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A Visual Analysis of Digital Financial Inclusion and Enterprise Innovation based on CiteSpace

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Abstract: *Digital financial inclusion has emerged as a crucial instrument for fostering technological innovation in businesses. However, systematic literature review in this area is still relatively limited. Based on CiteSpace software, this study systematically combed 116 related literatures on digital financial inclusion and enterprise innovation during 2021-2025, aiming to reveal the research hotspots, knowledge structure, and evolutionary trends. Keyword co-occurrence analysis indicates that "digital financial inclusion," "technological innovation," and "financing constraints" are the core themes of the research network, reflecting the academic community's profound comprehension of the impact of digital financial inclusion on the technological innovation capacity of enterprises. Cluster analyses further reveal the three main directions of the research, including the direct impact of digital financial inclusion on enterprise innovation, the support of green technological innovation, and the enhancement of Small and Medium-sized Enterprises' innovation capacity. Timeline and emergent analyses demonstrate the dynamic development process of the research themes from the construction of basic theories to practical applications, especially the outstanding performance in green development and technology-deepening applications in recent years. The findings suggest that the role of digital financial inclusion in enterprise innovation shows unique manifestations in different fields and different enterprise sizes. At the same time, future research in this area should pay more attention to its long-term effects, including how to promote enterprise technological innovation to achieve sustainable development.*

Keywords: Digital Financial Inclusion, Enterprise Technological Innovation, Financing Constraints

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1. Introduction

The swift advancement of digital technology has established digital financial inclusion as a vital catalyst for fostering high-quality economic growth, especially in promoting enterprise innovation and enhancing economic vitality, showing unique advantages. Digital financial inclusion, a significant financial technology sector, utilizes technology to transcend conventional financial services' geographical and informational constraints. It offers enterprises broader and more accessible financial support, reducing costs and enhancing efficiency, helping them make breakthroughs in innovative practices. Since 2021, when the study of digital financial inclusion and enterprise innovation began to receive extensive academic attention, its importance in supporting enterprises' Research and Development

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investment stimulating the vitality of technological innovation, and promoting the transformation of business models has gradually emerged. The significant role of digital financial inclusion in reducing enterprises' size difference, advancing SMEs' technological upgrading, and realizing green innovative development has become increasingly prominent. Against this background, the correlation between digital financial inclusion and enterprise innovation has rapidly become a core topic in the research field. It provides important references for exploring economic development and technology-driven innovation.

To deeply reveal the core literature of digital financial inclusion and enterprise innovation, this study systematically combed and researched the core literature in the field of digital financial inclusion and enterprise innovation based on the CiteSpace tool, using bibliometric and visualization methods. Through the analysis of time distribution, author and research structure, keyword co-occurrence analysis, keyword clustering analysis, and keyword timeline and emergence analysis of the literature, it comprehensively reveals the research hotspots and development trends of digital financial inclusion in supporting enterprise technological innovation, promoting high-quality economic growth, and realizing green transformation, which will provide important inspirations for the subsequent academic research and policy formulation.

2. Literature Review

By examining and summarising research in related fields, it is evident that the current scholars on digital financial inclusion-related research primarily concentrate on the following aspects:
First is the impact of digital financial inclusion on enterprise innovation. Research generally focuses on how digital financial inclusion directly promotes enterprise innovation activities by improving financial accessibility, reducing financing constraints, improving resource allocation efficiency, etc. Zhang et al. (2024) show that digital financial inclusion significantly increases the number of enterprise patent applications and grants and stimulates innovation dynamics by improving credit availability and reducing financing costs. Wang & Liu (2024) further point out that digital financial inclusion enhances enterprise innovation by increasing the number of enterprises' patents and authorizations and stimulating innovation vitality. Liu (2024) further shows that digital financial inclusion markedly enhances the innovation effectiveness of firms, especially the expansion of its coverage, which promotes innovation efficiency more significantly. Sheng et al. (2023) find that digital financial inclusion promotes the technological innovation of manufacturing industries mainly in alleviating financial constraints. However, its impact diminishes as market rivalry intensifies. Taken together, digital financial inclusion promotes enterprise innovation through multi-dimensional mechanisms, necessitating additional policy assistance to enhance the inventive advancement of various enterprises.

Second is the impact of digital financial inclusion and green technology innovation. Green technological innovation emerged as a prominent focus in the study of digital financial inclusion. It focuses on exploring how digital financial inclusion can promote enterprise innovation in areas such as energy conservation, emissions reduction, and new energy technologies by alleviating financing constraints, optimizing resource allocation, and strengthening regional cooperation. Empirical studies show that digital finance substantially promotes green technological innovation and has stronger effects in specific contexts. Li & Zhou (2024), employing data from A-share listed companies, found that digital financial inclusion significantly influences green innovation by enhancing the distribution of financial resources and mitigating financing constraints, especially for enterprises with extensive

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coverage and application, as well as those with elevated pollution levels and non-high-tech classifications. Li et al. (2024) analyze the mediating effect of financing constraints through a spatial Durbin model and find that financing constraints significantly influence the direct impact of local digital finance on green technological innovation while fully mediating the indirect impact of the digitization level of the neighboring regions. Ma et al. (2022) demonstrate that digital financial inclusion directly fosters local green innovation but also further enhances innovation efficacy by reinforcing the positive moderating effect of environmental regulation, especially when the effect is more pronounced at higher levels of digital finance. In summary, digital financial inclusion promotes green technological innovation through multi-dimensional mechanisms and synergizes with environmental regulation, providing an important reference for policymaking.

