources

Table 3 presents the most relevant sources for publications on Open Banking, indicating where the majority of research on the topic is

disseminated. The Journal of Payments Strategy and Systems is the most prolific source, publishing 15 articles, demonstrating its focus on financial systems, payments, and emerging technologies like Open Banking. The Lecture Notes in Computer Science series, which includes subseries on artificial intelligence and bioinformatics, follows with 5 articles, reflecting the technical and computational aspects of Open Banking research. The ACM International Conference Proceeding Series and the Journal of Risk and Financial Management both contribute 4 articles each, indicating a strong focus on the intersection of technology, risk, and financial management in the context of Open Banking. Communications in Computer and Information Science, European Business Law Review, and Lecture Notes in Networks and Systems each published 3 articles, highlighting contributions from information science and legal perspectives. Finally, Advances in Intelligent Systems and Computing, Applied Sciences (Switzerland), and the Banking Law Journal each have 2 articles, showcasing a mix of intelligent systems, applied sciences, and legal viewpoints in the study of Open Banking. These sources collectively illustrate the multidisciplinary nature of Open Banking research, encompassing financial systems, technology, law, and risk management.

4.5. Countries' Scientific Production

Table 4 displays the scientific production of articles on Open Banking by region. The UK leads with 76 articles, reflecting the country's significant role in pioneering Open Banking regulations, particularly through initiatives like the Open Banking Standard. India follows with 44 articles, highlighting its focus on financial inclusion and digital payments through systems like UPI (Unified Payments Interface), which is closely related to Open Banking principles. China has contributed 43 articles, showcasing its focus on fintech innovations and regulatory advancements in the banking sector. Australia and Brazil also have substantial contributions, with 39 and 38 articles, respectively, both countries having implemented Open Banking frameworks. Italy has published 28 articles, indicating a growing interest in Open Banking, likely driven by European regulations like PSD2. Spain follows with 19 articles, while Indonesia, Norway, and the USA each have 17 articles, reflecting the increasing global attention on Open Banking. These countries'' contributions demonstrate the international scope of Open Banking research, with significant academic output from both developed and emerging markets.

4.6. Thematic Map

Figure 2 presents thematic mapping of author keywords in Open Banking research categorized into four quadrants based on their centrality and development. The themes in the top-right quadrant-

Table 4: Countries' scientific production

Region	Article
UK	76
India	44
China	43
Australia	39
Brazil	38
Italy	28
Spain	19
Indonesia	17
Norway	17
USA	17

for instance, data sharing, regulation, and API-are identified as Motor Themes, which are highly central and well-developed. These intensively researched themes are connected with other centrepiece ideas by pointing out the role taken by technical infrastructure and regulatory frameworks as backbone elements for the development of Open Banking. On the other hand, NICHE themes, positioned in the top left quadrant, are those that are highly developed but less central, which means that while these areas may be comprehensively researched, the nature of the research in these areas is more specialist and not as well integrated into the wider body of research. On the bottom right, we have the central Basic Themes, which include Open Banking, Fintech, or PSD2. These themes reveal that though such themes are foundational in the field, there is yet great scope for further explanation. The bottom-left quadrant contains Emerging or Declining Themes, such as security and risk assessment of Open Banking APIs, that are less central and less developed. These can be new fields of interest that will develop further in the near future or retiring areas that have lost their importance. A thematic map will reveal that, while regulatory and technical aspects of Open Banking are well developed, security and risk-related themes are currently turning into one of the most important tasks for future research.

4.7. Factorial Analysis – Topic Dendrogram

Figure 3 shows the hierarchical relationships between themes and topics that configure the research on Open Banking. This kind of visualization is particularly functional to represent a dendrogram, thus the tree-like diagram showing how closely related topics are to each other when considering its co-apparition in the literature. This figure illustrates several branches, with each branch showing a cluster of related research themes. For any two topics, deeper levels of depth denote the degree of similarity. At a high level, high-order generic topics such as blockchain, risk assessment, network security, and authentication are underlined, indicating distinct clusters at the high level existing in Open Banking research: these are focused on technological infrastructure and aspects pertaining to security. As you go down the tree, you see that the branches continue to subdivide, narrowing further and further into highly specific themes of discussion. For example, blockchain bifurcates into related themes, including smart contracts and financial exchange, demonstrating how blockchain technologies are being considered in the context of Open Banking. On the right-hand side, another large branch unfolds into themes of Open Banking, Fintech, and regulation with subsequent sub-branching into more specific areas of focus, such as machine learning, APIs, and customer experience. These groupings seem to illustrate that, in the domain of Open Banking, research is heavily concentrated on aspects related to the infusion of technology into banking services, such as machine learning and APIs, together with the regulatory challenges accompanying such change. Overall, the dendrogram very clearly clusters research on Open Banking. The two clear emerging thematic areas are "Security and Technological Integration" converging around a main theme, while subtopics of financial inclusion and user privacy form more specific branches of those larger themes.

