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A study on the knowledge networks in digital finance through bibliometric alchemy

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ABSTRACT

This study employs bibliometric alchemy to explore the knowledge networks in the space of digital finance research between 2013 and 2025. It begins with 15,776 articles and finally through the process of bibliometric alchemy a dataset of 8838 articles is analyzed. The study critically identifies the key influencing factors, existing gaps, opportunities, and future trends in digital finance research. It identifies the four key major research areas (digital currencies, digital inclusive finance, fintech, and blockchain technology) among the diversified nature of digital finance research. The analysis reveals distinct thematic and geographical patterns: scholars in developed economies concentrate on crowdfunding, cryptocurrencies, and blockchain, while those in developing economies particularly China emphasize financial inclusion. In addition to it the present study highlights the institutional, market, and infrastructural determinants shaping divergent innovation pathways. Lastly, the present study identifies the following grey areas for future studies namely societal impact of financial inclusion, economic implications of the rise in Fintech's, and economic valuations of Non-Fungible Tokens.

1. Introduction

Technological advancements and evolving business models have driven the rise of digital finance, offering new opportunities to reduce transaction costs and expand access to personalized financial services, particularly for underserved populations (Pazarbasioglu et al., 2020). The COVID-19 pandemic further accelerated digital transformation, positioning the digital economy as a key source of global competitiveness. This shift has highlighted the strategic role of digital finance in national economic agendas, especially in fostering growth and alleviating poverty (Pazarbasioglu et al., 2020). Positioned at the nexus of financial services and digital innovation, digital finance now extends beyond incremental improvements in financial technologies. Yet, despite the proliferation of terms such as *fintech* and *digital finance* in academic and policy discourse, no universally accepted definition has emerged. This conceptual ambiguity reflects the field's inherently interdisciplinary character, spanning innovations such as fintech, cryptocurrencies, digital payment systems, and inclusive financial platforms. Since 2013, research on digital finance has expanded rapidly but remains fragmented across regions and themes, lacking an integrated understanding of its underlying knowledge structure. This study addresses

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that gap by mapping the intellectual landscape of digital finance, identifying major research trajectories, and offering a systematic framework to understand its evolution and future directions.

Scholars and institutions have offered varying definitions of digital finance. The Irish International Digital Research Centre (2014) and the Financial Stability Board (2022) conceptualize fintech as a transformative force reshaping financial services through digital innovation. The European Commission (Directorate-General for Financial Stability, ca. 2020) emphasizes the influence of emerging technologies on financial services, while Chinese regulators (2015) define internet finance as the provision of financial services via internet-based platforms. Huang and Huang (2018) differentiate between *internet finance*, typically offered by technology firms, and *fintech*, which focuses on technological applications within financial services. By contrast, *digital finance* serves as a broader and more neutral umbrella term encompassing both. Wang and Hu (2023) present a comprehensive review, underscoring the roles of big data, cloud computing, blockchain, and artificial intelligence in transforming financial services. Building on these perspectives, this study develops a holistic conceptualization of digital finance that integrates fintech and internet finance. From early innovations such as mobile payments and peer-to-peer lending to more recent developments including blockchain and central bank digital currencies (CBDCs), these technologies collectively delineate the scope of the field.

The interaction between finance and technology has deep historical roots, from the adoption of the telegraph in the nineteenth century to the introduction of automated teller machines in 1967, and the coinage of the term *fintech* by Bettinger (1972). In the aftermath of the 2008 global financial crisis, fintech startups began delivering innovative financial services directly to consumers, harnessing technologies such as big data, blockchain, and artificial intelligence (Arner et al., 2015; Zetzsche et al., 2017). Research output on digital finance exhibits pronounced regional variation. In developed economies—particularly the United States—scholars have concentrated on crowdfunding (Burtch et al., 2013; Agrawal et al., 2015), cryptocurrencies (Dyhrberg, 2016a; Corbet et al., 2018a), and blockchain applications (Lansiti and Lakhani, 2017; Chang et al., 2020). By contrast, research in developing countries has primarily focused on financial inclusion, mobile payments, and peer-to-peer lending (Li et al., 2020; Wang et al., 2022; Purohit et al., 2022).

A growing body of review studies has examined the evolution of digital finance and fintech research from diverse perspectives. Foundational contributions have proposed conceptual frameworks and research agendas (Gomber et al., 2017) and traced thematic developments using bibliometric methods (Bajwa et al., 2022). Other analyses have focused on specific domains, such as digital financial inclusion (Gallego-Losada et al., 2023), or have identified emerging fintech themes through Scopus-based mapping, albeit with limited integration of policy and institutional dimensions (Sethi et al., 2025). Region-specific studies such as those on China's fintech, cryptocurrency, and central bank digital currency (CBDC) transformation (Allen et al., 2022) and on the broader trajectory of China's digital finance development (Li and Zhang, 2024) offer valuable localized insights but fall short of providing systematic cross-regional comparisons or integrating multiple research streams. While these contributions have advanced the literature within their respective scopes, none has synthesized the key thematic streams cryptocurrency and blockchain, fintech and financial inclusion, CBDCs, and decentralized finance into a unified framework that bridges academic, policy, and industry perspectives over a decade long horizon. This study addresses that gap, offering novelty in both thematic breadth and integrative depth.

Building on these identified gaps, this study undertakes a comprehensive bibliometric analysis of digital finance literature published between 2013 and 2025. Drawing on 8838 peer-reviewed articles from the Web of Science Core Collection, we employ CiteSpace to conduct co-citation and keyword-clustering analyses. These methods facilitate the identification of influential authors, institutions, journals, and thematic clusters, as well as their evolution across temporal and geographical dimensions. Complementing this quantitative mapping, we perform a qualitative content analysis of the most highly cited publications to capture emerging research frontiers. This dual approach enables us to visualize the field's knowledge structure, trace its historical trajectory, and reveal patterns of convergence and divergence.

Against this backdrop, the novelty of this study lies in its unified analytical framework for defining digital finance and systematically examining the field's evolution, current landscape, and future prospects from a comparative and integrative perspective. Unlike prior reviews that address isolated aspects of the field or focus narrowly on a single country or theme, our approach synthesizes multiple strands of literature encompassing cryptocurrency and blockchain, fintech and financial inclusion, central bank digital currencies (CBDCs), and decentralized finance while explicitly comparing patterns across diverse regulatory and institutional contexts. The contribution extends beyond thematic integration to methodological rigor, achieved through an expanded set of search keywords that ensures broad coverage of relevant literature and minimizes the risk of omitting influential studies. This combination of thematic breadth and methodological refinement yields insights that move beyond confirming established global trends, illuminating how contextual differences shape the trajectory, scope, and policy relevance of digital finance.

Guided by this objective, the study addresses four interrelated questions: (1) How has digital finance evolved over time, and what defining features emerge across different institutional, regulatory, and market contexts? (2) In what ways does digital finance contribute to economic growth, promote financial inclusion, and address economic disparities? (3) How do blockchain, cryptocurrencies, and related digital innovations shape the infrastructure, functionality, and governance of digital finance systems? (4) What are the prevailing research trends, thematic priorities, and unresolved gaps that will shape the future trajectory of digital finance scholarship?

The contributions of this research are manifold. First, it advances a unified definition of digital finance by synthesizing disparate conceptualizations in the literature, thereby establishing a shared framework for future inquiry. Second, it conducts a comprehensive literature search based on an expanded and systematically designed set of keywords, ensuring broad thematic coverage and minimizing the risk of omitting influential studies. Third, it identifies key milestones and turning points in the evolution of digital finance, providing a historical perspective on its development. Fourth, through a regional analysis, it highlights the countries and regions at the forefront of digital finance scholarship and identifies potential avenues for cross-border collaboration. In addition, by mapping

influential institutions, authors, and journals, the study offers insights into the field's thought leadership and authoritative sources. The thematic analysis isolates four frontier research areas—digital currency, financial inclusion, fintech, and blockchain technology—thereby illuminating existing research gaps and outlining priorities for future investigation. Collectively, these contributions equip policymakers, scholars, and practitioners with a robust analytical foundation to navigate the evolving digital finance landscape and inform decision-making.

The following sections are organized as follows: Section 2 discusses key areas in digital finance; Section 3 details the research methodology and data sources; Section 4 presents the main findings, including scientometric and qualitative analyses; Section 5 offers a discussion of the results; and Section 6 concludes with limitations and suggestions for future research.

2. Conceptual domains and functional areas in digital finance

This section does not aim to provide a conventional literature review. Instead, it offers a conceptual and functional overview of the principal domains in digital finance research. By synthesizing influential academic contributions, it establishes the thematic foundations for the bibliometric and content analyses presented in subsequent sections.

The literature on digital finance is inherently dynamic and interdisciplinary. Scholars have examined a wide range of topics, including its role in advancing financial inclusion, the transformative impact of financial technologies, the proliferation of digital currencies and cryptocurrencies, the evolution of peer-to-peer lending and crowdfunding, innovations in digital banking and payment systems, the entry of large technology firms into financial services, and the emergence of robo-advisory platforms. As the field continues to evolve, it offers critical insights into the future architecture, accessibility, and governance of financial systems.

2.1. Digitalization and payments

Within the digital financial ecosystem, entities such as digital banks, mobile banks, and e-banks have transformed how individuals manage their finances. Mobile banking applications, accessible via smartphones, enable users to conduct a wide range of transactions, including balance inquiries and payments. A recurrent focus in the literature is the influence of user demographics—such as age, gender, and education—on the adoption of mobile banking (Laukkanen et al., 2007). The expansion of mobile banking has, in turn, driven the growth of mobile payments and cashless transactions, reshaping the global payment landscape. Research on mobile payment ecosystems often adopts a multi-perspective framework to examine the roles of various actors (Apanasevic, 2013; Cheng and Huang, 2013). Other strands of scholarship analyze business models (Alshare and Mousa, 2014) and strategic market considerations (Kazan and Damsgaard, 2013). While early studies emphasized market fragmentation, recent work has increasingly addressed security and privacy concerns (Alshare and Mousa, 2014). Technical research has also focused on the development of protocols and security proofs (Gannamaneni et al., 2015). The global payment system is further shaped by the rise of digital currencies issued by both private entities and central banks. Adrian and Mancini-Griffoli (2021) classify payment methods into five main categories.

1. Central Bank Money: This includes physical cash and Central Bank Digital Currency (CBDC). Research on CBDC examines its impact on financial inclusion, cost-effectiveness, and payment security (Mancini-Griffoli et al., 2018).
2. Cryptocurrency: Cryptocurrencies like Bitcoin and Ethereum are created on blockchain technology, though primarily used for investment rather than as a medium of exchange (Baur et al., 2018).
3. B-money: This method includes commercial bank deposits and is widely used for payments, such as debit cards and wire transfers (Adrian and Mancini-Griffoli, 2021).
4. E-money: Like b-money but without government backing, e-money includes systems like Alipay, WeChat Pay, Paytm, and M-Pesa (Adrian and Mancini-Griffoli, 2021). Stablecoins also fall into this category, although their definition is still evolving (G7 Working Group, 2019). Regulatory frameworks for e-money exist but may require updating to address risks (Financial Stability Board, 2020).
5. I-money: A potential new payment method, i-money differs from e-money by offering variable currency redemption, making it a quasi-equity instrument, as seen with Libra, backed by assets such as government securities.

2.2. Crowdfunding, lending & borrowing

Digital finance has played a pivotal role in expanding access to credit for individuals traditionally excluded from formal credit markets. The emergence of peer-to-peer (P2P) lending platforms and crowdfunding mechanisms has disrupted conventional lending and fundraising models. As an innovative financing method, crowdfunding has transformed the entrepreneurial finance ecosystem (Block et al., 2018). Beyond facilitating capital formation, it enables entrepreneurs to cultivate virtual communities of supporters (Butticè et al., 2017), who provide valuable feedback for refining early-stage innovations (Chemla and Tinn, 2020).

Crowdfunding also functions as a tool for gauging market reactions to products (Balykhin and Generalova, 2015) and assessing demand (Agrawal et al., 2014). In addition, it serves as an effective marketing channel (Brown et al., 2017), enhances brand visibility (Stanko and Henard, 2017), and fosters open innovation (Brem et al., 2019). Its applications extend beyond commercial ventures to the support of artistic, cultural, and social initiatives, as well as the promotion of financial inclusion (Kim and De Moor, 2017).

Peer-to-peer (P2P) lending, a prominent form of crowdfunding, offers distinct advantages for both lenders and borrowers. It provides lenders with the prospect of higher returns and offers borrowers more affordable credit, particularly for those facing barriers to obtaining traditional bank loans (Milne and Parboteeah, 2016). By lowering entry barriers for individuals with low credit scores,

P2P lending reduces inefficiencies and indirect borrowing costs (Chen et al., 2020). The literature emphasizes its potential as a viable alternative to conventional financing (Liu et al., 2020). While high interest rates may, in some cases, drive small businesses back to traditional funding channels, P2P lending nonetheless enhances working capital availability and supports growth ambitions, even when associated with elevated costs (Lu, 2018; Gao et al., 2018).