The third one is the impact of digital financial inclusion, which supports SMEs' innovation. SMEs, by virtue of their flexibility and innovative capacity, greatly benefit from digital financial inclusion in fostering technological innovation. Numerous studies demonstrate that digital financial inclusion has provided important support for SMEs' technological development, business model innovation, and market competitiveness enhancement by easing financing constraints, improving financing efficiency, expanding financial coverage, and lowering transaction expenses. Specifically, Sun & Zhang (2024) used the Peking University China Digital Financial Inclusion Index and the National Bureau of Statistics' innovation data for Small and Medium-sized Enterprises to substantiate the critical influence of digital financial inclusion in promoting technological innovation in SMEs by mitigating financing constraints and enhancing consumption. The study highlights that digital finance creates a more level playing field for SMEs and reduces the cost of innovation based on increased coverage and availability. Gu et al. (2023) empirically analyzed the impact of digital financial inclusion on SMEs' technological innovation, utilizing panel data from 2011 to 2021 and employing a fixed-effect model. It was found that digital financial inclusion greatly mitigates the financing difficulties of SMEs, particularly enhancing technological innovation of non-state-owned SMEs. This provides an important policy reference for the government to develop a digital financial inclusion strategy for SMEs. In addition, Zhang et al. (2023) further explored the moderating roles of financial regulation and government subsidies in the incentive effects of digital financial inclusion using New Third Board-listed companies.

3. Methodology

This study mainly employs the bibliometric analysis, choosing CiteSpace 6.3 R1 as the analysis tool, specifically exploring the impact of digital financial inclusion on corporate innovation through the analysis of the issuance of articles, authors and structure of research, keyword co-occurrence analysis, keyword clustering analysis, and keyword timeline and emergence analysis, to reveal the core theme, identify the important literature and knowledge base of the research field, and Capture research hotspots and cutting-edge dynamics, and provide a scientific basis for structured sorting of the research field.

In addition, this study utilized the Web of Science Core Collection and Scopus databases as data sources, with subject phrases chosen for the literature search. Only journal studies were included to guarantee the authority and accuracy of the analysis outcomes. Literature types such as conference studies, review articles, and monographs were excluded. Specifically, the search strategy was defined as ALL=("Digital Finance" OR "Digital Financial Inclusion" OR "Digital Inclusive Finance") AND ("Impact" OR "Effect") AND ("Economic Growth" OR "Financial Performance" OR "Social Equity" OR "Poverty Alleviation" OR "SME Innovation"

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OR “Regional Development” OR “Green Finance” OR “Technological Innovation” OR “Corporate Productivity” OR “Household Consumption” OR “Regional Disparities” OR “Green Development” OR “Financial Stability”). This search formula yielded 128 documents from the Web of Science database and 94 documents from the Scopus database.

To enhance the relevance of the literature, this study manually screened all the retrieved results, article by article, in conjunction with the relevant ranking of the databases. Through the examination of the titles, abstracts, and keywords, removing irrelevant literature, and taking the concatenation and de-weighting of the search results from the two databases, 116 high-quality English-language journal articles covering research results between 2021 and January 2025 were finally screened. These documents formed the sample for this study and were used for subsequent knowledge graph analysis.

4. Results and Discussion

4.1 Publication Volume

According to the statistical analysis of the change in annual publication volume in the domains of digital financial inclusion and enterprise innovation (see Figure 1), it can be found that this field has shown a significant growth trend since 2021. Especially in recent years, the amount of research has consistently increased with the swift advancement of the digital economy and the extensive implementation of digital technology in enterprise management and innovation. In 2021, there were 12 publications, indicating that the area is in its nascent stage of development, followed by a substantial increase to 28 publications in 2022, with a growth rate of 133%. The growth in this stage is mainly attributed to the policy support, technological drive, and heightened demand of enterprises for digital financial inclusion. The focus of the research has begun to expand to the application scenarios of enterprise innovation and the statistical examination of its correlation with economic growth. In 2023, the number of publications increased further to 45, which reflects that the academic fervor in the research of digital financial inclusion and enterprise innovation has reached a new height. At the same time, the research themes show a diversified trend, including not only the impact of digital finance on enterprise performance and technological innovation but also the exploration of the path of green innovation and technological progress of SMEs.

However, preliminary statistics show that the number of articles issued in 2024 has dropped back to 30, which may be related to the gradual maturity of some research themes or the dispersion of academic hotspots, but still maintains a high level. As the data for 2025 is only January data, it is not analyzed for the time being. Overall, research in the field of digital financial inclusion and Enterprise Innovation has shown a notable growth trend in published articles driven by policies, technologies, and social demands, especially reaching a peak in 2023, indicating the research heat and development potential of this field. At the same time, further attention to the segmentation and crossover of different research directions may be needed in the future to continuously promote the in-depth development of the field.

