The Impact of Digital Financial Inclusion on Technological Innovation Among Small and Medium-Sized Enterprises: A Conceptual Framework

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ABSTRACT

Digital financial inclusion has emerged as an important development in the financial sector, particularly for small and medium-sized enterprises (SMEs) that often face financing constraints and information asymmetry. This conceptual study develops an integrated framework to examine how digital financial inclusion may influence technological innovation among SMEs. Drawing on Financial Constraint Theory, Resource-Based View, and Information Asymmetry Theory, the study proposes that digital financial inclusion can improve SMEs' technological innovation by expanding financing accessibility, enhancing information transparency, and improving resource allocation efficiency. The framework further identifies digital financial literacy and institutional support as two boundary conditions that may strengthen the relationship between digital financial inclusion and technological innovation. By integrating direct effects, mediating mechanisms, and moderating conditions into a unified framework, the study provides a more comprehensive explanation of how digital financial development may be transformed into innovation outcomes. The proposed framework contributes to the literature by extending the understanding of digital financial inclusion beyond financial accessibility and highlighting its potential role in supporting SME technological upgrading and innovation capability. It also provides practical implications for SME managers, financial institutions, and policymakers seeking to improve access to digital financial services and create a supportive environment for innovation. Future empirical research can test the proposed relationships across different industries, regions, and institutional contexts.

Keywords: Digital financial inclusion; Technological Innovation; Small and Medium-Sized Enterprises; Digital Financial Literacy; Institutional Support

INTRODUCTION

Digital technologies have increasingly transformed the structure and delivery of financial services (Gomber et al., 2018; Gomber et al., 2017). The development of mobile payment systems, online lending platforms, digital banking, big-data credit assessment, and other financial technologies has expanded the ways through which enterprises can access financial resources (Alt et al., 2018). This transformation has contributed to the emergence of digital financial inclusion, which combines digital technologies with inclusive financial services to improve the accessibility, affordability, and convenience of financial resources. Compared with traditional financial services, digital financial inclusion can potentially reach enterprises that have previously been underserved by conventional financial institutions.

Small and medium-sized enterprises (SMEs) are particularly relevant to the development of digital financial inclusion. SMEs play an important role in employment creation, economic activity, industrial development, and entrepreneurial activity. However, SMEs often face difficulties in obtaining external financing because of limited collateral, short operating histories, insufficient credit records, and relatively high information asymmetry between firms and financial institutions (Abe et al., 2015; Song et al., 2018). These constraints can limit their ability to invest in research and development, acquire advanced technologies, employ skilled personnel, and

undertake other innovation-related activities. Technological innovation is an important source of SME competitiveness and long-term development. Innovation can allow SMEs to improve products, production processes, technological capabilities, and market responsiveness. Nevertheless, technological innovation generally requires continuous investment and involves substantial uncertainty. Research and development activities may not generate immediate financial returns, while innovative projects can face technological and market risks. Consequently, SMEs with limited internal resources may be particularly sensitive to financing constraints when making technological innovation decisions.

Digital financial inclusion may provide an alternative mechanism for addressing these constraints. By using digital technologies to collect, process, and analyze information, digital financial services may reduce transaction costs and improve the ability of financial institutions to evaluate SMEs. Online financial platforms may also expand access to credit and other financial services beyond the geographical and institutional boundaries of traditional banking. As a result, digital financial inclusion may provide SMEs with greater access to the resources necessary for technological innovation.

The potential relationship between digital financial inclusion and technological innovation can be understood from several perspectives. First, improved financial accessibility may directly increase the availability of funds for research and development. Second, digital financial systems may reduce information asymmetry by generating and processing transaction and business information, thereby improving the transparency of SME operations (Kumar et al., 2023). Third, digital finance may improve resource allocation by directing financial resources toward enterprises and projects with productive and innovative potential. Importantly, digital financial inclusion should not be understood simply as an increase in the amount of financing available to SMEs. Its potential contribution also lies in improving the efficiency, accessibility, and inclusiveness of financial resource allocation. An SME may have access to financial services but still face difficulties in using these resources effectively. Therefore, examining digital financial inclusion as a multidimensional financial and technological mechanism provides a broader perspective for understanding its possible influence on SME technological innovation.

Despite the growing literature on digital finance and innovation, several gaps remain. Existing studies have examined digital financial inclusion in relation to household consumption, entrepreneurship, income distribution, financial inclusion, and firm performance. Other studies have investigated the determinants of technological innovation among SMEs, including financing constraints, managerial capabilities, human capital, and institutional environments. However, relatively limited attention has been given to an integrated theoretical explanation of how digital financial inclusion may influence SME technological innovation and through which mechanisms this relationship operates. To address this gap, this study develops a conceptual framework integrating Financial Constraint Theory, Resource-Based View, and Information Asymmetry Theory. Financial Constraint Theory explains how improved access to external financial resources can support innovation investment. Resource-Based View emphasizes the importance of financial resources and organizational capabilities for developing technological innovation. Information Asymmetry Theory explains how digital information processing and financial technologies may reduce information barriers between SMEs and financial institutions. Building on these theoretical foundations, the proposed framework identifies financing accessibility, information transparency, and resource allocation efficiency as three potential mediating mechanisms. Digital financial literacy and institutional support are further proposed as contextual factors that may strengthen the relationship between digital financial inclusion and technological innovation.