The entry of large technology firms into the financial sector has given rise to "BigTech credit," which provides digital lending solutions that leverage alternative data sources—such as payment histories, e-commerce transactions, and mobile activity—without human intervention. BigTech lenders emphasize convenience; Buchak et al. (2018) highlight their competitive advantage in streamlining the lending process, while Fuster et al. (2019) document a 20 % reduction in U.S. mortgage loan processing times attributable to fintech innovations. In China, Hau et al. (2021) describe how Alibaba's application of enterprise data underpins the "3-1-0" loan model, enabling businesses to complete credit applications in 3 min, receive approval in 1 s, and require zero human interaction.

2.3. Insurance

InsurTech—a portmanteau of "insurance" and "technology"—is an expanding frontier within digital finance. It harnesses advanced technologies, including big data analytics, blockchain, and artificial intelligence, to transform core insurance processes such as product design, pricing, marketing, and claims management. By addressing industry challenges and alleviating operational inefficiencies, InsurTech strengthens the overall insurance ecosystem (Xu, 2017a, 2017b). Startups in this space have exerted a significant impact on incumbent insurers and have contributed to broader economic growth (Manta, 2021; Chang, 2023a). Liu et al. (2023) contend that InsurTech is a strategic imperative for insurers navigating the digital transformation, enhancing both technological innovation and long-term sustainability. More broadly, digitalization is fundamentally reshaping the financial insurance landscape (Eling and Lehmann, 2018).

Empirical evidence suggests that the relationship between InsurTech startups and established insurers is, in many cases, more collaborative than competitive (Cappiello, 2020). Incumbent firms increasingly regard innovative startups as strategic partners rather than purely as market disruptors (Cappiello, 2018, 2020; Duane, 2022). Nevertheless, Chang (2023b) finds that while InsurTech entrants can erode the competitiveness and performance of smaller insurers, they also generate competitive pressures that enhance the business performance of larger incumbents. In this environment, regulatory authorities play a critical role in ensuring industry stability, managing technological disruptions, and fostering sustainability (Liu et al., 2023).

2.4. Investment tools

Digital finance has spurred the development of a wide array of innovative investment instruments, including cryptocurrencies, decentralized finance (DeFi) platforms, non-fungible tokens (NFTs), robo-advisors, and automated portfolio management systems. Blockchain-based digital assets and currencies have recently gained substantial academic and market attention. Cryptocurrencies, as digital assets, are primarily employed for investment purposes, with secure transactions facilitated by distributed ledger or blockchain technology (Härdle et al., 2020). This investment-oriented role distinguishes them from their original function as a medium of exchange (Baur et al., 2018).

Cryptocurrency markets have become increasingly integrated into contemporary financial systems, attracting interest due to their transparency (Koutmos, 2018), portability (Urquhart, 2016), divisibility (Grobys and Sapkota, 2019), and perceived resistance to inflation (Corbet et al., 2018b). Nevertheless, persistent concerns remain regarding security vulnerabilities (Corbet et al., 2018a, 2018b), inefficiencies (Urquhart, 2016), technical limitations (Corbet et al., 2018b; Urquhart, 2016), volatility, and regulatory gaps (Klarin, 2020).

The inclusion of cryptocurrencies in institutional investment portfolios is gaining momentum, yet scholarly debate persists regarding their effectiveness as hedging instruments and safe-haven assets (Dyhrberg, 2016a, 2016b; Conlon and McGee, 2020). Building on the same technological foundation, blockchain-based financial services are fueling the rapid expansion of decentralized finance (DeFi), which seeks to establish a digital, decentralized financial system (Schär, 2021; Schueffel, 2021). DeFi carries significant disruptive potential for the future of financial intermediation (Chen and Bellavitis, 2020; Grigo et al., 2020), but its development is constrained by technical vulnerabilities, the risk of illicit activities, regulatory ambiguity, and challenges related to institutional integration, scalability, and security (Chen and Bellavitis, 2020).

2.5. Artificial intelligence and machine learning

Artificial intelligence (AI) has emerged as a dominant technology in the 2020s, particularly within digital finance applications such as robo-advisors and automated portfolio management systems. Robo-advisors leverage extensive open data to provide households with informed benchmarks for managing consumption, savings, investment, and debt (D'Acunto and Rossi, 2023). By lowering the monetary, cognitive, and psychological costs of financial decision-making, these tools help address household financial constraints, ultimately fostering greater equity ownership and improving portfolio performance (D'Acunto and Rossi, 2021).

AI-driven technologies—especially machine learning and deep learning—are increasingly supplanting traditional econometric models for stock return prediction (Ghosh et al., 2022). Their applications extend to portfolio construction, volatility forecasting, and liquidity assessment. For example, Chen and Ge (2021) employ neural networks to implement optimal investment strategies, demonstrating AI's potential to enhance predictive accuracy and investment efficiency.

3. Research design and methodology

To provide a comprehensive and systematic overview of the scholarly landscape in digital finance, this study adopts a dual-method approach that integrates bibliometric analysis with qualitative content analysis. In contrast to traditional narrative reviews that often rely heavily on subjective interpretation, this design enables both macro-level structural mapping and micro-level conceptual synthesis. Bibliometric techniques facilitate the objective quantification of publication patterns, citation networks, and thematic clusters, while qualitative analysis adds interpretive depth by examining the substantive content of the most influential contributions. This hybrid methodology yields a more holistic understanding of the evolution, diversity, and intellectual foundations of digital finance research.

3.1. Bibliometric analysis with CiteSpace

Bibliometrics concerns the measurement and analysis of scholarly literature, focusing on the impact of research outputs, the evaluation of academic journals, the interpretation of scientific citation patterns, and the application of these measures in policy and management contexts (Leydesdorff and Milojević, 2013). In this study, bibliometric analysis forms the backbone of the quantitative approach, offering a macro-level perspective on the intellectual structure and developmental trajectory of digital finance research.

Applied to a specific field, bibliometric analysis yields a comprehensive depiction of the research landscape, encompassing the historical evolution of publication volume, geographical distribution, collaboration networks, and the concentration of outputs among institutions, journals, and authors. It also maps influential scholars and their collaborative relationships. Keyword network clustering identifies the thematic structure of research topics and traces their historical development, while co-citation network analysis elucidates the progression from foundational knowledge to the research frontier, thereby clarifying emerging trends across subfields.

We employ bibliometric analysis using CiteSpace software to examine key dimensions of digital finance research, including temporal trends, geographical distribution, and the identification of influential authors. This approach facilitates the detection of significant literature on emerging topics and enables the visualization of developments within the field, with particular emphasis on nascent trends in knowledge domains (Chen, 2006). CiteSpace first conducts a feature analysis of the dataset, assessing publication trajectories, the distribution of articles by country or region, institutional affiliations, journal outlets, and author collaboration networks. It then applies keyword clustering and co-citation analysis to map thematic concentrations and research hotspots.

The dataset is drawn from the Web of Science (WoS) Core Collection, restricted to journals indexed in the Social Sciences Citation Index (SSCI). The analytical timespan covers publications from 2013 to 2025. The year 2013 serves as the starting point, reflecting both the emergence of significant scholarly interest in Bitcoin and blockchain technologies and a milestone in China's digital finance development marked by the launch of Yu'e Bao (Huang and Huang, 2018).

To ensure methodological rigor, we implemented the following parameters in CiteSpace: the time slicing was set to one year per slice; term sources included title (TI), abstract (AB), author keywords (DE), and Keywords Plus (ID). Node selection employed the *g*-index with a scaling factor *k*, thereby prioritizing highly cited publications. Cluster validity was assessed using the Modularity *Q* statistic to evaluate structural significance and the Silhouette *S* score to measure internal consistency. Cluster labeling relied on the log-likelihood ratio (LLR) method, which identifies statistically salient terms for each cluster.

This configuration enables the analysis to capture both the temporal evolution of digital finance research and the structural coherence and topical differentiation across subfields. The bibliometric findings thereby provide a robust empirical foundation for the subsequent qualitative interpretation of emerging research themes.

3.2. Qualitative content analysis

To complement the quantitative mapping, we conduct a qualitative content analysis of the most influential publications identified through citation analysis. This approach enables us to uncover the conceptual foundations, theoretical orientations, and evolving research trajectories that cannot be fully discerned from network structures alone.

Specifically, we selected the most highly cited articles for in-depth examination. Guided by the bibliometric clustering results, we conducted a thematic comparison of these works to synthesize the core research themes within and across clusters. For each theme, we identified the central research questions, methodological approaches, and scholarly contributions, as well as areas of divergence and emerging points of consensus.

This interpretive layer allows us to move beyond identifying prominent topics to explaining how and why these themes have evolved. It also facilitates the detection of knowledge gaps, unresolved debates, and promising avenues for future research. By integrating qualitative content analysis with bibliometric findings, the study bridges structural mapping and conceptual interpretation, yielding a more nuanced and policy-relevant overview of the digital finance field.

3.3. Data collection and search strategy

To construct a robust and representative dataset, we retrieved publication records from the Web of Science Core Collection using an extensive search query designed to capture the full breadth of digital finance related research. The search strategy was guided by the conceptual framework outlined in Section 2, which systematically maps the field's core definitions, thematic domains, and functional areas, and was informed by insights from the existing literature.

An expanded and systematically designed keyword set was developed to encompass major subdomains—including fintech, financial inclusion, blockchain, cryptocurrencies, and central bank digital currencies—along with their common variants and synonyms. This framework-based approach was refined through iterative trial searches and cross-checking against high-impact publications to ensure broad thematic coverage and to minimize the risk of excluding influential studies.

Consistent with this thematic mapping, the final keyword set was operationalized through the "Topic" field in the Web of Science, encompassing Titles, Author Keywords, Keywords Plus, and Abstracts. This approach allows broader parent terms to subsume finer-grained concepts whenever they appear in an article's descriptive fields. For example, *RegTech* and *SupTech* typically co-occur with "fintech" or "digital finance" in policy-oriented studies; cross-border or instant payments are captured under "digital payment*" or "real-time payment*"; asset tokenization is generally framed with "blockchain," "cryptocurrenc*," or "stablecoin"; and digital identity or e-KYC commonly appears in research on "digital bank*" or "mobile payment*." Given this Topic-level retrieval strategy, enumerating all granular variants is neither necessary nor efficient. Furthermore, targeted trial searches that temporarily incorporated several derivative terms (e.g., *RegTech*, *SupTech*, cross-border payments, tokenization) yielded no substantive changes to the core clusters, high-centrality nodes, or thematic distributions—confirming that the existing query provides comprehensive coverage without compromising precision.

The full search string was as follows: TS=("digital finance" OR "digital inclusive finance" OR "digital financial inclusion" OR fintech OR fintech OR "fin tech" OR "financial technolog*" OR "internet financ*" OR "digital currenc*" OR "digital money" OR "virtual currenc*" OR cryptocurrenc* OR blockchain OR Bitcoin OR stablecoin OR "central bank digital currenc*" OR CBDC OR "decentralized financ*" OR DeFi OR P2P OR "peer-to-peer lending" OR "digital bank*" OR "mobile bank*" OR e-bank* OR crowdfund* OR "mobile payment*" OR "cashless payment*" OR "real-time payment*" OR "bigtech credit" OR insurtech OR "robo advisor*" OR "automated portfolio management").

The search was restricted to English-language journal articles classified under the "Business Economics" category. The initial query returned 15,776 records. After refining the results by document type and subject category, the final dataset comprised 8838 articles. While some highly specialized or newly emerging terms may not have been fully captured, any such omissions are unlikely to materially affect the observed patterns or thematic structures identified in the analysis. This corpus forms the foundation for all subsequent analyses.

3.4. Parameter settings and robustness assessment

To ensure the validity and interpretability of the CiteSpace-generated visualizations and clusters, we adopted several methodological safeguards. The primary parameters—time slicing, term sources, and node selection strategy—were selected in accordance with established best practices in bibliometric research.

In particular, the *g*-index with $k = 25$ was employed to prioritize highly cited publications while preserving thematic diversity. The *g*-index, introduced by Egghe (2006), identifies the largest number g such that the top g publications collectively receive at least g^2 citations. CiteSpace operationalizes this by allowing the user to specify a scaling factor k, which determines the maximum number of nodes selected per time slice. Under this rule, nodes are chosen such that the cumulative citations of the top g publications meet or exceed g^2, without surpassing $k \times g$ nodes.

We assessed the structural robustness of the co-citation and keyword clusters using two standard diagnostic indicators: Modularity Q and Silhouette S. The Modularity Q statistic, grounded in network theory, measures the extent to which a network is partitioned into distinct communities by comparing the density of links within clusters to that between clusters; values above 0.3 are generally interpreted as indicating a meaningful modular structure (Newman and Girvan, 2004). The Silhouette S coefficient evaluates cluster cohesion and separation by comparing the average intra-cluster distance with the average inter-cluster distance; values exceeding 0.7 indicate high internal consistency and well-defined cluster boundaries (Rousseeuw, 1987). Across all analyses, our results consistently surpassed these thresholds, confirming the high quality and interpretability of the clustering outcomes.