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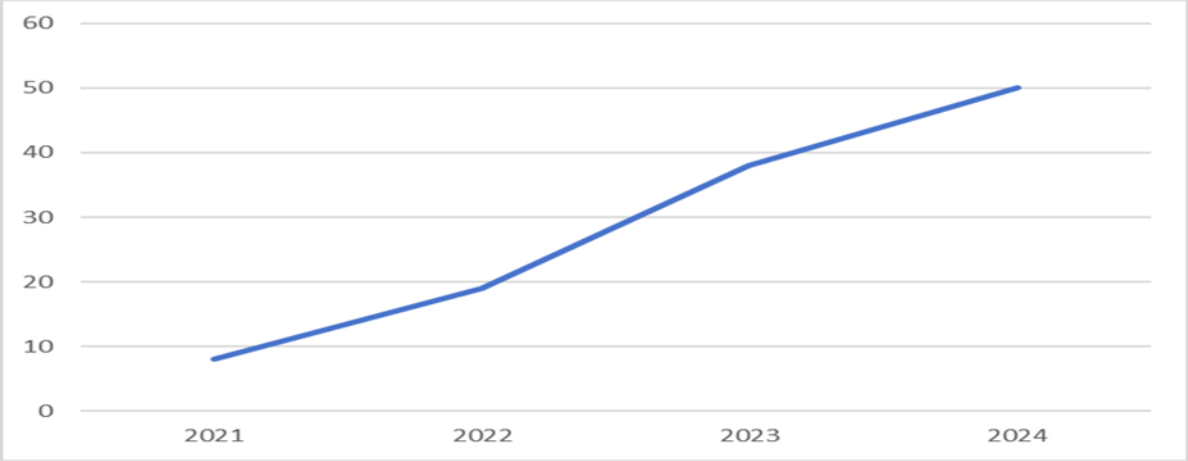

Figure 1: Number of Articles from 2021 to 2024

4.2 Research Authors

Co-citation analysis of authors of cited literature using CiteSpace software can visually display high-impact authors and their research networks within the topic of study. The co-citation analysis identifies the core scholars in the field through centrality and frequency. It reveals the research topic associations and academic collaborations among the authors, thus helping researchers to understand the academic network structure, research focal points, and future developments. This study conducts a co-citation analysis of authors of cited documents by 116 English documents. It comes up with a map, as shown in Figure 2.

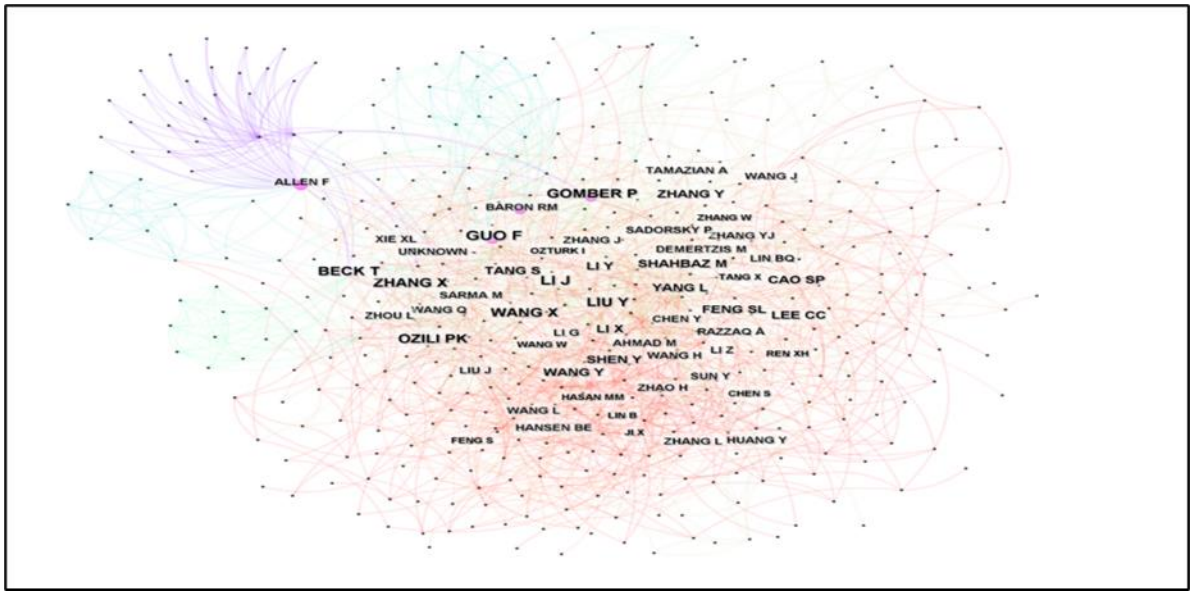

Figure 2: Co-Citation Analysis of Cited Authors

Meanwhile, the data was further collated to list the top 10 authors based on citations (Table 1). From the data analysis, the scholar with the highest citation count was GOMBER P (42 times, centrality of 0.19), indicating a significant role in the knowledge network. In addition, GUO F (39 times, centrality of 0.05) and LI J (35 times, centrality of 0.1) also have high citation counts, showing their important contributions in promoting research in digital financial inclusion. Meanwhile, researchers with high centrality, such as OZILI PK (0.07) and BECK T (0.07), serve a pivotal role in connecting different research themes and directions in the network, further highlighting their criticality in the academic network.