4.8. Trend Topics

Figure 4 illustrates the Trending Topics in Open Banking research over time, with the size of the circles representing the

Figure 2: Thematic map

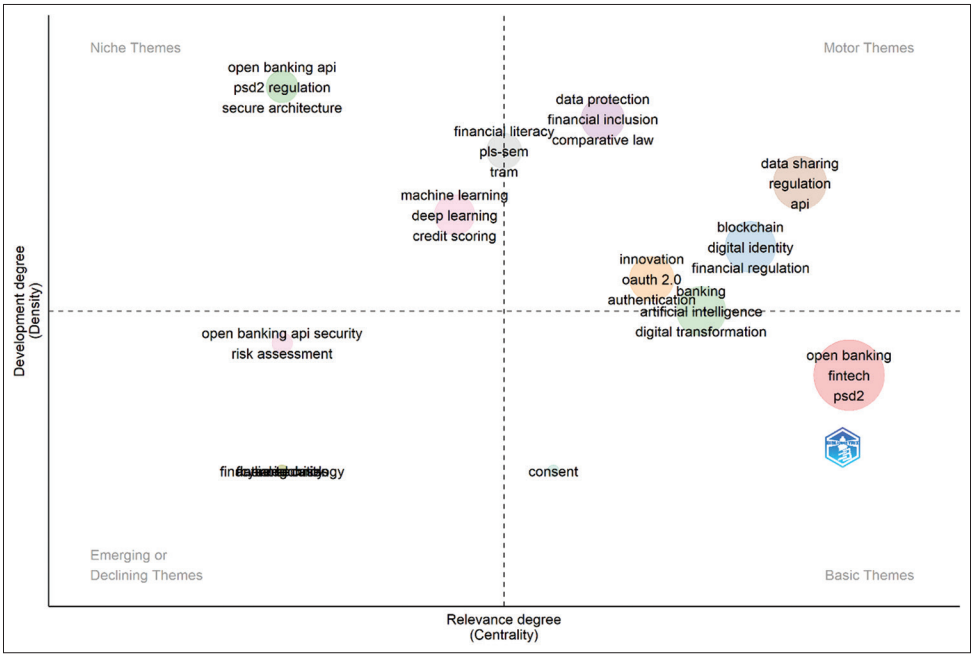


Figure 3: Topic dendrogram

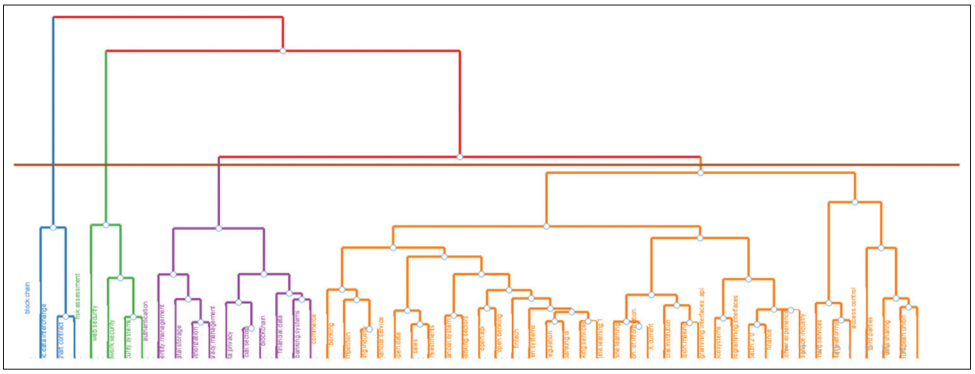
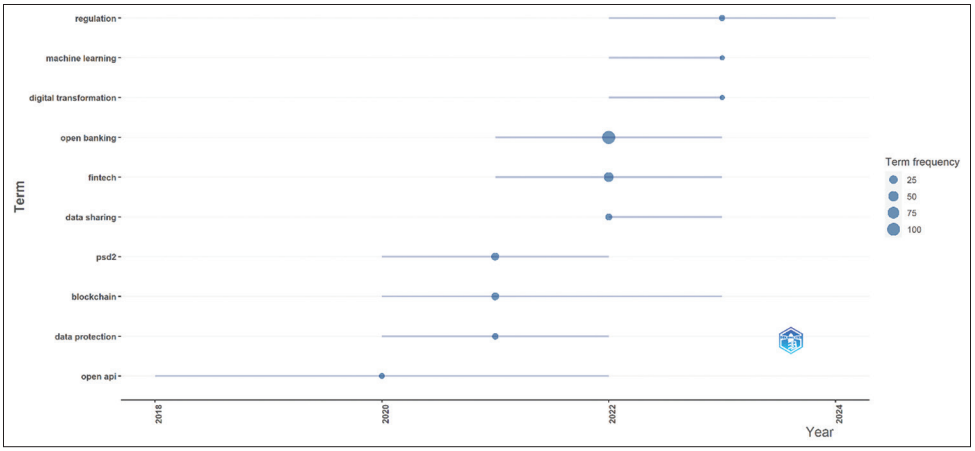