Cluster labeling was performed using the log-likelihood ratio (LLR) algorithm, which selects the most representative terms for each cluster based on their statistical distinctiveness. This method ensures that cluster labels capture salient, domain-relevant concepts (Chen, 2006). Taken together, these parameter settings and diagnostic checks strengthen the methodological rigor of the study and enhance confidence in the interpretive insights derived from the visualization results.

4. Results

4.1. Publication Annual Trend

Fig. 1 presents the annual distribution of academic publications on digital finance from 2013 to 2024. Following the release of several groundbreaking studies in 2013 and 2014, the field experienced sustained growth, culminating in 1829 publications by 2024 a trajectory that underscores the rising prominence of digital finance research in the global academic landscape.

This trajectory can be divided into three distinct phases. The first phase (2013–2018) represents the formative stage, with annual publications increasing from 20 to 278. While scholarly interest expanded during this period, digital finance had yet to achieve mainstream recognition. The second phase (2019–2021) marks a period of rapid acceleration, with annual output averaging around 300 articles and peaking at 1195 in 2021—representing a 4.3-fold increase relative to 2018. The third phase, beginning in 2022, is characterized by more moderate growth and gradual consolidation. Although the expansion rate slowed between 2022 and 2024, the overall upward trajectory suggests that digital finance remains a vibrant and evolving area of scholarly inquiry.

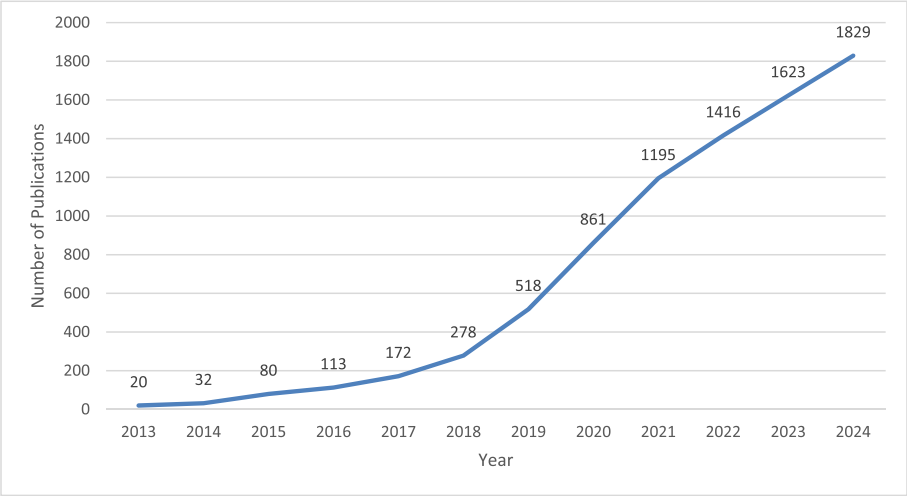


Fig. 1. Annual Trend of Publications. *Note*. The figure shows the trend in annual number of academic articles published on Digital Finance (2013-2024).

The sharp increase in publications after 2019 reflects not only the growing visibility of digital finance but also deeper structural shifts in the global financial and research landscapes. First, the COVID-19 pandemic accelerated the digitalization of financial services, prompting both industry practitioners and academic researchers to examine new delivery models, risk mechanisms, and regulatory frameworks. Second, the surge of interest in cryptocurrencies intensified scholarly debates over volatility, financial stability, regulatory design, and central bank responses, including the rapid proliferation of CBDC initiatives—making crypto-related topics a central research priority. Third, the thematic expansion of digital finance into sustainability, green finance, and artificial intelligence applications has broadened its disciplinary appeal, attracting contributions from economics, computer science, law, and development studies. Taken together, these dynamics underscore the transformation of digital finance from a peripheral topic into a pivotal domain of interdisciplinary financial research.

4.2. Regional distribution characteristics

This section analyzes the geographical distribution of scholarly contributions to digital finance research. Authors from 78 countries and regions have published in this field, reflecting its broad international scope. Table 1 reports the top ten countries and regions ranked by publication volume between 2013 and 2025. China, the United States, and the United Kingdom occupy the top three positions, underscoring their leading roles in advancing digital finance scholarship.

From the perspective of betweenness centrality, the United Kingdom, United States, France, and Spain register notably high scores of 0.23, 0.13, 0.12, and 0.12, respectively. Introduced by Freeman (1978), betweenness centrality measures the extent to which a node functions as a bridge along the shortest paths in a network. High centrality values indicate substantial international collaboration, whereas low values suggest more localized research activity. Despite China's dominance in publication volume, its relatively low centrality score points to limited cross-border collaboration in digital finance research.

Fig. 2 presents the international co-authorship network, illustrating the geographical distribution of collaborative activity. Node colors correspond to the year of initial collaboration, while link colors reflect the year the connection was first established. The width of a node's inner rings represents the number of publications in the corresponding year, and node sizes are proportional to a weighted

Table 1
Most influential countries (regions).

Rank	Count	Centrality	Year	Country (Region)
1	3040	0.02	2013	PEOPLES R CHINA
2	1879	0.13	2013	USA
3	1069	0.23	2013	ENGLAND
4	580	0.12	2014	FRANCE
5	516	0.05	2014	ITALY
6	508	0.04	2014	INDIA
7	502	0.03	2014	GERMANY
8	483	0.06	2013	AUSTRALIA
9	327	0.12	2013	SPAIN
10	322	0.02	2014	CANADA

Note. This table shows the top 10 countries and regions by number of publications in Digital Finance (2013-2025). Year indicates when scholars in the country or region first published literature on digital finance. Centrality denotes the degree of betweenness centrality of the country or region.

International Research Collaboration

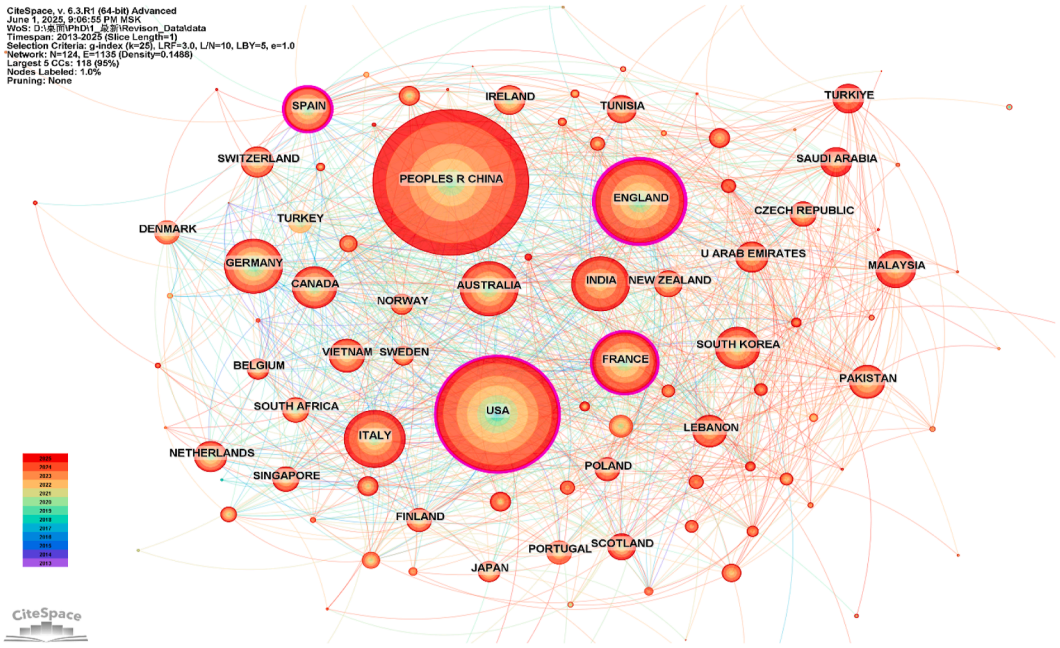


Fig. 2. International Research Collaboration. *Note*. This figure shows the co-occurrence network depicting international research collaborations in the context of regional distribution. The threshold for displaying text on a node is the number of publications greater than 100. The colors of the node rings and links represent specific years, as shown in the lower left corner of the figure. The width of the rings within the nodes reflects the volume of publications for the respective year. The purple circle on the outermost circle of the node represents a betweenness centrality with greater than or equal to 0.1.

combination of publication volume and centrality. Nodes outlined with a purple ring denote high betweenness centrality (Chen, 2006). The United Kingdom, United States, and China emerge as pivotal actors in the global digital finance research network.

The country-level distribution exhibits distinct geographical patterns. The dominance of China and the United States reflects both nations' leadership in digital infrastructure, the development of robust digital finance ecosystems, and sustained academic output. China's strong presence is further supported by policy-driven initiatives promoting digital financial inclusion and the widespread adoption of mobile payment systems. In contrast, U.S.-based research places greater emphasis on technological innovation and regulatory discourse, particularly in relation to crypto-assets and platform-based finance. Significant contributions from scholars in Singapore, the United Kingdom, and Australia highlight the pivotal role of globally integrated, innovation-oriented economies in advancing digital finance scholarship and shaping cross-border knowledge networks.

4.3. Research institution distribution characteristics

Table 2 presents the top ten institutions ranked by the number of publications in international journals on digital finance. These institutions represent leading contributors to global academic discourse in the field. The results show that four institutions from China and two from the United States dominate in publication frequency, followed by leading institutions from India, the United Kingdom, and Vietnam. India's Indian Institute of Management ranks first overall. Prominent Chinese contributors include the Chinese Academy of Sciences, Peking University, Southwest University of Finance and Economics, and Renmin University of China. Other notable entries include Lebanon's Lebanese American University and Vietnam's University of Economics Ho Chi Minh City, reflecting the increasingly globalized nature of digital finance scholarship.

It is noteworthy that seven of the ten most influential institutions are located in developing economies, underscoring the shifting locus of research capacity toward the Global South. This trend reflects the practical urgency and policy relevance of digital finance in contexts where traditional financial infrastructure remains underdeveloped. In particular, institutions in China and India have leveraged domestic digital payment ecosystems and government-backed fintech initiatives to produce a substantial volume of applied research. The inclusion of Lebanon and Vietnam further highlights the growing role of emerging economies in shaping digital finance scholarship, often driven by rapid digital adoption and the imperative for inclusive finance.

A further finding is the strong correlation between institutional research output and national digital finance strategies. China's substantial publication volume is closely linked to state-led initiatives such as the 14th *Five-Year Digital Economy Development Plan*. Similarly, India's leading position reflects an academic response to national programs including *Digital India* and *Jan Dhan Yojana*.

Table 2
Most influential institutions.

Rank	Count	Institution	Country
1	144	INDIAN INSTITUTE OF MANAGEMENT IIM SYSTEM	INDIA
2	140	LEBANESE AMERICAN UNIVERSITY	LEBANON
3	138	STATE UNIVERSITY SYSTEM OF FLORIDA	USA
4	130	UNIVERSITY OF LONDON	UK
5	120	UNIVERSITY SYSTEM OF OHIO	USA
6	111	SOUTHWESTERN UNIVERSITY OF FINANCE ECONOMICS CHINA	CHINA
7	109	CHINESE ACADEMY OF SCIENCES	CHINA
8	108	PEKING UNIVERSITY	CHINA
9	94	HO CHI MINH CITY UNIVERSITY ECONOMICS	VIETNAM
10	90	RENMIN UNIVERSITY OF CHINA	CHINA

Table 3
Most influential journals.

Rank	Count	Journal	JCI (2023)	Category/Rank
1	804	FINANCE RESEARCH LETTERS	2.72	BUSINESS, FINANCE (2/233)
2	317	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2.60	BUSINESS (5/304) REGIONAL & URBAN PLANNING (1/54)
3	265	RESEARCH IN INTERNATIONAL BUSINESS AND FINANCE	1.92	BUSINESS, FINANCE (12/233)
4	255	INTERNATIONAL REVIEW OF FINANCIAL ANALYSIS	2.31	BUSINESS, FINANCE (8/233)
5	196	INTERNATIONAL JOURNAL OF BANK MARKETING	1.15	BUSINESS (66/304)
6	194	FINANCIAL INNOVATION	2.40	BUSINESS, FINANCE (5/233) SOCIAL SCIENCES, MATHEMATICAL METHODS (5/67)
7	177	IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	1.23	BUSINESS (61/304) ENGINEERING, INDUSTRIAL (12/69) MANAGEMENT (87/407)
8	162	INTERNATIONAL REVIEW OF ECONOMICS FINANCE	1.39	BUSINESS, FINANCE (28/233) ECONOMICS (84/603)
9	160	APPLIED ECONOMICS	0.56	ECONOMICS (276/603)
10	155	APPLIED ECONOMICS LETTERS	0.40	ECONOMICS (356/603)

Note. The table shows the top 10 journals by number of publications in digital finance. JCI (2023) denotes the JCI score in 2023 according to the Journal Citation Reports (JCR) for each journal. Category/Rank represents the rank of the journal in the category it belongs to base on the JCI score.

These examples illustrate how coordinated policy frameworks can stimulate both domestic innovation and scholarly productivity in digital finance.