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In terms of temporal distribution, GOMBER P and GUO F's research became highly cited in 2021-2022, indicating that this period is closely related to policy impetus, technological change, or changes in the market environment, reflecting the rapid response and in-depth research in digital financial inclusion in response to the academic hotspots of the time. Newer research hotspots are concentrated in 2023, such as LI X and LIU Y, indicating that scholarly activity in this domain has persisted and that there is a trend toward various study themes.

Table 1: The top 10 most-cited authors

Number	Count	Centrality	Year	Cited Authors
1	42	0.19	2022	GOMBER P
2	39	0.05	2021	GUO F
3	35	0.1	2021	LI J
4	29	0.07	2022	OZILI PK
5	25	0.02	2022	TANG S
6	24	0.01	2022	DEMERTZIS M
7	20	0.04	2022	WANG X
8	19	0.01	2023	LI X
9	19	0.01	2023	LIU Y
10	18	0.07	2022	FENG SL

Overall, the academic network in digital financial inclusion has become increasingly mature and has gradually formed a stable structure dominated by core scholars. The strong co-citation relationship among highly cited scholars further strengthens the solidity of the academic network. Meanwhile, research in this field presents a good combination of internationalization and localization. Chinese scholars, represented by GUO F, LI J, etc., have formed close cooperation with international scholars, such as GOMBER P, OZILI PK, etc., demonstrating the strong potential of transnational cooperation and academic influence in this field. This balanced mode of localised and internationalised research promotes the depth and breadth of research in the field while also providing a good basis for development and space for cooperation in future research.

4.3 Research Institutions

The analysis of research institutions reveals their contributions to research and collaborative relationships in digital financial inclusion. This study utilized CiteSpace visualization and analysis of data from 116 documents. Consequently, 97 research institutions were identified, with 78 connecting lines and a network density of 0.0168. This signifies a little degree of collaboration between research institutions in digital financial inclusion and enterprise innovation and a low level of connectivity in the academic network. Although some research institutions may excel in article publication or field influence, the overall frequency of cooperation between different institutions is low, and a close cooperation network has not yet been formed.

From the statistical results, Wuhan University ranks first with four studies in the number of publications, showing its outstanding research contribution to digital financial inclusion; Nanjing Forestry University and Hunan University are tied for second place with three studies each. In addition, Beijing Technology and Business University (BTBU), Nanjing Normal University (NNU), Jinan University (JNU), and Nanjing University of Finance and Economics (NUFE) also showed strong academic activity, with three relevant research studies published. Notably, Beijing Jiaotong University and Dalian University of Technology published

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significantly in 2023, indicating that they are gradually strengthening their research investment in the field as emerging players. However, from the analysis of the overall network density, despite the fact that high-publishing institutions occupy an important position in the domestic research within this field, the level of inter-institutional collaboration is relatively low, the academic resources have not yet been fully integrated, and there is still room for improving the depth and breadth of research. Observed from the time dimension, most of the institutions with high publication volume are concentrated in 2022 and 2023, which is closely associated with the rapid development of policy promotion and digital transformation in recent years. In the future, there is a need to strengthen collaboration among research institutions, especially between top universities and emerging institutions, to facilitate the promotion and implementation of research results in the international arena and to provide more academic support and practical solutions for digital financial inclusion.

4.4 Keyword Co-occurrence Analysis

Based on the keyword co-occurrence function of CiteSpace, this study generated a keyword co-occurrence network graph from 2021 to 2025 (see Figure 3). The size of each node corresponds to the frequency of keywords, and the connecting lines between the nodes signify the co-occurrence relationship between the keywords. Through the co-occurrence network graph analysis, this study reveals the hot issues of the research field from the dimensions of keyword frequency and centrality.