Figure 4: Trend topics



frequency of each term's appearance in publications. The x-axis represents the years from 2018 to 2024, while the y-axis lists the key terms. Larger circles indicate more frequent use of the term, reflecting the level of focus in the research community. From 2018 onwards, terms like open API and PSD2 (the European regulatory framework) appear early but are less frequent compared to later years. As we move toward 2020 and beyond, topics such as open banking, fintech, and data sharing become more prominent, showing substantial growth in academic discussions. Open banking and fintech are especially dominant from 2021 onwards,

reflecting the increasing focus on these core aspects of financial innovation. Additionally, terms like regulation, machine learning, and digital transformation begin to emerge as significant topics in the more recent years (2022-2024). This shift indicates a growing interest in the intersection of technology, financial regulation, and digital innovation. Blockchain and data protection also see notable mentions, though at a smaller frequency compared to other terms. Overall, this figure highlights the evolving focus of Open Banking research, with key topics transitioning from foundational regulatory concepts to advanced technological integrations and broader digital transformation in the financial sector.

4.9. Network Visualization of Co-citation of Cited Authors

Figure 5 provides a network visualization of co-citation among cited authors, divided into 11 clusters that reflect different thematic areas within open banking research. Cluster #0, the largest, focuses on European Union regulations with 61 members and key contributors like Zachariadis M and Arner DW, indicating a strong emphasis on regulatory frameworks shaping open banking within the EU. Cluster #1, with 56 members, centers around empirical studies, highlighting authors like Ajzen I, and includes research related to user adoption and behavioral models in open banking. Cluster #2, with 50 members, explores emerging roles and risks within the open banking ecosystem, featuring authors such as Brodsky L, with research focusing on the challenges and risks faced by stakeholders.

The visualization also includes Cluster #3, which focuses on blockchain technology with 40 members and influential authors like Guo Y and Zyskind G, indicating the importance of decentralized financial systems in open banking. Cluster #4 discusses future research agendas, with key authors like Wang H and He Z, signaling the direction of open banking research. Cluster #5, with 25 members, explores customer experience, particularly focusing on user satisfaction and technology acceptance, led by authors such as Hair JF and Venkatesh V. Cluster #7 delves into the banking industry's adaptation to open banking, with authors like Premchand A and Farrow GS, indicating research on how traditional banking systems are responding to open banking innovations.

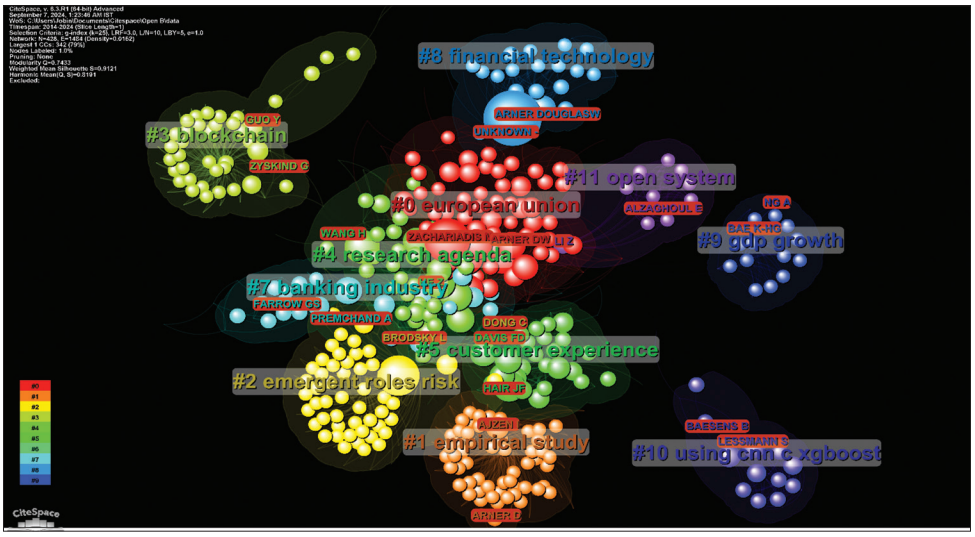
Smaller clusters, such as Cluster #8 on financial technology (19 members) and Cluster #9 on GDP growth (13 members), highlight key technological and economic dimensions of open banking, with prominent authors like Arner DouglasW and Ng A. Cluster #10, with 12 members, emphasizes the use of machine learning models, such as CNN and XGBoost, in financial analytics, featuring authors like Lessmann S and Baesens B. Finally, Cluster #11, the smallest with 11 members, focuses on open system architectures, led by authors like Li Z, reflecting research on the technological frameworks supporting open banking. This network visualization offers a comprehensive view of the collaborative and thematic landscapes within the open banking research community.

4.10. Timezone Network Visualization of Co-citation of Cited Journals

Figure 6 presents a timezone network visualization of co-citation among cited journals, with the network divided into seven major clusters, each representing distinct thematic areas within open banking research. The largest cluster, Cluster #0 (Emergent Roles Risk), with 30 members and a silhouette value of 0.712, focuses on the evolving roles and risks in the open banking ecosystem, addressing how stakeholders manage new risks introduced by digital financial services. Cluster #1 (Online Credit Scoring), with 29 members and a silhouette value of 0.785, centers on the application of open banking data for credit scoring models, enhancing the accuracy and reach of online credit assessment systems. Another prominent cluster, Cluster #2 (Banking Sector), also with 29 members but a slightly lower silhouette value of 0.662, explores the transformation of the traditional banking industry due to open banking reforms, addressing operational shifts and the integration of digital services in conventional banking.