4.4. Journal distribution characteristics

Table 3 reports the top ten journals by publication volume in the field of digital finance. The distribution is highly concentrated, with *Finance Research Letters* leading at 804 articles—accounting for 9.10 % of the total 8838 publications. Collectively, the top ten journals contribute 30.38 % of all output. This concentration reflects both the field's growing academic legitimacy and its inherently multidisciplinary character.

Several of the leading journals occupy the top decile of their respective categories in the 2023 *Journal Citation Indicator* (JCI) rankings—for example, *Finance Research Letters* (2/233 in Business, Finance), *Technological Forecasting and Social Change* (1/54 in Regional & Urban Planning), and *Financial Innovation* (5/233 in Business, Finance). This suggests that high-impact research in digital finance is not limited to traditional finance outlets but increasingly appears in interdisciplinary and policy-relevant journals. Notably, titles such as *Financial Innovation*, *IEEE Transactions on Engineering Management*, and *Technological Forecasting and Social Change* bridge the domains of finance, engineering, and social science, underscoring the hybrid intellectual identity of the field.

At the same time, the presence of generalist economics journals such as *Applied Economics* and *Applied Economics Letters*—despite their comparatively lower JCI rankings—indicates a growing interest in applying mainstream economic frameworks to digital finance questions. Together, these patterns point to both vertical depth within finance and horizontal expansion into adjacent disciplines, reinforcing the evolving, boundary-crossing nature of digital finance scholarship.

4.5. Core authors and author collaboration networks

Table 4 lists the ten most prolific authors in digital finance research, with Elie Bouri leading in terms of publication volume. While output counts provide a useful measure of scholarly activity, they do not fully capture intellectual influence. Incorporating citation-based metrics—such as Total Global Citations (TGC)—reveals that authors including Bouri, Roubaud, Lucey, Corbet, and Vismara consistently appear among both the most cited works and the most productive contributors. Their repeated presence in the top 100 cited articles, combined with high publication rankings, indicates that these scholars are not only prolific but also play a central role in shaping the international research agenda in digital finance.

Table 4
Most influential authors.

Rank	Count	Centrality	Year	Author
1	73	0.01	2017	Bouri, Elie
2	51	0.04	2018	Corbet, Shaen
3	46	0.02	2021	Goodell, John W
4	39	0.02	2022	Yousaf, Imran
5	38	0.02	2021	Naeem, Muhammad Abubakr
6	35	0.02	2018	Yarovaya, Larisa
7	31	0.01	2016	Vismara, Silvio
8	29	0.01	2018	Urquhart, Andrew
9	27	0.02	2018	Lucey, Brian
10	26	0.01	2019	Sensoy, Ahmet

Note. The table shows the top 10 authors by number of publications in digital finance. Year indicates when the author first published article on digital finance. Centrality denotes the degree of betweenness centrality of the author.

Fig. 3 depicts the co-authorship network, illustrating the collaborative dynamics underpinning the field. The network features a dense central cluster, reflecting sustained collaboration among key scholars such as Lucey, Corbet, Goodell, and Naeem, alongside multiple peripheral or weakly connected clusters. This structure suggests that, while certain regional or thematic research communities maintain strong internal linkages, the field as a whole remains relatively fragmented. Central hubs are formed by scholars affiliated with institutions in Lebanon, Ireland, the United Kingdom, France, and Pakistan, underscoring both the global scope of digital finance research and the absence of dominance by any single geographic region.

The observed collaboration patterns also indicate a predominance of topic-driven alignment rather than broad disciplinary convergence. For example, authors clustered around Bouri, Yousaf, and Yarovaya focus predominantly on empirical analyses of cryptocurrency volatility and market contagion. While such thematic specialization has advanced domain-specific knowledge, cross-cluster interaction remains limited, pointing to a need for more integrative collaboration across subfields. Expanding intergroup scholarly exchange could facilitate the development of more comprehensive theoretical frameworks and contribute to the formation of a unified research agenda for digital finance.

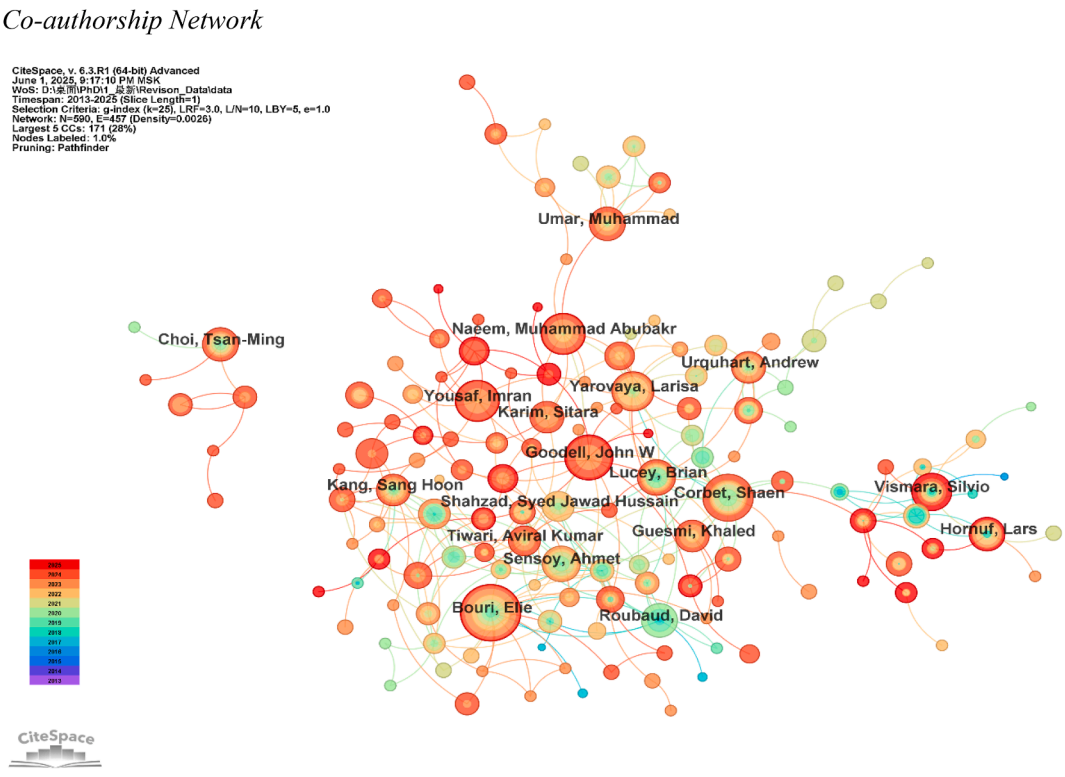


Fig. 3. Co-authorship Network. *Note*. The figure depicts the primary author collaboration network in digital finance. The threshold for displaying text on a node is the number of publications by the author greater than 15.

Table 5
Keyword distribution.

Rank	Centrality	Year	Keyword	Count
1	0.02	2018	Bitcoin	799
2	0.03	2013	Impact	796
3	0.01	2015	Technology	633
4	0.02	2014	Information	629
5	0.02	2013	Model	616
6	0.01	2014	Performance	611
7	0.03	2015	Innovation	514
8	0.01	2018	Volatility	487
9	0.04	2014	Risk	446
10	0.05	2015	Management	439

Note. The table shows the top 10 keywords by frequency of occurrence. Year indicates when the keyword first appeared in digital finance literature. Centrality denotes the degree of betweenness centrality of the keyword.

4.6. Keywords analysis

To elucidate the intellectual structure and evolving research priorities within digital finance, we conducted a comprehensive keyword analysis of publications indexed in the Web of Science from 2013 to 2025. Using CiteSpace, we performed co-occurrence, clustering, and burst detection analyses to identify dominant themes, map their interrelationships, and detect emerging topics of scholarly attention.

4.6.1. Keywords frequency and centrality

To map the knowledge structure of digital finance research, we first examined high-frequency keywords and their betweenness centrality within the co-occurrence network. As reported in Table 5, “Bitcoin” (799 occurrences), “Impact” (796), and “Technology” (633) are the most frequently used terms, reflecting the field's strong emphasis on cryptocurrency and technological applications. Despite their prevalence, these keywords exhibit relatively low betweenness centrality scores (all below 0.1), indicating that they function more as focal points within specific subfields than as bridges linking disparate research areas. Among them, “Risk” (0.04) and “Management” (0.05) register slightly higher centrality values, suggesting a modest degree of cross-topic connectivity. These results point to a thematic concentration within specialized domains and underscore the potential for advancing digital finance scholarship through more integrative, cross-cutting analytical approaches.

4.6.2. Keywords thematic clustering

To identify the underlying thematic structure of digital finance research, we performed a keyword co-occurrence clustering analysis using the log-likelihood ratio (LLR) algorithm in CiteSpace. The resulting network, presented in Fig. 4, reveals eight major keyword clusters. The quality of the clustering is high, with a modularity score of $Q = 0.5229$—indicating a well-defined division between thematic areas—and a mean silhouette score of $S = 0.7744$, suggesting strong internal consistency within clusters (Chen, 2006). These clusters trace the evolution of digital finance research from early focus areas, such as payment technologies, to more complex and policy-relevant domains. The network exhibits a balanced distribution of thematic clusters, with no single topic exerting overwhelming dominance. This pattern reflects the field's multifaceted and dynamic development, in which multiple strands of inquiry—spanning technology, regulation, inclusion, and innovation—have progressively gained prominence over time.

Table 6 presents the composition and thematic focus of each keyword cluster. Cluster #0 (Cryptocurrency Market) encompasses terms such as blockchain, safe haven, policy uncertainty, and COVID-19, reflecting macro-financial concerns with volatility, crisis resilience, and policy responses. Cluster #1 (Mobile Banking) focuses on user adoption and behavioral continuance, representing the early diffusion phase of digital financial technologies. Cluster #2 (Peer-to-Peer Lending) centers on alternative financing channels, incorporating topics such as equity crowdfunding and reward-based models. Cluster #3 (Blockchain Technology) highlights practical applications in smart contracts, supply chain management, and the circular economy. Cluster #4 (Digital Finance) emphasizes institutional and firm-level issues, including fintech, corporate innovation, and financing constraints. Cluster #5 (Digital Inclusive Finance) integrates themes of financial inclusion, green finance, and carbon emissions, signaling a recent shift toward sustainability and inclusive development. Finally, Clusters #6 (Considering Blockchain) and #7 (Bank Marketing), though smaller in scale, point to emerging research on contextual adoption factors and digital marketing strategies in finance. Taken together, these clusters provide a comprehensive and multi-layered representation of the intellectual landscape of digital finance between 2013 and 2025.

4.6.3. Evolution timeline analysis

Fig. 5 presents a timeline visualization of keyword clusters, tracing the thematic evolution of digital finance research. Each node denotes the initial emergence and sustained prominence of key concepts, with node size proportional to term frequency and ring thickness indicating publication volume. Notably, red outer rings—representing the years 2024 and 2025—are concentrated in Cluster #0 (Cryptocurrency Market), Cluster #4 (Digital Finance), and Cluster #5 (Digital Inclusive Finance), signaling intensified scholarly engagement with macroeconomic transformation, structural adjustment, and regulatory debates surrounding digital currencies and financial access in recent years.

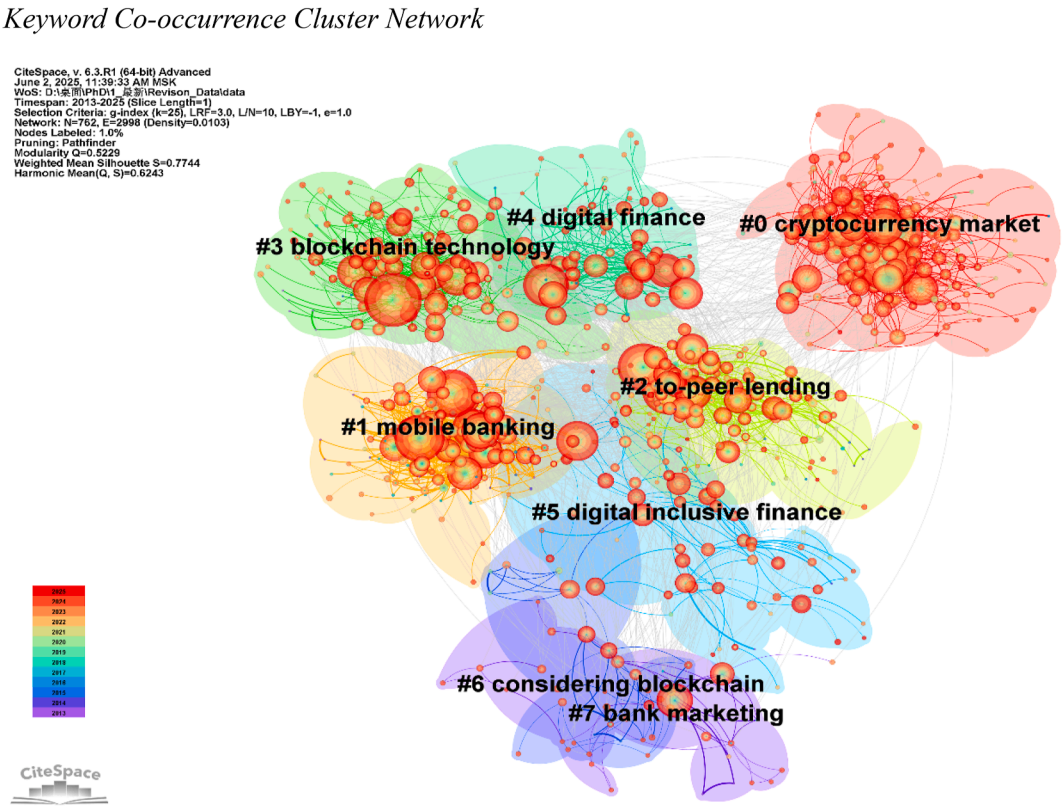


Fig. 4. Keyword Co-occurrence Cluster Network. *Note*. The figure shows the keyword co-occurrence cluster network with the eight largest clusters. The colors of the clusters are for well differentiation on the clustered areas.