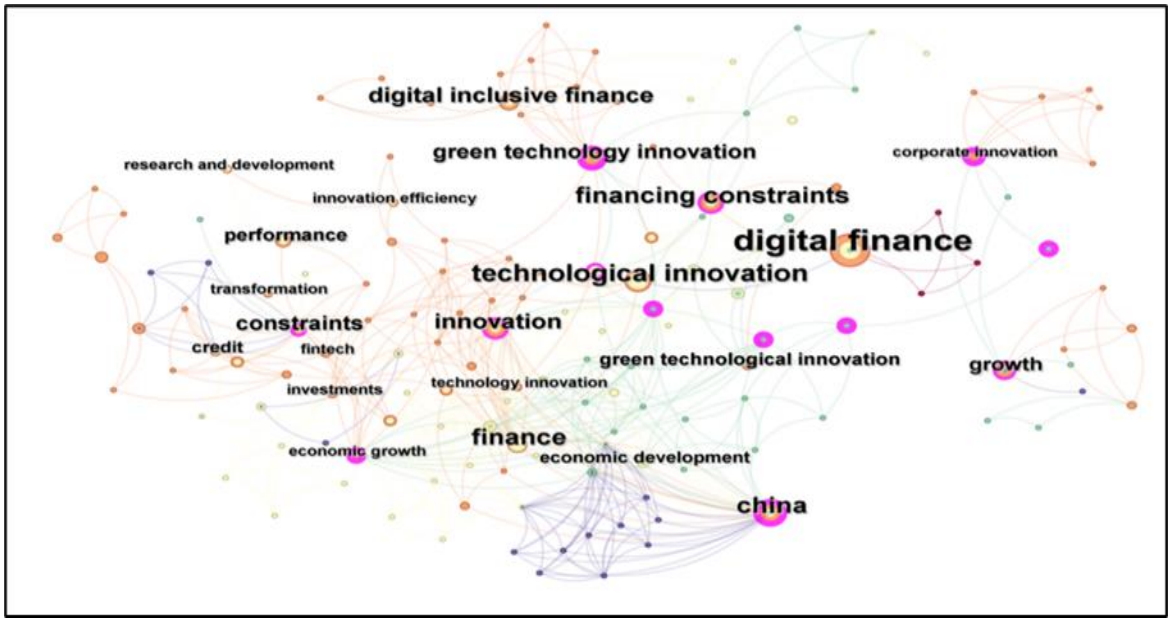

Figure 3: Keywords Co-occurrence Analysis

The keyword frequency statistics (see Table 2) reveal that the core research theme is “digital finance” (49 times), indicating that it occupies a dominant position in the domain of digital financial inclusion and enterprise innovation. Moreover, “technological innovation” (21 times) and “financing constraints” (17 times) also show high research intensity, reflecting the academic community’s interest in digital finance. “China” and “finance” ranked fourth 17 times, respectively, indicating that the research has strong regional characteristics, particularly within the setting of China, where the relevant research has received greater attention.

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Table 2: The frequency and centrality of keywords

No	Keywords	Frequency	Centrality
1	digital finance	49	0.07
2	technological innovation	21	0.04
3	financing constraints	17	0.19
4	China	17	0.32
5	finance	17	0.09
6	innovation	14	0.14
7	digital inclusive finance	13	0.07
8	green technology innovation	10	0.29
9	constraints	10	0.14
10	growth	9	0.17

Regarding the centrality index, the keyword "China" ranks the highest with a centrality of 0.32, indicating that it has the most significant connecting role in the network and is an important hub for multiple research themes. The centrality of "green technology innovation" and "financing constraints" are 0.29 and 0.19, respectively, indicating that these themes are crucial in the research network. The centrality of "green technology innovation" and "financing constraints" are 0.29 and 0.19, respectively, indicating that these themes are pivotal in the research network, especially the application of green technology innovation, and the alleviation of financing constraints is closely related to digital finance research. In addition, "growth" also highlights the importance of research on the effects of economic expansion with a high degree of centrality 0.17.

In terms of the overall structure of the co-occurrence network diagram, "digital finance" is closely related to "technological innovation," "financing constraints," and "China," indicating that the research gradually focuses on how digital finance can enhance the mechanism of promoting economic development through innovation and financing. The terms "green technology innovation" and "growth" also show a high frequency of co-occurrence, suggesting that academics are beginning to explore digital finance in conjunction with green development goals and business growth.

However, there are still some isolated nodes in the network, such as "constraints" and "performance." Although these topics have some research value, they are less connected to the core keywords, indicating that relevant research has not yet formed a tight knowledge network. Although these topics have some research value, they are less connected to the core keywords, indicating that the relevant research has not formed a close knowledge network. In addition, low-frequency keywords such as "credit" and "transformation" have a certain position in the digital finance ecosystem. Still, their research heat and network influence are relatively low, so it is necessary to strengthen the exploration of these directions further in the future. It is imperative to enhance the exploration of these directions in the future.

4.5 Keyword Clustering Analysis

This study employed the Log-Likelihood Ratio (LLR) method to do a cluster analysis of high-frequency keywords, aiming to thoroughly examine the research hotspots in digital financial inclusion and investigate the patterns of keyword combinations. A clearer keyword clustering map was generated by adjusting the threshold value several times (Figure 4). According to academic standards, a module value (Q) beyond 0.3 signifies a statistically significant

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clustering structure. In contrast, an average profile value (S) greater than 0.7 indicates that the clustering is efficient and the results are reliable. Overall, the modular value of Q in this study is 0.5005, signifying highly significant clustering. The average contour value S is 0.7938, indicating that the clusters have good internal consistency and credibility. Therefore, the mapping has strong scientific and explanatory power.

Through the cluster mapping generated by CiteSpace, the main knowledge structure and research themes of the research area were revealed. The following ten clusters were identified (see Table 3): #0 enterprise innovation, #1 regional economies, #2 enhancing innovation performance, #3 digital financial inclusion financing constraint, #4 organizational resilience perspective, #5 Chinese cities, #6 renewable energy technology innovation, #7 financing constraints perspective, #8 innovation inequality, and #9 green technology innovation. These clusters reflect the diversified directions of current research and provide a useful tool for further investigating the relationship between digital financial inclusion and enterprise innovation. They also provide a clear academic framework for further exploring their connection.