Other clusters delve into more specialized areas. Cluster #3 (Selecting Open Banking Business Partner), consisting of 29 members with a silhouette value of 0.61, examines strategies for choosing business partners in the open banking landscape,

Figure 5: Network visualization of co-citation of cited authors



highlighting the need for collaboration to build successful platforms. Cluster #4 (Using CNN and XGBoost), with 24 members and a silhouette value of 0.664, focuses on applying advanced machine learning models like CNN and XGBoost to analyze open banking data, showing the rise of computational techniques in the field. Cluster #5 (GDP Growth), with 21 members and a high silhouette value of 0.802, studies the macroeconomic impact of open banking, particularly how financial innovation driven by open banking contributes to economic growth and GDP. Finally, Cluster #6 (Extensive Formal Security Analysis), the smallest cluster with 7 members but the highest silhouette value of 0.952, concentrates on security concerns in open banking, emphasizing the importance of formal analyses to ensure the safety and integrity of open banking systems. Together, these clusters provide a comprehensive view of the diverse research themes shaping the open banking landscape.

4.11. Timeline Network Visualization of Co-occurrence of Keywords

Figure 7 offers a timeline network visualization of co-occurrence of keywords in open banking literature, illustrating the evolution of research topics across 10 distinct clusters. Cluster #0 (Extensive Formal Security Analysis) is the largest, consisting of 45 members with a silhouette value of 0.79, focusing primarily on keywords like "open banking" (108 occurrences), "data protection" (7), "open finance" (6), and "financial inclusion" (3). This cluster likely highlights the critical security challenges within open banking, particularly regarding data protection, financial inclusion, and the broader concept of open finance. Cluster #1 (Nudging Data Privacy Management), with 38 members and a higher silhouette value of 0.834, centers around keywords such as "data sharing" (13), "data privacy" (12), "blockchain" (10), and "open data" (9), reflecting the increasing importance of managing data privacy and sharing mechanisms in open banking, with blockchain emerging as a key technology for safeguarding data.

Cluster #2 (View-Controller Architecture), comprising 29 members with a silhouette value of 0.671, focuses on technological aspects, such as "financial service" (8), "artificial intelligence" (7), "payment services" (7), and "third party" (7). This cluster likely investigates the technical infrastructure and architecture supporting open banking services, particularly the integration of AI and third-party services.

Figure 6: Timezone network visualization of co-citation of cited journals

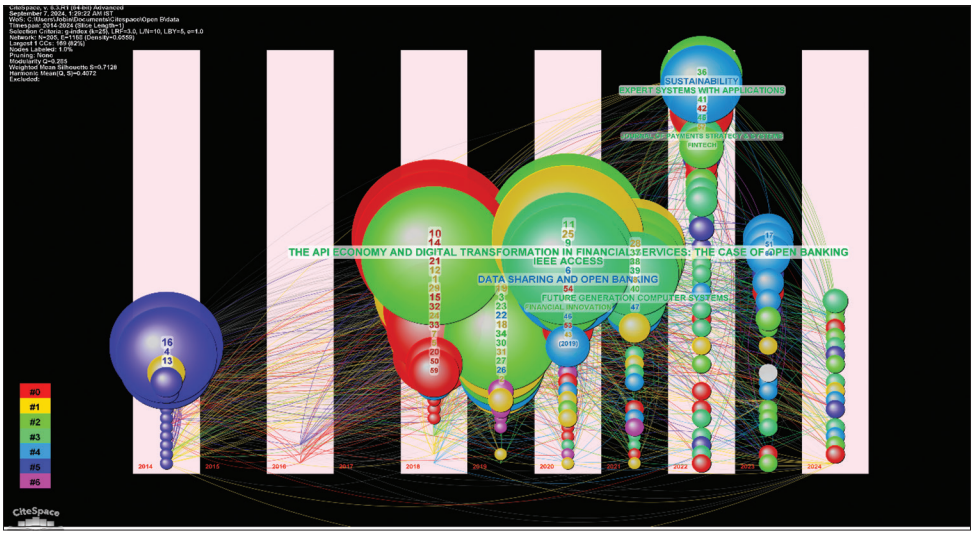
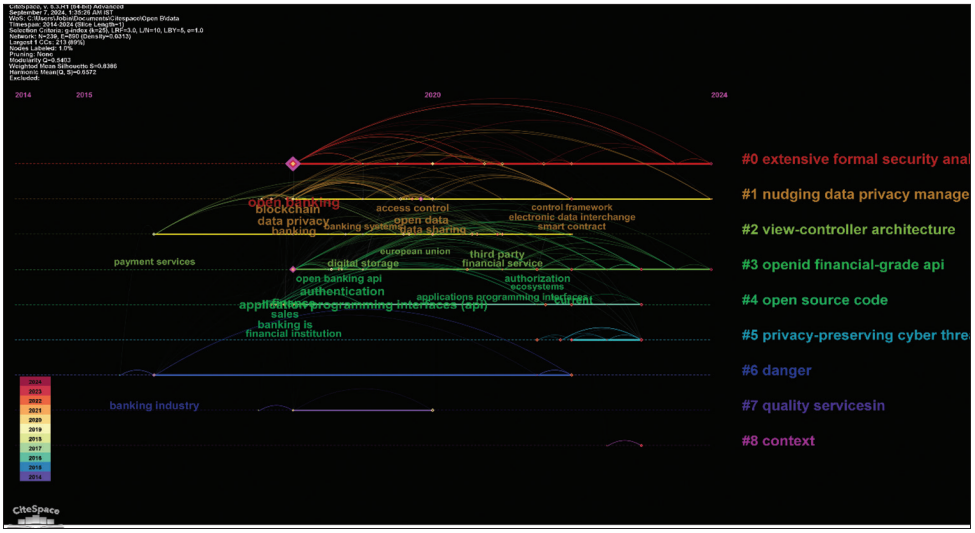