Table 6
Keyword clusters.

ID	Size	Silhouette	Year	Label (LLR)	Cluster
0	158	0.804	2020	Cryptocurrency Market; Safe Haven; Covid-19 Pandemic; Blockchain Technology; Economic Policy Uncertainty	Cryptocurrency Market
1	131	0.819	2016	Mobile Banking; Mobile Payment; Continuance Intention; Mobile Payment Service; Mobile Payment System	Mobile Banking
2	124	0.673	2018	Peer-To-Peer Lending; Equity Crowdfunding; Crowdfunding Campaign; P2p Lending; Reward-Based Crowdfunding	Peer-To-Peer Lending
3	120	0.73	2019	Blockchain Technology; Supply Chain; Smart Contract; Supply Chain Performance; Circular Economy	Blockchain Technology
4	76	0.77	2019	Digital Finance; Bank Fintech; Corporate Innovation; Financing Constraint; Total Factor Productivity	Digital Finance
5	73	0.767	2020	Digital Inclusive Finance; Financial Inclusion; Digital Financial Inclusion; Green Finance; Carbon Emission	Digital Inclusive Finance
6	29	0.919	2020	Considering Blockchain; Smart Factory; Coincidental Brand Origin; Using Debit Card; Intelligent Manufacturing	Considering Blockchain
7	27	0.91	2020	Bank Marketing; Actor Engagement; Serial Crowdfunding; Blockchain Technology; Switching Intention	Bank Marketing

Note. The table shows the detailed breakdown of keyword clusters. Silhouette denotes the S value of the cluster. Label (LLR) denotes the keywords summarized in a cluster by the Log-Likelihood Ratio (LLR) algorithm.

Earlier clusters, such as #1 (Mobile Banking) and #2 (Peer-to-Peer Lending), rose to prominence between 2013 and 2016 but have since receded, reflecting a thematic shift from user adoption and behavioral continuance toward more systemic, policy-oriented inquiries. This temporal progression underscores the maturation of the field: initial research on consumer-facing technologies has evolved into a multifaceted, interdisciplinary discourse addressing institutional design, market stability, sustainability, and societal impact.

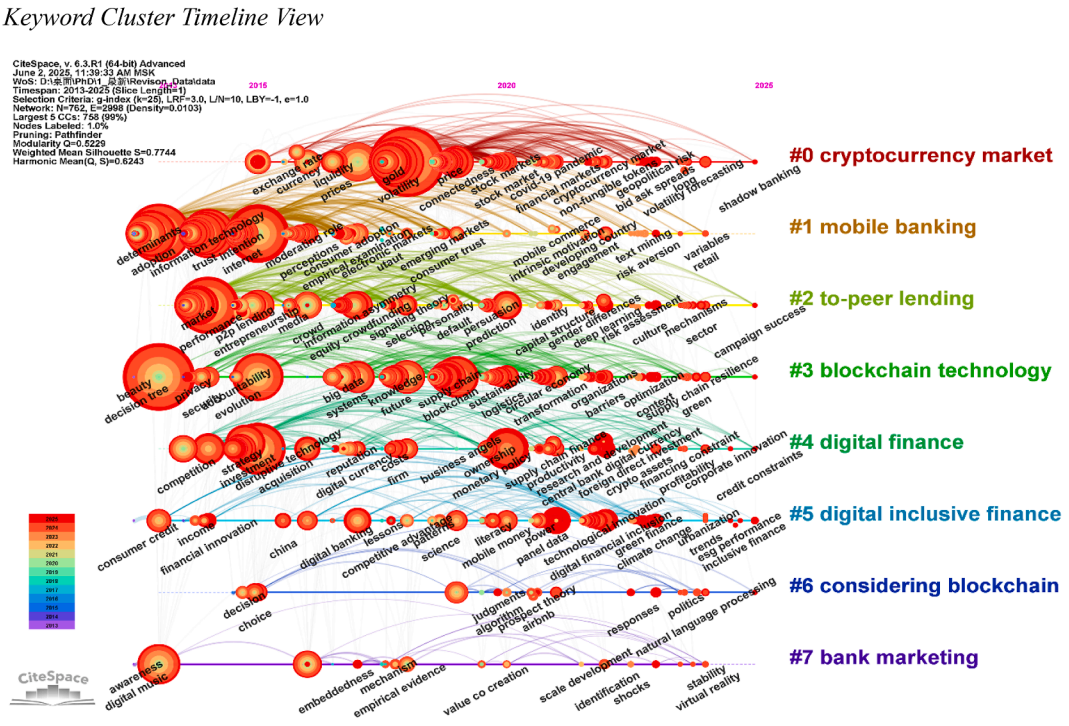


Fig. 5. Keyword Cluster Timeline View. *Note*. The figure shows the timeline view of the keyword co-occurrence cluster network. Keywords in the same cluster were placed on the same horizontal line. The year at the top of the figure represents the first appearance of the keyword.

4.6.4. *Burst keywords analysis*

To capture dynamic shifts in research priorities over time, we performed a burst detection analysis of keywords, identifying terms that exhibited pronounced and sustained increases in usage frequency. Such keyword bursts, characterized by rapid short-term surges, often signal the emergence of significant research frontiers (Chen, 2006). The analysis imposed a minimum burst duration of two years to ensure thematic persistence, and the identified bursts were ordered chronologically by their onset year. As presented in Table 7, the results reveal a distinct temporal sequence of thematic evolution within the digital finance literature.

In the early phase (2013–2017), burst keywords such as *customer satisfaction*, *adoption*, and *trust* underscore an initial emphasis on user experience and technology acceptance, particularly in the contexts of mobile and online banking. During the intermediate phase (2018–2020), the focus shifted toward market performance and empirical investigation, as reflected in bursts such as *inefficiency*, *dollar*, and *empirical examination*. These terms correspond to a wave of studies examining the volatility and efficiency of cryptocurrencies, as well as the associated risks in peer-to-peer finance.

In the most recent phase (2021–2025), the burst analysis reveals a marked transition toward policy-oriented and system-level concerns. Prominent terms include *digital finance* (burst strength = 34.92), *digital inclusive finance* (15.98), and *efficient tests* (9.95). These keywords point to an expanding scholarly focus on digital finance as a vehicle for promoting inclusive growth, advancing regulatory innovation, and facilitating macroeconomic transformation. The sustained intensity of these bursts indicates that these topics have moved beyond transient popularity to become enduring focal points, likely to shape the trajectory of future research in the field.

4.7. *Citation analysis*

Citations are instrumental in positioning a researcher's work within the broader scholarly discourse, either by building upon or challenging prior studies, thereby shaping new trajectories for knowledge creation (Hyland and Jiang, 2019). This study conducts citation analysis from two complementary perspectives. First, treating the articles as citing documents, we examine their co-citation patterns to trace the progression from foundational contributions to the research frontier, thereby identifying active scholarly debates and emergent thematic directions across subfields. Second, considering the articles as cited works, we analyze their Total Global Citation (TGC) frequencies to assess their academic influence. This dual approach provides insight into both the intellectual lineage and the impact profile of digital finance scholarship over the past decade.

4.7.1. *Analysis of scholars' impact*

In CiteSpace, co-citation networks delineate the underlying knowledge base, whereas citing articles represent the research frontier by engaging with and extending this foundation. Noun phrases extracted from the titles of citing articles are clustered within the co-

Table 7
Top 25 keyword bursts.

Keywords	Year	Strength	Begin	End
Customer satisfaction	2013	14.32	2013	2018
Consumer acceptance	2013	12.34	2013	2019
Satisfaction	2013	11.62	2013	2019
Adoption	2013	9.69	2013	2017
Mobile banking	2014	24.75	2014	2018
User acceptance	2014	24.15	2014	2019
Information technology	2014	19.53	2014	2018
Networks	2014	18.67	2014	2020
Online banking	2014	12.82	2014	2020
Trust	2014	12.43	2014	2018
Peer-to-peer lending	2014	9.55	2014	2020
Economics	2015	25.65	2015	2021
Internet banking	2015	18.16	2015	2018
Online	2015	13.9	2015	2019
Technology acceptance model	2015	12.54	2015	2019
P2p lending	2015	12.31	2015	2021
Initial trust	2015	11.47	2015	2019
Mobile payment	2015	11.05	2015	2018
Entrepreneurial finance	2014	14.93	2016	2019
Empirical examination	2017	11.46	2017	2021
Inefficiency	2018	40.56	2018	2020
Dollar	2019	10.07	2019	2020
Digital finance	2020	34.92	2024	2025
Digital inclusive finance	2022	15.98	2024	2025
Efficient tests	2024	9.95	2024	2025

Note. The table shows the evolution of bursting keywords in digital finance research, in order of burst appearance. The threshold for the duration of keyword bursts was set at two years. Year indicates when the keyword first appeared in digital finance literature. Strength denotes the strength of burst. Begin denotes when the keyword bursts begin. End indicates when the keyword bursts end.

citation network, with each cluster corresponding to a distinct frontier of inquiry. Co-citation analysis relies on the CR (Cited Reference) field of the dataset, wherein CiteSpace identifies unique references and aggregates their co-citation relationships. For this study, the 8838 selected articles generated a substantial volume of cited references. To determine the time-slice threshold, we applied a modified g-index with a scale factor $k = 25k = 25k = 25$, thereby prioritizing highly cited works while retaining thematic diversity.

The scope of co-cited references extends beyond the dataset's initial thematic and temporal constraints, encompassing influential works not strictly aligned with the original selection criteria. Table 8 lists the ten most frequently co-cited references. Notably, the fourth- and eighth-ranked publications predate the defined time window, illustrating the enduring influence of certain foundational studies. The top three co-cited works are all situated in the domain of crowdfunding, underscoring its central role in shaping the intellectual contours of digital finance.

Fig. 6 and Table 9 identify eight major co-cited reference clusters: #0 Cryptocurrency Market, #1 Mobile Banking, #2 Equity Crowdfunding, #3 Blockchain Technology, #4 Volatility Spillover, #5 Commercial Bank, #6 Peer-to-Peer Lending, and #7 Digital Finance. All clusters exhibit high Silhouette scores ($S > 0.882$), indicating strong internal cohesion and clear thematic boundaries. Among these, Clusters #0, #3, #4, #5, and #7 constitute the core research nexus. Clusters #0, #3, and #4 center on cryptocurrency price volatility, regulatory frameworks, and risk transmission channels—representing one of the most dynamic and intensively studied domains in recent years. Cluster #5 underscores the foundational role of blockchain infrastructure in enabling and scaling digital finance systems. Cluster #7 captures the socio-economic evolution of digital finance, emphasizing inclusive finance, policy design, and governance mechanisms.

Table 8
Most influential Co-citation articles.

Rank	Count	Centrality	Year	Authors and Source
1	819	0.08	2014	Mollick E, 2014, J BUS VENTURING, V29, P1, DOI 10.1016/j.jbusvent.2013.06.005
2	517	0.01	2015	Ahlers GKC, 2015, ENTREP THEORY PRACT, V39, P955, DOI 10.1111/etap.12157
3	517	0.04	2014	Belleflamme P, 2014, J BUS VENTURING, V29, P585, DOI 10.1016/j.jbusvent.2013.07.003
4	482	0.03	1981	FORNELL C, 1981, J MARKETING RES, V18, P39, DOI 10.2307/3151312
5	440	0.12	2018	Corbet S, 2018, ECON LETT, V165, P28, DOI 10.1016/j.econlet.2018.01.004
6	419	0.01	2017	Bouri E, 2017, FINANC RES LETT, V20, P192, DOI 10.1016/j.fri.2016.09.025
7	418	0.01	2016	Dyhrberg AH, 2016, FINANC RES LETT, V16, P85, DOI 10.1016/j.frl.2015.10.008
8	400	0	2008	Nakamoto S, 2008, BITCOIN: A PEER -TO -PEER ELECTRONIC CASH SYSTEM, V0, P0
9	400	0.09	2015	Cheah ET, 2015, ECON LETT, V130, P32, DOI 10.1016/j.econlet.2015.02.029
10	398	0.03	2016	Urquhart A, 2016, ECON LETT, V148, P80, DOI 10.1016/j.econlet.2016.09.019

Note. The table shows the top 10 most frequently co-cited references. Year indicates when the article was published. Centrality denotes the degree of betweenness centrality of the article.