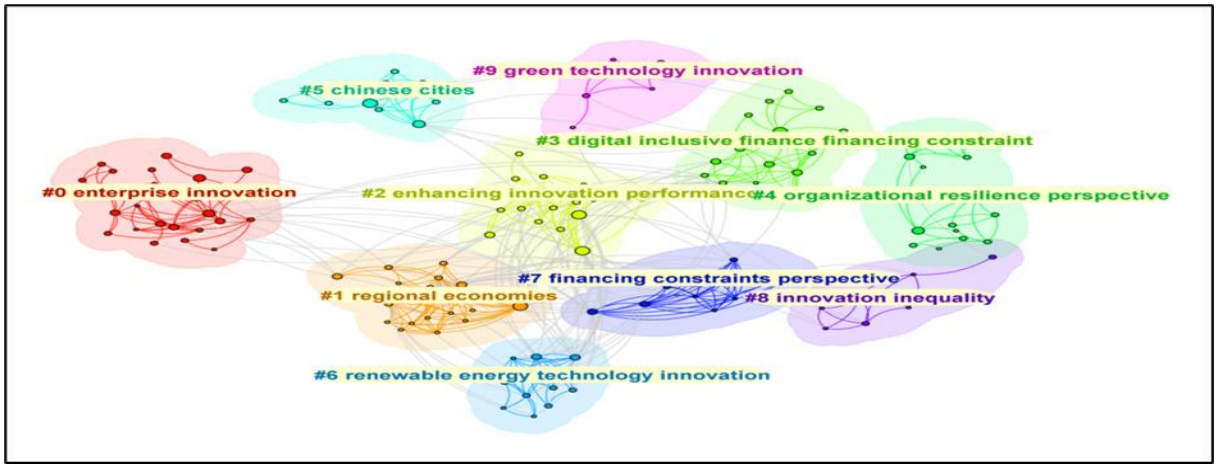

Figure 4: Keyword clustering analysis

Table 3: Research Hotspot Clustering

Cluster ID	Size	Silhouette	Year	Cluster Name	Key Words
0	26	0.902	2023	Enterprise Innovation	Enterprise Innovation, Digital Transformation, SME Innovation
1	18	0.876	2023	Regional Economies	Regional Economies, Spatial Disparities, Urban-Rural Divide
2	17	0.891	2022	Enhancing Innovation Performance	Innovation Performance, R&D Investments, Technological Capabilities
3	16	0.865	2023	Digital Inclusive Finance Financing Constraint	Digital Inclusive Finance, Financing Constraints, Credit Accessibility
4	14	0.812	2022	Organizational Resilience Perspective	Organizational Resilience, Adaptation Strategies, Crisis Management
5	12	0.921	2023	Chinese Cities	Chinese Cities, Regional Development, Policy Impacts
6	10	0.845	2023	Renewable Energy Technology Innovation	Renewable Energy, Technology Innovation, Sustainable Development
7	9	0.835	2023	Financing Constraints Perspective	Financing Constraints, Investment Barriers, Financial Accessibility
8	8	0.897	2022	Innovation Inequality	Innovation Inequality, Income Disparities, Economic Participation
9	6	0.876	2022	Green Technology Innovation	Green Technology, Sustainable Finance, Environmental Innovation

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4.6 Keyword Timeline Analysis

Keyword timeline analysis helps to reveal the dynamic evolution process and development path of the research field. The keyword timeline mapping generated by CiteSpace software (see Figure 5) can clearly observe the evolutionary path of digital financial inclusion and enterprise innovation research, showing the trajectory of changes and thematic associations of research hotspots at different time points. In this study, keyword time series analyses are conducted for studies between 2021 and 2025, revealing the developmental lineage of digital financial inclusion and enterprise innovation research themes.

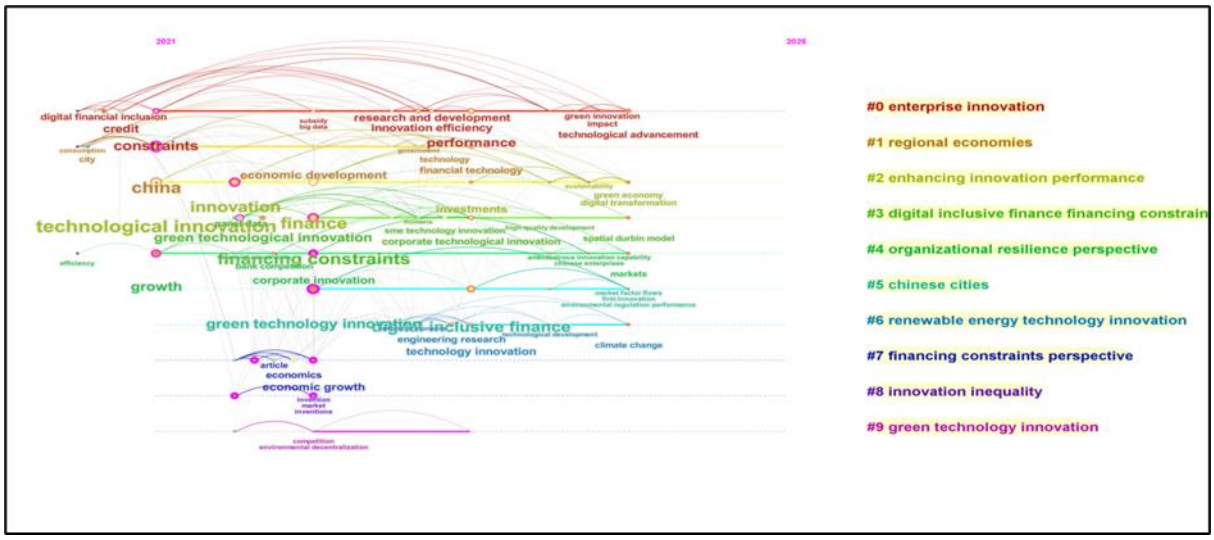

Figure 5: Keywords Timeline Analysis

As can be seen from the timeline diagram, the research officially started in 2021, concentrating initially on the terms“digital financial inclusion” and “credit,” primarily emphasizing the conceptual construction of digital financial inclusion and its fundamental application in enhancing credit accessibility. The initial phase of research focuses on the keywords “digital financial inclusion” and “credit.” The main focus is on the conceptual construction of digital financial inclusion and its basic application in enhancing credit availability and promoting financial inclusion.