Figure 7: Timeline network visualization of co-occurrence of keywords



Similarly, Cluster #3 (Extensive Formal Security Analysis), with 27 members and a higher silhouette value of 0.93, focuses on API-driven security systems, with key terms like "finance" (23), "application programming interfaces (API)" (11), and "authentication" (5), emphasizing the importance of secure API frameworks in enabling open banking. Cluster #4 (Open Source Code), with 25 members and a silhouette value of 0.806, explores open-source technologies in banking, featuring keywords such as "financial institution" (9), "sales" (7), and "open API" (5), underscoring the role of open-source code in fostering innovation within the financial sector.

Smaller clusters in the network delve into more specialized topics. Cluster #5 (Privacy-Preserving Cyber Threat Information Sharing), with 20 members and a high silhouette value of 0.903, focuses on advanced technologies like "machine learning" (5) and "deep learning" (4), signaling the growing use of AI techniques in cybersecurity within the banking industry. Cluster #6 (Danger), consisting of 14 members and a silhouette value of 0.991, includes keywords like "banking industry" (4), "branchless banking" (2), and "5G mobile communication systems" (2), indicating emerging risks associated with new technologies in banking. Cluster #7 (Quality Services), with 7 members and a high silhouette value of 0.992, focuses on keywords like "banking services" (5) and "digital banking" (3), suggesting research into improving service quality in digital banking. Meanwhile, Cluster #8 (Context), with 5 members and a silhouette value of 0.959, covers social and behavioral themes, such as "social influence" (2) and "artificial neural networks" (1). Finally, Cluster #10 (Bibliometric Analysis-Driven Definition), the smallest cluster with 3 members and a silhouette value of 0.987, is centered on methodological keywords like "bibliometrics" (1), pointing to research methodologies that analyze patterns within open banking studies. This timeline visualization captures the broad scope of open banking research, from privacy and security concerns to technological advancements and social dynamics.

The most frequently occurring keywords in open banking research highlight key themes shaping the field, with "open banking" being the dominant term (108 occurrences) in Cluster #0, reflecting the focus on security and financial inclusion. "Finance" (23 occurrences) in Cluster #3 is linked to security and the pivotal role of APIs (11 occurrences), which enable open banking services. Cluster #1 addresses critical issues like data sharing (13 occurrences), data privacy (12), banking (12), and blockchain (10), emphasizing the need for secure data management and blockchain technology to ensure transparency. Similarly, "open data" (9 occurrences) in Cluster #1 underlines the significance of accessible data, while "financial institution" (9 occurrences) in Cluster #4 explores how traditional banks are adapting to the open banking ecosystem. Lastly, "financial service" (8 occurrences) in Cluster #2 touches on the technical frameworks supporting these digital services. Overall, these keywords encapsulate research on data privacy, blockchain, APIs, and the evolution of financial institutions within a more open, digitized banking environment.

4.12. Timezone Network Visualization of Countries' Collaboration

Figure 8 presents a timezone network visualization of countries' collaboration in open banking research, divided into four distinct clusters, each representing different collaboration patterns between countries. The largest cluster, Cluster #0 (Mental Health), consists of 11 members with a silhouette value of 1, indicating strong cohesion in collaboration. The most cited members in this cluster are the United Kingdom (36 citations), Australia (16), Italy (15), Germany (8), and the Netherlands (6), suggesting a high level of collaboration between these countries, particularly in the intersection of mental health and open banking topics, possibly around financial well-being or access to services. Cluster #1 (Nudge Theory), the second largest with 10 members and a silhouette value of 0.902, focuses on research influenced by behavioral economics and nudge theory in open banking. The most cited countries in this cluster are China (11 citations), Norway (7), Saudi Arabia (4), Denmark (4), and Jordan (2), indicating significant collaboration in applying nudge theory principles to influence consumer behavior and policy in financial services.