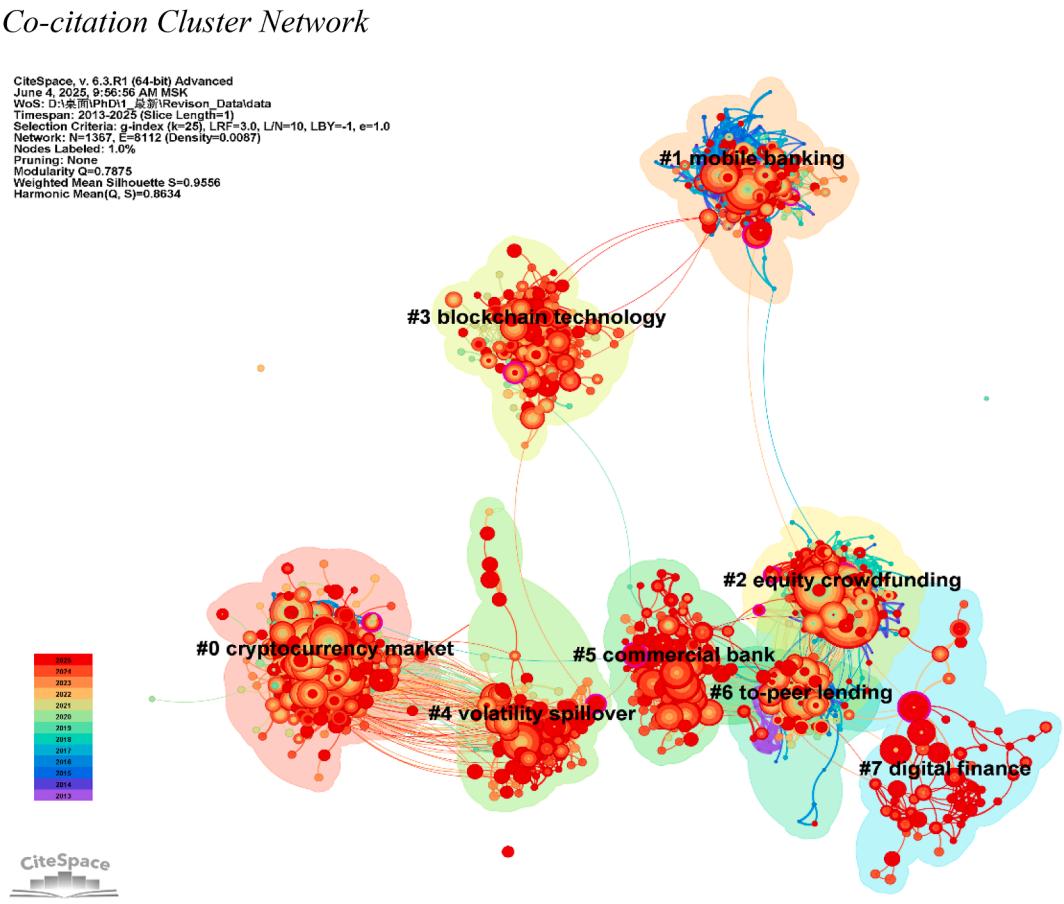


Fig. 6. Co-citation Cluster Network. *Note*. The figure shows the co-citation cluster network with the eight largest clusters. The colors of the clusters are for well differentiation on the clustered areas.

Table 9
Co-citation clusters.

ClusterID	Size	Silhouette	Label (LLR)	Average Year
0	247	0.882	Cryptocurrency market	2015
1	222	0.993	Mobile banking	2005
2	197	0.972	Equity crowdfunding	2015
3	133	0.99	Blockchain technology	2017
4	97	0.925	Volatility spillover	2017
5	85	0.964	Commercial bank	2018
6	65	0.972	Peer-to-peer lending	2006
7	57	0.98	Digital finance	2020

Note. The table shows the detailed breakdown of co-citation clusters. Silhouette denotes the S value of the cluster. Label (LLR) denotes the thematic labels summarized in a cluster by the Log-Likelihood Ratio (LLR) algorithm. Average Year denotes the average year of publication of co-cited literature in the cluster.

The cluster labels generated by CiteSpace using the Log-Likelihood Ratio (LLR) algorithm delineate the evolving research frontiers in digital finance from 2013 to 2025. While certain frontiers may now be considered mature or declining, they nonetheless offer valuable insights into thematic trajectories within the field. Cluster #1 centers on behavioral models of mobile banking customers (Singh and Srivastava, 2018), representing one of the earliest focal areas in fintech research. As mobile banking has reached a mature stage, it no longer constitutes a primary research hotspot. Cluster #2 examines platform information disclosure, investment behavior, and related themes (Butticè and Ughetto, 2021), reflecting shifts in start-up financing channels. While crowdfunding research has entered a phase of steady growth following an earlier period of rapid expansion, it is increasingly influenced by emerging mechanisms such as blockchain. Although now a more marginal topic, certain subfields—notably green crowdfunding and the role of social signals—remain active. Cluster #6 focuses on early platform models and lending behavior mechanisms. With the withdrawal of P2P lending platforms in China and the move toward standardized global platform development, this topic has receded from the research

Table 10
Most influential articles.

Rank	Authors	Source	Cited	Year
1	Mollick, E	JOURNAL OF BUSINESS VENTURING	2514	2014
2	Warner, KSR; Wäger, M	LONG RANGE PLANNING	1472	2019
3	Belleflamme, P; Lambert, T; Schwienbacher, A	JOURNAL OF BUSINESS VENTURING	1531	2014
4	Ahlers, GKC; Cumming, D; Guenther, C; Schweizer, D	ENTREPRENEURSHIP THEORY AND PRACTICE	1151	2015
5	Lansiti, M; Lakhani, KR	HARVARD BUSINESS REVIEW	1027	2017
6	Dyhrberg, AH	FINANCE RESEARCH LETTERS	922	2016
7	Corbet, S; Meegan, A; Larkin, C; Lucey, B; Yarovaya, L	ECONOMICS LETTERS	856	2018
8	Bouri, E; Molnár, P; Azzi, G; Roubaud, D; Hagfors, LI	FINANCE RESEARCH LETTERS	840	2017
9	Gomber, P; Kauffman, RJ; Parker, C; Weber, BW	JOURNAL OF MANAGEMENT INFORMATION SYSTEMS	877	2018
10	Urquhart, A	ECONOMICS LETTERS	845	2016

Note. The table shows the top 10 articles in order of total global citations. Year denotes when this article was published.

frontier. Nonetheless, it continues to serve as a valuable entry point for examining concepts such as “soft information” and “reputation mechanisms” (Wang et al., 2019).

4.7.2. Most influential articles

The second dimension of the citation analysis evaluates the dataset's literature as cited references. Table 10 presents the ten most influential articles, ranked by their Total Global Citations (TGC) in the WoS database. These rankings reveal a mix of works representing early-stage research themes that have since matured, alongside studies addressing currently emerging topics.

The most cited article, Mollick (2014), investigates key determinants of success in crowdfunding projects, emphasizing the role of updates and social backing. Similarly, Belleflamme et al. (2014) analyze various crowdfunding models and their implications for entrepreneurs, while Ahlers et al. (2015) highlight how project-related signals—such as founder education and equity offerings—influence investor decision-making. Together, these three studies constitute the theoretical foundation of crowdfunding research; however, as the field has matured, opportunities for major new theoretical breakthroughs have diminished.

By contrast, several highly cited works align with active and fast-developing research themes. Warner and Wäger (2019) examine how firms develop dynamic capabilities to navigate digital transformation—an increasingly central issue in contemporary organizational and strategy research. Lansiti and Lakhani (2017) conceptualize blockchain not merely as a technological innovation but as a foundational infrastructure for rebuilding trust in business processes, particularly in supply chain management and identity verification systems. These studies illustrate the field's ongoing shift toward broader, system-level inquiries at the intersection of technology, governance, and organizational adaptation.

4.7.3. Research frontiers

This section integrates content analysis with the preceding keyword- and citation-based bibliometric analyses to provide a comprehensive overview of the research frontiers in digital finance. The content analysis was conducted in two sequential phases.

In the first phase, we systematically filtered the corpus of relevant literature. Using keyword searches, we identified 8838 articles and categorized them into three temporal segments: the full period from 2013 to 2025, the post–COVID-19 period from 2020 to 2025, and the most recent three-year period from 2023 to 2025. For each period, we selected the top 30 most-cited articles, yielding an initial pool of 90 articles. We then excluded 11 works outside the economics domain—such as those focused on supply chain management—or centered on mature or declining topics, including peer-to-peer lending and crowdfunding. A further five duplicate entries were removed, resulting in a final sample of 74 articles.

In the second phase, we conducted in-depth reading and thematic coding of these 74 articles. Our analysis encompassed the thematic focus, abstracts, introductions, research methodologies, and conclusions of each work. This close reading, combined with cross-referencing of relevant literature within the same thematic clusters, provided the empirical basis for identifying the prevailing research frontiers and emerging trajectories in digital finance.

A salient finding from this analysis is that the four principal and emergent research frontiers—digital currency, digital inclusive finance, financial technology (FinTech), and blockchain technology exhibit distinct geographic and institutional orientations. Research on digital currency and blockchain technology is predominantly driven by developed economies, reflecting their advanced financial infrastructures, mature regulatory frameworks, and deep capital markets, although studies on central bank digital currencies (CBDCs) also figure prominently in developing-economy contexts. In contrast, digital inclusive finance is primarily anchored in developing economies, where policy imperatives focus on poverty alleviation, expanding financial access, and mitigating regional inequalities. FinTech represents a relatively balanced frontier, with significant contributions from both developed and developing economies, though each tends to emphasize different application contexts and regulatory challenges. Understanding these geographic and institutional distinctions is critical for interpreting thematic priorities, methodological choices, and the diffusion of ideas across these research streams.

We next examine each of these themes in detail, outlining their core research focus, representative studies, and regional contexts in the sections that follow.

4.7.3.1. Digital currency. Digital currencies—encompassing cryptocurrencies, virtual currencies, and central bank digital currencies (CBDCs)—constitute one of the most intensively examined domains within digital finance. Private digital currencies such as Bitcoin and Ethereum have attracted extensive scholarly attention. Bitcoin, introduced by Satoshi Nakamoto (2008), has catalyzed a substantial body of research spanning technological design, market dynamics, and policy implications. Much of this literature is anchored in developed-economy contexts, reflecting early blockchain adoption, deep and liquid capital markets, and mature regulatory institutions. This geographic concentration raises questions about the external validity of findings for emerging markets, where institutional capacity, adoption incentives, and macroeconomic conditions differ markedly.

CBDCs, while sharing certain features with private digital currencies, bridge developed and developing contexts. Notably, most operational or advanced pilot projects have emerged in developing economies, yet the global academic and policy discourse remains disproportionately shaped by advanced-economy concerns—particularly with respect to technical architecture, privacy safeguards, and cross-border settlement mechanisms.

Research on digital currencies can be broadly categorized into three principal areas.

(1) Key Characteristics

Private cryptocurrencies such as Bitcoin and Ethereum have been the subject of extensive scholarly inquiry, focusing on their underlying design principles, governance structures, and associated systemic risks (Boehme et al., 2015; Baur et al., 2018). However, much of this literature implicitly assumes the presence of robust legal enforcement and strong investor protections, limiting the direct applicability of its conclusions to jurisdictions with weaker institutional frameworks. For instance, Foley et al. (2019) estimate that illicit transactions constitute approximately one-quarter of Bitcoin activity, yet such figures may understate the role of informal economies in developing countries, where cryptocurrency adoption often serves as a substitute for volatile or depreciating local currencies.

Beyond legal and governance considerations, the proliferation of privately issued cryptocurrencies raises macro-financial concerns analogous to those associated with CBDCs—most notably, potential disruptions to monetary policy transmission mechanisms and reductions in seigniorage revenues (Bordo and Levin, 2017). Although Bordo and Levin's framework was originally developed to analyze central bank–issued digital currencies, it can be adapted to evaluate how widespread private cryptocurrency adoption might generate comparable risks, particularly in small or resource-dependent economies.

Furthermore, recent work on the environmental classification of cryptocurrencies (Sharif et al., 2023) offers insights into the distinction between "green" and "dirty" digital assets. However, much of this empirical literature assumes the existence of deep and liquid green finance markets—an assumption that does not hold in many emerging economies, thereby limiting the external validity of these findings.

(2) Market Dynamics

Research on price formation and speculative cycles in cryptocurrencies (Urquhart, 2016; Ciaian et al., 2016) has documented persistent inefficiencies characteristic of nascent asset classes. Empirical studies examining Bitcoin's co-movements with gold and oil during the COVID-19 period (Mnif et al., 2020; Gkillas et al., 2022; Goodell and Goutte, 2021) provide evidence of its increasing integration into broader financial systems. However, the macroeconomic implications for emerging markets—particularly with respect to exchange-rate volatility, capital flows, and inflation expectations—remain insufficiently explored.