By 2022, the research will gradually shift to the correlation between digital financial inclusion and business innovation, with the keywords “technological innovation,” “performance,” and “green technology innovation” frequently used. The keywords “technological innovation,” “performance,” and “green technology innovation” appear frequently, suggesting that research is beginning to focus on the impact of digital financial inclusion in driving technological innovation and improving the operational efficiency of enterprises. In addition, the emergence of keywords such as “carbon emissions” and “green economy,” the gradual incorporation of green development into research themes, and the function of digital financial inclusion in supporting green technological innovation and achieving the goal of sustainable development have become the focus of research. The significance of digital financial inclusion in supporting green technological innovation and achieving the Sustainable Development Goals has emerged as a prominent study subject.

In 2023, the research is further expanded with the keywords “sustainability,” “SMEs,” and “regional economies,” “regional economies,” indicating that academics are beginning to explore the differential impact of digital financial inclusion in particular areas and across different business sizes. The development of SMEs, particularly, has been a key research focus

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at this stage due to their importance in the economy and the need for digital transformation. This change is also closely linked to policy support, such as the policy push for digital capacity building for SMEs.

By 2024 and 2025, the research themes show a higher level of complexity and diversity, with the keywords “organizational resilience,” “green technology innovation,” and “digital transformation.” The keywords “organizational resilience,” “green technology innovation,” and “innovation inequality” suggest that research is not only covering the support of digital financial inclusion for business innovation and green development but is also beginning to explore its role in innovation inequality across economies. In addition, “heterogeneity” shows the refinement of the research methodology, as scholars have started to further reveal the complexity in the impact mechanism of digital financial inclusion through heterogeneity analysis.

In summary, the timeline mapping clearly presents the dynamic development of research from the exploration of the basic concepts of digital financial inclusion to the in-depth integration with enterprise innovation, green development, and regional economy to the exploration of heterogeneity and differentiated applications. These changes not only reflect academia’s response to policy and social needs but also provide a clear direction and inspiration for forthcoming research. Future research can further concentrate on the in-depth application of digital financial inclusion in specific contexts and explore its deeper impact on social equity and innovation enhancement.

4.7 Keyword Emergence Analysis

Keyword emergence analysis can reveal rapid changes and trends in a research field over a specific time period, helping to understand research priorities and future directions. By analyzing keyword emergence using CiteSpace software, Figure 6 reveals the dynamic evolution of research hotspots in the field between 2021 and 2025.

The analysis reveals that the terms “city” and “efficiency” appear in 2021, indicating that studies regarding digital financial inclusion in urban economic growth and efficiency improvement are beginning to receive attention. The research context of this phase is closely related to the global urbanization process and economic recovery policies, especially in the post-epidemic era, where the utilization of digital financial tools to facilitate economic recovery has become an important issue.

The year 2022 is the most active in terms of keyword emergence, including “spatial spillover effect,” “green technological innovation,” and “economic development.” Keywords such as “spatial spillover effect,” “green technological innovation,” “economic development,” etc., emerged strongly. Among them, the “spatial spillover effect” indicates that academics are increasingly focusing on the spatial spillover effect of digital financial inclusion in interregional economic development. At the same time, “green technological innovation” reflects the research hotspot. The term “green technological innovation” reflects that the research hotspot has gradually shifted to sustainable development, exploring how digital financial inclusion can realize a mutually beneficial outcome between economic growth and environmental conservation through supporting green technological innovation. In addition, “economic development” as a keyword further proves the significant significance of digital financial inclusion in promoting regional economic development.

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Also, in 2022, "financial constraints" and "subsidy" appear, indicating that research is beginning to explore how digital financial inclusion might mitigate the financing constraints of enterprises, especially SMEs, and promote the effective allocation of financial resources through policy support. This trend is highly consistent with the strategic goal of many countries to support SME development, especially within the framework of China's 14th Five-Year Plan, which explicitly mentions enhancing the digital capabilities of SMEs.

By 2023, the keywords "technological innovation," "SME technology innovation," and "digitization" have emerged, reflecting scholars' in-depth exploration of technological innovation in enterprises. In particular, the technological innovation capability of SMEs, as a crucial impetus for economic transformation, has become the core direction of research attention. In 2024 and beyond, the emergence of the keyword 'technological advancement' signifies the further development of research in the direction of in-depth application of technology. Scholars focus on how digital financial inclusion can drive economic transformation and social progress through technological innovation, reflecting the common global demand for high-quality economic growth and technological change.