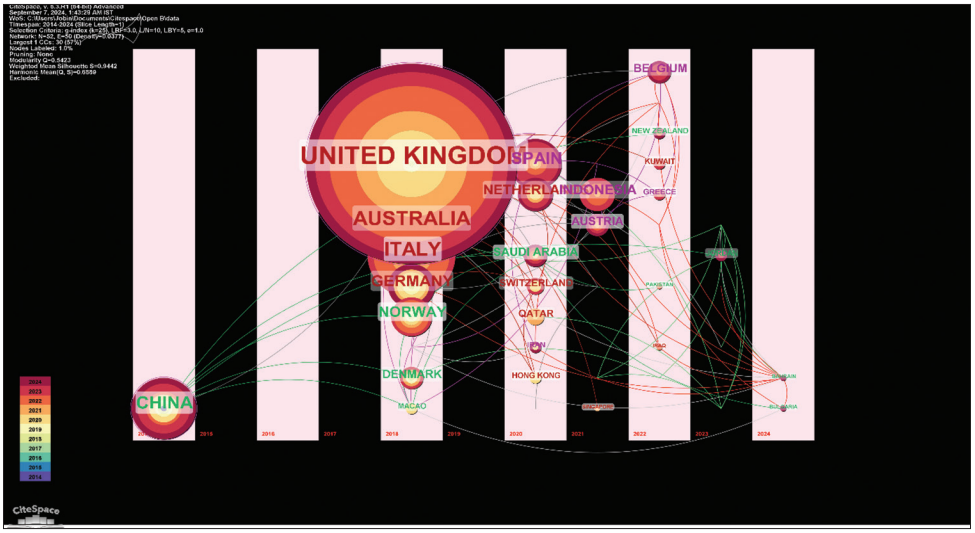
Cluster #2 (Privacy-Preserving Industry Application) includes 6 members with a silhouette value of 0.924, focusing on industry applications with an emphasis on privacy. The most cited countries in this cluster are Spain (9 citations), Indonesia (6), Austria (4), Belgium (4), and Iran (2), highlighting international collaboration on privacy-preserving technologies and their applications in open banking. Finally, Cluster #3 (Mental Health), with 3 members and a silhouette value of 0.921, includes Brazil (13 citations), the United States (8), and Ireland (5), suggesting research collaborations in the area of mental health, possibly exploring the financial implications of mental well-being through open banking. Overall, this visualization reflects a global collaborative network where research themes like mental health, nudge theory, and privacy-preserving technologies are explored across various regions.

5. DISCUSSION

The bibliometric analysis of Open Banking research from 1999 to 2024 follows a line of 12.73% annual growth of research in this area. The dataset is represented by 206 documents, 156 sources, and the contributions of 485 authors. Thus, it points toward a collaborative and diverse academic environment. Therefore, the average citation rate of 6.35 per paper reflects the average academic impact of 15.53% in international co-authorship publications. This analysis corroborates the fact that Open Banking research is genuinely multi-disciplinary, and that journals, books, and conference papers are the leading dissemination channels.

The volume of scientific publications annually has been quite steep since 2018, due to regulatory frameworks such as PSD2 and technological developments regarding financial services. For example, by 2020, the research output increases notably, an issue reflected in 50 articles published in 2022 itself-a fact that underlines growing academic interest in the subject. Key authors to consider in this respect are Borgogno O and Colangelo G, among others that have made great contributions; central journals that publish works with regards to Open Banking also include the Journal of Payments Strategy and Systems. With respect to countries, the leading positions for scientific production have been taken by the UK, India, and China, which is a consequence of interest in regulatory frameworks and fintech innovations.

Figure 8: Timezone network visualization of countries' collaboration



The thematic analysis reveals that the themes of data sharing, regulation, and APIs represent the heart of the current Open Banking discussion, while PSD2 regulation and secure architecture are specialized yet peripheral areas of discourse. Themes of recent growth, such as the security of Open Banking APIs and risk assessment, portend the direction of future research. Where the factorial analysis emphasizes a number of important clusters, such as blockchain, fintech, and customer experience, the Open Banking research is concentrated on technological integration and regulatory challenges. Trending topics also show a shifting pattern from foundational regulatory issues to advanced themes in technology such as machine learning, fin-tech, and digital transformation in recent years.

Finally, the network visualizations provide insights into global collaboration patterns and thematic clusters. Co-citation analysis reveals strong focus areas, including European Union regulations, blockchain technology, and customer experience. In terms of country collaborations, the UK, China, and Spain play significant roles, with topics such as mental health, nudge theory, and privacy-preserving technologies showing strong international cooperation. The evolution of keywords like "open banking," "blockchain," and "data sharing" indicates the dynamic and evolving nature of the field, with security, privacy, and technological infrastructure emerging as critical research areas.