Insights from Obstfeld et al. (2010) indicate that volatile capital flows can destabilize economies with limited currency credibility, increasing the risk of speculative attacks and reserve depletion. By analogy, unregulated cryptocurrency markets could engender similar vulnerabilities, as abrupt price fluctuations and cross-border capital movements have the potential to amplify macro-financial instability in such contexts. Moreover, recent evidence of volatility spillovers between clean energy markets and cryptocurrencies (Arfaoui et al., 2023) underscores their integration with sustainable finance. Yet, the nature and magnitude of these relationships are likely to differ in economies lacking deep renewable energy markets, limiting the generalizability of current findings.

(3) Hedging and Safe-Haven Properties

Early empirical studies (Dyhrberg, 2016a, 2016b; Bouri et al., 2017) identified Bitcoin as a potential hedge or safe-haven asset. However, subsequent research during systemic crises, such as the COVID-19 pandemic (Bouri et al., 2020; Corbet et al., 2020; Conlon and McGee, 2020; Conlon et al., 2020), has cast doubt on these claims. More recent evidence by Khalfaoui et al. (2023) shows that geopolitical shocks—most notably the Russia–Ukraine conflict—generate non-linear effects that further diminish Bitcoin's safe-haven attributes.

For emerging economies, these results have amplified relevance: if Bitcoin's protective qualities are contingent even in stable financial systems, they are even less likely to persist in less resilient environments characterized by shallow markets, high exchange-rate pass-through, and elevated macroeconomic volatility. This is consistent with portfolio theory, which posits that correlation structures between assets tend to shift under stress, thereby eroding diversification benefits when they are most needed.

(4) Central Bank Digital Currencies

Central bank digital currencies (CBDCs) have attracted growing scholarly and policy attention, with several central banks in both advanced and emerging economies launching pilot or operational systems (Atlantic Council, 2023). The e-CNY project (Allen et al., 2022) stands out as a rare large-scale implementation in a developing economy, combining payment efficiency with policy-driven financial inclusion objectives. Nevertheless, much of the global literature remains concentrated on advanced-economy priorities—namely, technical architecture, privacy safeguards, and cross-border settlement mechanisms (Bindseil, 2020).

From a regional development perspective, CBDCs in emerging markets have the potential to lower transaction costs in rural areas, reduce reliance on foreign-dominated payment networks, and strengthen monetary policy transmission in partially dollarized economies. Yet empirical studies on these dimensions remain limited. Insights from the financial development literature (Levine, 2005) suggest that such infrastructure could catalyze broader market deepening. However, without governance frameworks tailored to local institutional capacities, these benefits may be offset by heightened risks to privacy and political misuse.

Overall, the digital currency literature offers valuable conceptual and empirical foundations but exhibits two structural biases: (i) a geographic concentration on advanced economies, and (ii) a thematic emphasis on technical and speculative issues at the expense of developmental and institutional considerations. Addressing these gaps requires integrating monetary and financial system perspectives with regional development analysis, ensuring that research captures both systemic risks and the inclusive potential of digital currencies in emerging markets. Such integration is essential for aligning digital currency research with the broader digital finance transformation agenda examined in this paper.

4.7.3.2. Digital Inclusive finance. Digital inclusive finance has emerged as a central pillar of global development policy, particularly in emerging economies where poverty alleviation, income inequality, and financial exclusion remain pressing challenges. While early inclusive finance initiatives in advanced economies often centered on microcredit and community banking, the rapid proliferation of mobile payments and platform-based financial services in developing countries—most notably in China—has fundamentally altered both the scale and mechanisms of financial inclusion. In these contexts, digital infrastructure does not merely supplement existing systems but frequently leapfrogs traditional banking channels, introducing distinct policy and research considerations.

China's experience underscores both the scale and complexity of digital inclusive finance. The integration of mobile payment platforms such as Alipay into daily transactions has significantly broadened access to savings, credit, and insurance for rural and low-income populations, effectively lowering entry barriers to formal financial services. The Peking University Digital Financial Inclusion Index of China (Guo et al., 2020)—encompassing 31 provinces, 337 cities, and over 2800 counties—provides a uniquely granular and longitudinal measure of these developments, positioning China as one of the few countries with high-resolution data on digital inclusion.

The evolution and impact of digital inclusive finance in China can be examined from three interrelated perspectives.

(1) Macro Perspective

From a macroeconomic perspective, digital inclusive finance has been associated with accelerated economic growth, regional innovation, and industrial upgrading (Qian et al., 2020; Wen and Chen, 2020; Yang and Zhang, 2022), as well as with broader inclusive growth outcomes (Zhang et al., 2019). It has further been linked to environmental co-benefits, including reduced carbon emissions through optimized industrial structures and enhanced incentives for green innovation (Xu et al., 2022; Wang et al., 2022; Zhou et al., 2022; Cheng et al., 2023; Li et al., 2023a, 2023b). However, the bulk of this evidence is derived from China and may have limited direct applicability to economies lacking comparable digital infrastructure, industrial capacity, or institutional support. In low-income contexts, the scalability of these effects is contingent upon complementary conditions such as robust regulatory frameworks, sufficient human capital, and reliable network coverage—areas in which empirical research remains limited. Moreover, while aggregate economic and environmental gains are well-documented, much less is known about their distributional impacts across regions with heterogeneous institutional quality.

(2) Meso Perspective

At the meso level, digital inclusive finance has reshaped economic geography by narrowing urban–rural income disparities (Zhou et al., 2020; Ma and Zhou, 2022) and facilitating labor mobility toward non-agricultural sectors (Tian and Zhang, 2022; Ma and Hu, 2022). Evidence on its poverty implications, however, remains mixed. Some studies document poverty alleviation through enhanced entrepreneurship and agricultural mechanization (Lian et al., 2023; Liu and Liu, 2020), while others caution that it may exacerbate multidimensional poverty by increasing indebtedness or reinforcing existing digital divides (He et al., 2020; Zhang et al., 2022). This divergence underscores a persistent research gap concerning the interaction between digital finance and structural inequalities. In contexts with substantial disparities in digital literacy, platform-based services may initially benefit better-connected communities, thereby widening relative gaps before potential convergence occurs. Such transitional dynamics, and their broader developmental consequences, remain insufficiently examined outside the Chinese context.

(3) Micro Perspective

At the micro level, digital finance enhances household liquidity and stimulates consumption (Song, 2017; Yi and Zhou, 2018), while also shifting expenditure patterns toward higher-value or environmentally friendly goods (Xu et al., 2024). For firms, it expands access to credit and promotes innovation, particularly in green and high-technology sectors (Xie et al., 2018; Zhang and Long, 2022; Dong and Yu, 2023). Empirical evidence further indicates that the increased transparency associated with digital transactions can reduce corporate financial fraud (Sun et al., 2023). However, most firm-level analyses concentrate on relatively developed eastern Chinese provinces, raising questions about the generalizability of findings to SMEs in less-developed regions or to other developing economies with weaker enforcement mechanisms (Zhen et al., 2024). Moreover, while the observed relationship between digital finance and green innovation is promising, causal inference remains challenging due to potential endogeneity between innovation capacity and technology adoption (Zhang et al., 2019).

The broader literature on digital inclusive finance underscores its potential to expand financial access, reduce inequality, and stimulate economic participation, with China serving as the focal point for much of the most influential research. Although studies from other developing economies are emerging, they remain less prominent in highly cited work and thus underrepresented in frontier analyses. The prevailing emphasis on positive economic and social outcomes often overshadows critical issues such as over-indebtedness, the exclusion of digitally marginalized populations, and market concentration among dominant platforms. Incorporating a wider range of country experiences and engaging more systematically with both the benefits and risks would yield a more comprehensive understanding of digital inclusive finance within the broader transformation of digital finance.

4.7.3.3. Fintech. Financial technology (FinTech)—the integration of digital technologies into traditional financial services—has fundamentally transformed the operations of banks, securities firms, and insurance companies. Beyond delivering efficiency gains, FinTech has reshaped competitive structures, altered risk dynamics, and broadened access to credit. The literature, however, reveals distinct thematic emphases across contexts: in advanced economies, research tends to focus on competition, regulatory compliance, and the integration of novel technologies into mature financial systems, whereas in developing economies, attention centers on financial inclusion, SME financing, and the mitigation of infrastructural constraints. These divergent priorities influence both the analytical scope of existing studies and the degree to which their conclusions can be generalized across different institutional and market environments.

(1) Banking transformation and risk management

FinTech enables banks to diversify product offerings, enhance risk assessment, and automate credit approval, often through partnerships with technology firms that provide advanced analytics and operational tools (Thakor, 2020). Empirical evidence indicates that increased investment in IT personnel, digital infrastructure, and data governance reduces non-performing loan ratios and enhances long-term efficiency (Jin et al., 2020; Bao et al., 2022; Kou et al., 2021; Wang et al., 2023). In advanced economies, scholarship has emphasized integration with open banking frameworks, algorithmic credit scoring, and compliance automation (Vives, 2019). In developing markets, adoption is more directly linked to expanding basic credit access and informational reach (Frost et al., 2019), improving borrower screening where credit registries are incomplete. However, these benefits are accompanied by heightened exposure to cyber and operational risks that are more difficult to insure or supervise (Murinde et al., 2022). The early "internet finance" wave in China (Qiu et al., 2018) illustrates this duality: the same technologies that broaden access can also amplify run-like dynamics in the absence of robust governance frameworks.

(2) Productivity, financing constraints, and market structure

Firm-level evidence indicates that FinTech alleviates financing constraints, reallocates credit toward more productive firms, and enhances measured productivity, although the magnitude of these effects varies by institutional context (Sheng and Fan, 2020; Song et al., 2021; Yang et al., 2020). In developing economies, platform-enabled information—such as payment histories and e-commerce transaction data—can substitute for formal collateral and relationship lending, thereby fostering entrepreneurship and new-firm formation (Zhen et al., 2024). Platform-based credit provision has also addressed gaps left by underdeveloped banking networks; however, high market concentration and exclusive control over proprietary data may introduce new barriers to entry and heighten dependency risks (Demir et al., 2022). In advanced economies, competitive pressure from FinTech entrants has prompted incumbents to diversify fee-based income streams and adopt cost-reducing technologies, rather than exit core intermediation (Murinde et al., 2022). Comparative evidence suggests that identical technological innovations yield markedly different equilibrium outcomes depending on prevailing market structures, legal enforcement capacity, and the accessibility of financial data.

(3) Sustainable finance and development priorities

An expanding body of research links FinTech to environmental and social objectives. Digitized risk assessment tools and integrated data pipelines facilitate the origination of green loans and can enhance banks' risk-adjusted performance, provided that sustainability taxonomies and disclosure frameworks are credible and enforceable (Mirza et al., 2023). In many developing economies, however, the immediate developmental contribution of FinTech is more foundational—expanding payment access, reducing transaction costs, and

channeling working capital to SMEs. These mechanisms are central to financial inclusion, even where formal green finance markets remain nascent (Sheng and Fan, 2020; Song et al., 2021). This broader developmental orientation underscores the policy relevance of FinTech in emerging markets, despite its relatively limited visibility in the most widely cited literature.

By situating FinTech within these three thematic domains, the literature reveals a nuanced interplay between technology, regulation, and institutional capacity. A comprehensive understanding of these dynamics requires examining not only the functional outcomes of FinTech adoption but also the market structures and institutional conditions that mediate its effectiveness across diverse economic contexts.

4.7.3.4. Blockchain technology. Blockchain, first conceptualized by Nakamoto (2008), operates as an open, append-only ledger that fundamentally restructures transaction verification and coordination. Beyond the popular characterization as a "trust machine," the literature emphasizes that blockchain alters the mechanisms through which agreements are enforced and collaborative arrangements are organized, rather than simply digitizing existing processes (Lansiti and Lakhani, 2017).

(1) Governance and coordination

A central strand of the literature examines blockchain's governance mechanisms. Lumineau et al. (2021) contend that blockchains can both substitute for and complement contractual and relational governance by embedding rules and verification directly within the technological infrastructure, with their effectiveness contingent on transaction attributes such as asset specificity and measurability. From an economic perspective, theoretical contributions demonstrate how decentralization and smart contracts reshape incentives, redistribute market power, and alter entry barriers in platform-based markets (Cong and He, 2019). These governance and mechanism-design insights are particularly salient in environments where conventional enforcement is costly or unreliable. However, they also underscore important limitations: on-chain protocols cannot fully replace off-chain judgment, dispute resolution, or regulatory oversight, especially when transactions involve complex or multidimensional quality attributes.

(2) Applications, limits, and assetization

Blockchain applications range from cryptocurrencies and smart-contract platforms to enterprise deployments in domains such as supply chain management and health data systems. Empirical and conceptual studies document gains in traceability and information processing—illustrated by Cerchione et al. (2023) on electronic health records and Centobelli et al. (2022) on circular supply chains—while emphasizing that these benefits hinge on robust data governance, interoperability, and incentives for truthful reporting, many of which remain outside the chain.