Keywords	Year	Strength	Begin	End	2021 - 2025
city	2021	1.35	2021	2022	
efficiency	2021	1.27	2021	2021	
spatial spillover effect	2022	1.54	2022	2022	
green technological innovation	2022	1.33	2022	2022	
economic development	2022	1.07	2022	2023	
inventions	2022	1.02	2022	2022	
subsidy	2022	1.02	2022	2022	
invention	2022	1.02	2022	2022	
financial management	2022	1.02	2022	2022	
financial constraints	2022	1.02	2022	2022	
market	2022	1.02	2022	2022	
digitization	2022	1.02	2022	2022	
revolution	2022	1.02	2022	2022	
environmental decentralization	2022	1.02	2022	2022	
technological innovation	2021	2.84	2023	2023	
technology	2023	1.09	2023	2023	
sme technology innovation	2023	1.09	2023	2023	
technological advancement	2024	1.14	2024	2025	

Figure 6: Keywords with the strongest citation burst

5. Conclusions And Research Trends

5.1 Conclusions

Regarding the timing and number of literature issuance, the research on digital financial inclusion and enterprise innovation started in 2021. It then gradually heated up, with the number of issuance reaching a peak in 2023. This suggests that the field has become an important direction for research at the intersection of economic, technological, and social disciplines in the context of accelerating global digital transformation and clear 'dual-carbon' goals. The rapid growth of research reflects the growing interest of academia in the impact of digital financial inclusion in business innovation and economic development, hence offering significant support for the construction of related theories and policy practices.

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At the level of research authors and institutional cooperation, the academic network in this field has been gradually formed. The core authors are represented by highly cited scholars such as GOMBER P, GUO F, LI J, etc., serving a crucial bridging function in the knowledge network. In terms of institutions, Wuhan University, Nanjing Forestry University, and Hunan University are the main research institutions in China, and the research covers the economic effect, innovation effect, and sustainable development of digital financial inclusion. However, inter-institutional cooperation is overall more fragmented, especially in terms of inter-regional collaboration, with insufficient academic exchanges between Eastern, Central, and Western Universities. International cooperation is also limited, with current research focusing more on the Chinese context, and systematic comparative research from a global perspective still needs to be strengthened.

The analysis of keyword co-occurrence, clustering, timeline and emergence, keyword co-occurrence, clustering, timeline, and emergence regarding digital financial inclusion and enterprise innovation in the period of 2021-2025 can reveal the core hotspots and development trends within this domain. From the keyword co-occurrence analysis, “digital finance” and “technological innovation” are the core keywords in the research network, highlighting the significance of digital financial inclusion in fostering technical innovation in enterprises. Cluster further shows that the research hotspots focus on the direct promotion of digital financial inclusion in enterprise innovation, the support of green technological innovation, the assistance of technological transformation of SMEs, and the differentiated impact of regional enterprise innovation reflecting the multiple paths through which digital financial inclusion mitigates financing constraints. These promote green development and optimize resource allocation. The timeline analysis reveals that the research theme has gradually shifted from exploring the basic theories of digital financial inclusion to the applied research on technological innovation, regional economic differences, and SME development, with more emphasis on complex topics such as green technological innovation and corporate organizational resilience recently. The emergence analysis shows that keywords such as “spatial spillover effect,” “green technological innovation,” “technological innovation,” and other keywords are highlighted in different time periods, reflecting the high attention paid by academics to the regional economic spillover effect, green technological innovation and technology-driven development of digital financial inclusion.

Meanwhile, “financial constraints” and “subsidy” indicate that scholars have deeply explored the path of digital financial inclusion to promote innovative development by mitigating the financing constraints of SMEs. Overall, the research hotspots are advancing from theory to practice. The emergence of keywords shows the rapid and dynamic evolution of the research direction in line with changes in policy, technology, and socio-economic demand. This provides an important reference direction for future research focusing on digital financial inclusion and enterprise innovation.

5.2 Research Trends

Despite the substantial advancements in present research, many restrictions and gaps persist. The future should be combined with technological advances and social realities demand, focusing on the following directions to carry out in-depth research:

Firstly, research on dynamic and long-term effects should be strengthened. Contemporary research focuses more on short-term economic effects and pays less attention to the long-term impact of digital financial inclusion. Future studies should start from a dynamic perspective and systematically analyze the long-term effects of digital financial inclusion in promoting the

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improvement of enterprises' innovation capacity, promoting the optimization of industrial structure, and achieving sustainable development. For example, the dynamic function of digital financial inclusion in the accumulation of enterprise technology, the construction of innovation ecosystems, and the diffusion of innovation can be explored. Furthermore, we must consider the potential risks arising from the long-term application of digital financial inclusion, such as data misuse, technological ethical issues, and the aggravation of the digital divide, and study how to avoid these problems through policy and technological means effectively. In-depth research on the long-term impacts of digital financial inclusion will provide policymakers with a robust theoretical foundation and help enterprises achieve innovation-driven sustainable growth in the framework of economic development.

Secondly, internationalization and cross-regional comparative research should be deepened. Currently, research is concentrated on the Chinese context, with a deficiency in internationalization studies. In the future, it is necessary to strengthen cross-regional comparisons, explore the similarities and differences between different countries and regions regarding system design, technology application, and innovation effects, advance digital financial inclusion theory under the perspective of globalization, and provide a reference for global economic recovery and technological innovation.

Finally, explore the path of green finance and sustainable growth. In the framework of the "dual-carbon" goal, the integration of digital financial inclusion and green economic transformation has important research value. In the future, we can concentrate on the mechanism and effect of digital financial inclusion in supporting enterprises' green technological innovation, achieving carbon neutrality, and promoting economic green transformation.

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