5.1. Research Gaps

The bibliometric analysis on Open Banking identifies several areas where research is either underexplored or emerging, indicating potential gaps. First, while motor themes such as data sharing, regulation, and API development are well-researched and central to the field, other topics remain less integrated. For example, niche themes like PSD2 regulation and secure architecture, though well-developed, are more specialized and not widely connected to broader Open Banking research. This suggests a gap in integrating these specialized themes with more general topics, such as the practical application of PSD2 beyond the European context or how secure architecture can be standardized globally. Additionally, basic themes like Open Banking and fintech are foundational but remain underexplored, pointing to opportunities for deeper investigations, particularly in emerging markets where Open Banking is gaining traction but not as widely studied.

Another research gap lies in the emerging or declining themes, such as Open Banking API security and risk assessment, which are currently underdeveloped but could become more prominent as Open Banking expands. The relatively low attention given to security and risk-related topics, despite their importance, highlights the need for future research that focuses on cybersecurity threats, fraud prevention, and consumer protection in Open Banking. Furthermore, trending topics reveal a growing interest in machine learning, blockchain, and digital transformation, yet the interaction between these technologies and regulatory frameworks remains insufficiently studied. Bridging this gap would provide deeper insights into how advanced technologies can be integrated into Open Banking while adhering to regulatory compliance and ensuring data privacy.

6. CONCLUSIONS AND PRACTICAL IMPLICATIONS

The bibliometric study of Open Banking, therefore, shows that the field was growing very fast, with huge advances in research output since 2018, driven by many factors, including the introduction of regulatory frameworks like PSD2 and technological innovations. The core topics such as sharing data, API Regulation Fintech are well-developed while other logically related areas like API security and risk management have been relatively underdeveloped. These are leading contributors such as the UK, India, and China; this means that Open Banking actually draws immense attention in the modern world. Despite such growth, one lag remains in research on cybersecurity, fraud prevention, and the integration of blockchain and machine learning with emerging Open Banking frameworks; therefore, priority in ensuring API security and risk management to ensure the safety of the Open Banking systems is duly recommended. Besides, the innovation in Open Banking can be improved by the in-depth revelation of advanced technologies

such as blockchain or machine learning capability. Stronger collaboration should, in turn, be fostered from academia, industry, and regulatory bodies, focusing on comprehensive framework development that balances innovation with security. These steps are crucial to ensuring sustainable growth and safe practical applications of open banking worldwide.

Some of the practical implications for the future of Open Banking emanate from the findings in this bibliometric analysis. The dominance of the motor themes on data sharing and API development signals that, within financial institutions, the technical infrastructures supporting Open Banking are increasingly important. Therein, practitioners and policy makers should focus on refining these infrastructures so they can be scaled and interoperable across different core banking systems and regions. As fintech and digital transformation continue to grow, so does the need for financial institutions to invest in newer technologies such as machine learning and blockchain toward improving customer experiences, security, and operational productivity.

Most importantly, API security and risk assessment are under-explored areas that urgently need practitioners' attention. Indeed, with the continued growth of Open Banking, potential risks related to data breaches and fraud are much more significant. It is, thus, very important that the financial institutions and regulators work jointly in putting in place strong security protocols and risk management frameworks that will elude all threats. In the end, considering the interest in machine learning and blockchain, this may as well mean a new path that could be pursued by financial institutions in carrying out their strategies on open banking with a view to improving efficiency and security at the same time. This could result in the innovation of solutions relating to smart contracts, auto-compliance, among other personalized financial services and will further propel the digital transformation of the banking industry.

REFERENCES

Alhawamdeh, L.N., Alsmadi, A.A., Al-Okaily, M., Al-Sartawi, A. (2024), The rise of open banking: Analyzing consumer trust and data privacy concerns. In: Artificial Intelligence and Economic Sustainability in the Era of Industrial Revolution 5.0. Cham: Springer. p243-257.

Aytaş, B., Öztaner, S.M., Şener, E. (2021), Open banking: Opening up the 'walled gardens'. Journal of Payments Strategy and Systems, 15(4), 419-431.

Babin, R., Smith, D. (2022), Open banking and regulation: Please advise the government. Journal of Information Technology Teaching Cases, 12, 108-114.

Behbehani, D., Komninos, N., Al-Begain, K., Rajarajan, M. (2023), Open Banking API Security: Anomalous Access Behaviour. In: 2023 International Conference on Innovations in Intelligent Systems and Applications (INISTA). p1-4.

Behbehani, D., Rajarajan, M., Komninos, N., Al-Begain, K. (2022), Detecting Open Banking API Security Threats Using Bayesian Attack Graphs. In: 2022 14th International Conference on Computational Intelligence and Communication Networks (CICN). p789-796.

Bernards, N. (2023), Can technology democratize finance? Ethics and International Affairs, 37, 81-95.

Chan, R., Troshani, I., Rao Hill, S., Hoffmann, A. (2022), Towards an understanding of consumers' FinTech adoption: The case of open banking. International Journal of Bank Marketing, 40(4), 886-917.

Chen, Y. (2023), Research on regulation of personal financial data sharing in open banking. Asian Journal of Education and Social Studies, 45, 31-41.

Chinoda, T., Kapingura, F. (2023), The impact of digital financial inclusion and bank competition on bank stability in Sub-saharan Africa. Economies, 11, 15.