The literature on non-fungible tokens (NFTs) highlights the introduction of a distinct property-rights layer, enabling unique, transferable digital assets. Yet, markets for NFTs exhibit significant frictions: pricing inefficiencies and speculative cycles coexist with diversification benefits relative to traditional asset classes (Dowling, 2022a, 2022b; Karim et al., 2022; Wilson et al., 2022; Umar et al., 2022; Yousaf and Yarovaya, 2022). In consumer and luxury markets, token-based authenticity and digital identity systems can create novel branding channels (Sung et al., 2023).

Parallel discussions on the metaverse identify emerging business models and the role of blockchain in verifying ownership and facilitating exchange, while underscoring unresolved challenges related to interoperability standards, governance frameworks, and the legal recognition of digital property (Yuan and Yang, 2022; Chen and Cheng, 2022).

(3) Regional patterns and policy orientation

Research on blockchain exhibits a pronounced regional divergence. In advanced economies, scholarly work concentrates on mechanism design, tokenization, decentralized finance (DeFi) infrastructure, and institutional adoption (e.g., Cong and He, 2019; Biais et al., 2023). By contrast, studies in developing economies tend to focus on applied use cases—such as supply-chain provenance, identity and registry systems, and public-sector applications—where verifiability can substitute for weak intermediation, consistent with the governance framework articulated by Lumineau et al. (2021). Across both contexts, cross-border settlement and interoperability have emerged as shared policy priorities, closely linking blockchain infrastructure with payments innovation and digital-currency experiments (BIS, 2025).

Collectively, these streams suggest that blockchain's comparative advantage materializes where verification and coordination costs are high and where a credible, shared ledger can mitigate opportunism. However, capturing these gains depends critically on complementary institutional capacity, interoperability standards, and effective off-chain governance.

5. Discussion

Digital finance constitutes a financial paradigm rooted in the foundational principles of economics and finance yet transformed by the disruptive potential of digital technologies. The rapid acceleration of technological innovation has progressively expanded the functional scope of financial systems from early applications such as peer-to-peer lending and mobile payments to contemporary developments in blockchain, central bank digital currencies (CBDCs), and tokenized assets. These innovations not only redefine the delivery of financial services but also reshape the structural relationships among institutions, markets, and users. A defining feature of

digital finance lies in its ability to extend access to populations historically excluded from formal financial systems, thereby addressing persistent gaps in financial inclusion. Nonetheless, as evidenced by our findings, the evolution of digital finance is shaped as much by institutional and regulatory capacity as by technological advancement. This underscores the imperative for context-sensitive analysis that accounts for variations in governance, market maturity, and socio-economic conditions when assessing both the opportunities and risks inherent in digital finance.

This study extends prior literature reviews by offering both breadth and depth in mapping the knowledge structure of digital finance. Whereas earlier reviews have typically concentrated on discrete domains such as financial inclusion, blockchain, or FinTech or drawn on relatively narrow bodies of literature, our approach synthesizes a wider scope of research while preserving analytical detail. By integrating thematic, temporal, and institutional variation into a unified framework, we capture the dynamic interplay between evolving research priorities and underlying structural forces. Our findings reveal that shifts in emphasis for example, the post-pandemic transition from micro-level adoption behavior to macroeconomic, systemic, and regulatory concerns—are not isolated trends but rather manifestations of deeper drivers, including regulatory adaptation, market maturation, and socio-political imperatives. This perspective reinforces the view that digital finance is embedded within evolving national and international governance regimes. In these regimes, technological innovation interacts with legal norms, market incentives, and developmental objectives, jointly shaping adoption trajectories, competitive landscapes, and the long-term socio-economic impacts of digital financial systems.

Methodologically, our integration of co-citation analysis, keyword clustering, and qualitative synthesis enables a more nuanced interpretation of how ideas circulate, compete, and converge across disciplines. In this approach, bibliometric patterns are not treated as static descriptors but as dynamic signals of intellectual convergence, paradigm competition, and emerging interdisciplinary linkages. The frequent co-occurrence of academic literature with non-academic sources such as central bank frameworks, BIS reports, and industry white papers—underscores that policy developments and industry practices often precede, frame, and shape scholarly inquiry. This interplay positions digital finance research squarely at the nexus of theory, regulation, and application, rendering it highly responsive to technological disruptions, market innovations, and policy shifts.

Our thematic results point to three interlocking mechanisms that help explain why digital finance evolves differently across regions and topics. First, institutional capacity—including regulatory enforcement, market openness, and judicial reliability—defines the feasible design space for innovations such as CBDCs, stablecoins, and tokenized assets. In developing economies, where infrastructure gaps persist and monetary sovereignty is a key policy concern, CBDCs often emphasize inclusion, payment resilience, and policy control, with features like tiered-wallet structures, offline functionality, and transaction caps. In contrast, advanced economies tend to prioritize private-sector innovations (e.g., stablecoins, wholesale CBDCs, tokenized securities) with a focus on programmability, cross-border interoperability, and integration into sophisticated capital markets. Second, market structure especially platform concentration and data portability—shapes the trade-off between inclusion and competition. Highly concentrated markets may achieve scale quickly but risk entrenching incumbents and reducing innovation. By contrast, open and interoperable systems promote competition, product diversity, and consumer choice. Policy tools such as interoperability mandates and data mobility rights can help broaden access while preserving market dynamism. Third, digital and identity infrastructure covering payment interoperability, network coverage, and secure digital ID sets the baseline for both inclusion and systemic resilience. Weak infrastructure limits service reliability and viable use cases; strong, interoperable systems enhance both reach and stability. In underserved areas, targeted infrastructure investments often deliver disproportionately large gains in inclusion relative to their cost. Taken together, these mechanisms underscore the path-dependent nature of digital finance. Strategies that succeed under one institutional–market–infrastructure configuration may fail elsewhere, making universal "one-size-fits-all" models unrealistic. Instead, tailoring innovation pathways to local structural conditions is essential for sustainable and inclusive digital finance development.

The Chinese case illustrates how state-led strategies, granular data systems, and close academic–policy integration—exemplified by the Digital Inclusive Finance Index (Guo et al., 2020) can simultaneously accelerate scholarly output and practical deployment. By contrast, research in developed economies often centers on high-complexity challenges such as blockchain scalability, DeFi risk modeling, and cross-border interoperability, priorities that align with their mature infrastructures and more permissive regulatory sandboxes. These contrasts reinforce the view that digital finance is not a single, uniform global trajectory, but rather a series of localized transformations shaped by institutional context, market maturity, and policy priorities—yet linked through a set of shared technological enablers that diffuse across borders.

The convergence of academic research with policy experimentation and industry innovation is structural rather than incidental. Policy blueprints and technical standards frequently precede academic engagement, as seen in the People's Bank of China's (2021) e-CNY architecture, which detailed privacy tiers, offline operability, and wallet structures that later became focal points in CBDC literature. Global initiatives led by the BIS—such as Project mBridge and Project Helvetia III establish benchmarks for interoperability, legal harmonization, and infrastructure readiness (BIS, 2022, 2023a, 2023b). IMF's Fintech Notes (Bouis et al., 2024) and the World Bank's Findex Database (World Bank, 2022) provide structured frameworks for digital inclusion policy, while OECD and FSB evaluations of systemic risk and market concentration inform both national legislation and scholarly debate (OECD, 2020; Financial Stability Board, 2019).

Industry-led initiatives reinforce this bidirectional exchange. Projects like J.P. Morgan Kinexys's Project EPIC (J.P. Morgan Kinexys, 2024), integrating zero-knowledge proofs, decentralized identifiers, and cross-chain interoperability, push technical boundaries while influencing compliance architectures. PwC China's (2020) analyses of the digital RMB's business implications illuminate shifts in consumer behavior, competitive positioning, and banking strategies, serving as empirical inputs for academic analysis. Such cross-sector knowledge flows demonstrate that scholarship, regulation, and market practice co-evolve in real time.

By embedding policy, regulatory, and industry examples, our discussion underscores that digital finance should be understood as a multi-layered system in which technological innovation, institutional design, and socio-economic objectives are mutually constitutive.

This perspective naturally sets the stage for our conclusions, which consolidate the theoretical, empirical, and policy-oriented contributions of this study while outlining limitations and priorities for future research.

6. Conclusion, limitations and future work

This study provides a comprehensive mapping of the digital finance research landscape, drawing on 8838 peer-reviewed articles published between 2013 and 2025. Through an integrated approach that combines bibliometric analysis with qualitative synthesis, we identify four frontier themes—digital currency, digital inclusive finance, FinTech, and blockchain technology—each constituting a distinct yet interrelated strand of financial innovation. In contrast to prior reviews that concentrate narrowly on domains such as cryptocurrencies or financial inclusion, our analysis offers a more holistic, data-driven account of the field's intellectual structure, thematic evolution, and geographic distribution. Furthermore, by incorporating non-academic sources—including policy reports and industry white papers—we bridge academic and institutional perspectives, recognizing that such sources frequently shape practical developments ahead of scholarly consensus.

The findings yield several interconnected insights. Institutional capacity and data infrastructure jointly delineate the feasible design space and comparative advantages of digital currencies, blockchain applications, and inclusive finance initiatives, shaping adoption trajectories, risk externalities, and the sustainability of welfare gains. Platform market structure and data portability mediate the trade-off between expanding financial access and preserving competitive market conditions; interoperability mandates and transferable data rights can relax this constraint by lowering entry barriers and reducing switching costs. Decentralized finance and central bank digital currencies are not inherently substitutes but can serve as context-dependent complements, with governance architectures differing across dimensions such as privacy protection, cross-border interoperability, and systemic stability. Furthermore, the co-evolution of academic research, policy experimentation, and industry innovation is intrinsic to the field, with technical standards and regulatory pilots frequently preceding scholarly consolidation. This sequencing helps explain the heterogeneous empirical patterns observed across regions and highlights the need for research designs that explicitly address policy endogeneity.

Beyond theoretical contributions, this study offers actionable, context-specific guidance for policymakers and industry stakeholders. For central banks and regulators, phased CBDC deployments with tiered wallet structures—featuring small-value offline transaction thresholds and differentiated KYC and privacy tiers—are consistent with the BIS Committee on Payments and Market Infrastructures (BIS, 2023a) and the IMF's CBDC Handbook (Adrian and Mancini-Griffoli, 2021), balancing financial inclusion objectives with systemic safety. Cross-border CBDC pilots should adopt capped corridors and harmonized legal frameworks, as demonstrated by Project mBridge (BIS, 2022) and Project Icebreaker (BIS, 2023b), to mitigate contagion and compliance risks. Infrastructure and development agencies should prioritize interoperable digital identity and payment systems in line with the World Bank's ID4D initiative (World Bank, 2022), targeting at least 90 % population coverage and implementing performance monitoring for latency and reliability (OECD, 2020). For financial institutions and fintech firms, adopting open APIs and ensuring algorithmic transparency align with the Financial Stability Board's (2019) principles and the EU's PSD2 framework, while integrating measurable sustainability and inclusion objectives reflects the growing prominence of green fintech (Kwong, 2023).

Effective policy design must be calibrated to institutional maturity and prevailing market conditions. In advanced economies, priorities include refining data governance regimes, promoting cross-border interoperability, and embedding sustainability objectives into fintech innovation. In developing economies, emphasis should first be placed on foundational infrastructure—such as national digital identity systems, real-time payment networks, and last-mile connectivity—before scaling more advanced applications. In all contexts, sequencing is critical: premature liberalization without interoperability safeguards risks entrenching dominant platforms, while overly restrictive regimes may suppress innovation. Risk mitigation should be embedded in pilot programs through transaction caps, real-time monitoring, and sunset provisions, supported by independent evaluation frameworks that link adoption rates, costs, and distributional effects to policy objectives. Such strategies operationalize the institution–market–infrastructure framework and establish a clear pathway for translating empirical insights into measurable developmental outcomes.

This study has several limitations. While reliance on the Web of Science database ensures consistency and quality, it may exclude relevant research indexed in Scopus, Google Scholar, or regional journals. Bibliometric clustering and citation-based metrics can underrepresent emerging topics that have yet to accumulate significant citations, and qualitative synthesis inevitably involves interpretive judgment. Future research should integrate multiple bibliographic databases, employ machine learning–based topic modeling to identify nascent themes, and undertake longitudinal, cross-country analyses to assess how institutional, market, and infrastructural shifts influence the evolution of digital finance.

Looking forward, three research priorities merit particular attention. First, the macroeconomic consequences of CBDCs—covering their effects on monetary policy transmission, bank intermediation, and household behavior—should be examined through comparative empirical studies. Second, the governance structures and market dynamics of tokenized assets and decentralized finance should be analyzed in conjunction with competition policy and systemic risk frameworks. Third, the intersection between digital finance and sustainability—particularly the deployment of green fintech solutions that do not exacerbate digital exclusion—presents a promising domain for interdisciplinary inquiry. Embedding these agendas within the institution–market–infrastructure framework can yield insights that are analytically rigorous and directly actionable for policymakers and practitioners seeking to balance innovation, stability, and inclusion.

CRediT authorship contribution statement

Qiwei Li: Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Darko B. Vukovic:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Investigation, Formal analysis, Conceptualization. **Moinak Maiti:** Writing – review & editing, Supervision, Resources, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Xinyu Zhang:** Writing – review & editing, Validation, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

There is no conflict of interest.

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