Devaki, V., Ramganesh, D.E., Amutha, D.S. (2024), Bibliometric analysis on metacognition and self-regulation using biblioshiny software. Indian Journal of Information Sources and Services, 14(2), 115-125.

Dinçkol, D., Ozcan, P., Zachariadis, M. (2023), Regulatory standards and consequences for industry architecture: The case of UK open banking. Research Policy, 52(6), 104760.

Dzhaparov, P. (2020), About PSD2 and open banking: Opportunities and challenges. Izvestia Journal of the Union of Scientists - Varna Economic Sciences Series, 9, 179-190.

Farrow, G.S. (2020), Open banking: The rise of the cloud platform. Journal of Payments Strategy and Systems, 14(2), 128-146.

Gekhaeva, P., Bolotkhanov, E., Ismoilova, S. (2023), Global digital transformation trends: Financial-economic sector. SHS Web of Conferences, 172, 02025.

Gogia, J., Chakraborty, D. (2022), Open banking: A revolution in the Tech-Fin industry. International Journal of Electronic Banking, 3(2), 100-120.

Gozman, D., Liebenau, J., Mangan, J. (2018), The innovation mechanisms of fintech start-ups: Insights from SWIFT's innotribe competition. Journal of Management Information Systems, 35(1), 145-179.

Junior, C.A.D., Kissimoto, K.O., Laurindo, F.J.B. (2024), IT Enabling Factors in a new Industry Design: Open Banking and Digital Economy. arXiv preprint arXiv:2407.09487.

Khatun, R., Bist, J.P. (2019), Financial development, openness in financial services trade and economic growth: A panel data analysis in BRICS economies. International Trade, Politics and Development, 3, 42-65.

Li, Y. (2019), Emerging blockchain-based applications and techniques. Service Oriented Computing and Applications, 13(4), 279-285.

Ma, S., Guo, C., Wang, H., Xiao, H., Xu, B., Dai, H., Cheng, S., Yi, R., Wang, T. (2018), Nudging Data Privacy Management of Open Banking Based on Blockchain. In: 2018 15th International Symposium on Pervasive Systems, Algorithms and Networks (I-SPAN). p72-79.

Nam, R.J. (2023), Open Banking and Customer Data Sharing: Implications for Fintech Borrowers. SAFE Working Paper No. 364. Available from: https://ssrn.com/abstract=4278803.

Niazi, M.A. (2016), Review of "CiteSpace: A practical guide for mapping scientific literature" by Chaomei Chen. Complex Adaptive Systems Modeling, 4(1), 23.

Noctor, M. (2018), PSD2: Is the banking industry prepared? Computer Fraud and Security, 2018, 9-11.

Odorovic, A. (2023), Open banking: Between cooperation and competition. Anali Pravnog Fakulteta u Beogradu, 71, 65-91.

Packin, N.G. (2020), Show me the (data about the) money! Utah Law Review, 2020, 1277-1348.

Palmieri, A., Nazeraj, B. (2021), Open banking and competition: An intricate relationship. EU and Comparative Law Issues and Challenges Series (ECLIC), 5, 217-237.

Pascalis, F.D. (2022), The journey to open finance: Learning from the open banking movement. European Business Law Review, 33, 397-420.

Podder, S. (2022), Leveraging the provisions of open banking to fight financial crimes. In: Financial Technology and the Law: Combating Financial Crime. Cham: Springer. p19-46.

Premchand, A., Choudhry, A. (2018), Open Banking & APIs for Transformation in Banking. In: 2018 International Conference on Communication, Computing and Internet of Things (IC3IoT). p25-29.

Ramdani, B., Rothwell, B., Boukrami, E. (2020), Open banking: The emergence of new digital business models. International Journal of Innovation and Technology Management, 17(5), 2050033.

Remolina, N. (2019), Open banking: Regulatory challenges for a new form of financial intermediation in a data-driven world. SSRN Electronic Journal, 1-57.

Singh, C., Naik, G. (2017), Financial inclusion in India: A case study of Gubbi. SSRN Electronic Journal, 549.

Sun, W., Song, J., Dong, X., Kang, X., He, B., Zhao, W., Li, Z., Feng, Z., Chen, X. (2022), Bibliometric and visual analysis of transcranial direct current stimulation in the web of science database from 2000 to 2022 via CiteSpace. Frontiers in Human Neuroscience, 16, 1049572.

Thangavel, P., Chandra, B. (2023), Two decades of M-commerce consumer research: A bibliometric analysis using R biblioshiny. Sustainability, 15(15), 11835.

Xie, C., Hu, S. (2024), Open banking: An early review. Journal of Internet and Digital Economics, 4(2), 73-82.

Xu, Z., Wang, Q., Wang, Z., Liu, D., Xiang, Y., Wen, S. (2020), PPM: A Provenance-Provided Data Sharing Model for Open Banking via Blockchain. In: Proceedings of the Australasian Computer Science Week Multiconference.

Ziegler, T. (2021), Implementation of open banking protocols around the world. In: The Palgrave Handbook of Technological Finance, Germany: Springer Nature. p751-779.