The study makes three main contributions. First, it positions digital financial inclusion as an important financial and technological mechanism supporting SME innovation rather than merely a tool for improving financial access. Second, it integrates three complementary theoretical perspectives to explain the financial and informational channels through which digital finance may influence innovation. Third, the framework identifies specific mechanisms and boundary conditions that can be empirically tested in future studies.

LITERATURE REVIEW AND THEORETICAL FOUNDATION

Digital financial inclusion

Digital financial inclusion refers to the provision of accessible, affordable, and convenient financial services through digital technologies (Zhang et al., 2024). It combines the objectives of financial inclusion with technological innovations such as mobile internet, big-data analytics, digital payment systems, online credit platforms, and automated financial services (Du et al., 2023). Traditional financial systems may create barriers for SMEs because conventional lending often relies on collateral, standardized financial records, and established credit histories. SMEs may not possess these characteristics to the same extent as large enterprises. Digital financial inclusion can potentially reduce such barriers by using alternative information sources and digital transaction records to evaluate borrowers.

Another important characteristic of digital financial inclusion is its ability to reduce the cost of financial transactions. Digital platforms can simplify applications, payments, credit assessments, and other financial activities (Gomber et al., 2017). This may be particularly important for SMEs because smaller firms generally have fewer financial and administrative resources. Digital financial inclusion can therefore be understood through several dimensions, including financial accessibility, service availability, affordability, convenience, and digital financial infrastructure (Balboa et al., 2024). These characteristics distinguish digital financial inclusion from conventional financial services and provide a basis for examining its potential contribution to SME technological innovation. Operationally, digital financial inclusion captures the extent to which an SME accesses low-cost digital financial services; candidate indicators include adoption of digital lending platforms, digital payment usage frequency, perceived service affordability, and firm-level digital financial infrastructure coverage.

Technological Innovation among SMEs

Technological innovation refers to the development or adoption of new technologies, products, processes, and production methods that improve enterprise capabilities and competitiveness (Efimova & Kabakov, 2025; Zou, 2024). For SMEs, technological innovation can support productivity improvement, product differentiation, market expansion, and long-term competitiveness. However, innovation activities require financial, human, technological, and organizational resources. Research and development investment may generate uncertain returns and often involves relatively long periods before commercial benefits are realized. SMEs may therefore experience stronger barriers to innovation than firms with greater internal resources.

Financing constraints represent one of the most important obstacles to SME innovation. When external financing is difficult to obtain, firms may reduce research and development expenditure, postpone technology acquisition, or avoid projects involving substantial uncertainty. Improving access to financial resources may consequently increase SMEs' ability to undertake innovation activities (Yao & Yang, 2022). Technological innovation among SMEs is therefore not determined solely by internal technological capabilities. External financial conditions can also shape the extent to which firms can mobilize the resources required for innovation. Operationally, SME technological innovation is reflected by innovation inputs and outputs; candidate indicators include R&D intensity, patent applications, new technology adoption, and new product launch.

Digital financial inclusion and Technological Innovation

The relationship between digital financial inclusion and technological innovation can be understood through the resource requirements of innovation. Technological innovation requires firms to invest in research and development, technology acquisition, equipment, skilled employees, and commercialization activities. These investments require financial resources that may exceed SMEs' internal funding capacity (Ma, 2023). Digital financial inclusion may provide SMEs with additional financing channels and reduce barriers to accessing external capital. By improving financial accessibility, digital financial services may allow firms to obtain resources that can be directed toward innovation activities (Gu et al., 2023). In addition, digital financial services may improve information transparency. Digital transactions and data-based credit assessment can generate more

information about SME business activities and financial conditions. Greater information availability may reduce uncertainty faced by financial institutions and improve SMEs' ability to obtain financing.

Digital financial inclusion may also improve the efficiency of financial resource allocation. Traditional financing mechanisms may allocate resources based on relatively limited information. Digital technologies can potentially process larger volumes of information and identify firms with different financial and operational characteristics. More efficient resource allocation may increase the likelihood that innovative SMEs obtain appropriate financial support (Wang et al., 2025). However, the effect of digital financial inclusion may vary according to enterprise capabilities and institutional conditions. SMEs with stronger digital financial literacy may be better able to identify and use digital financial services. Similarly, institutional support may determine whether digital financial resources can be effectively transformed into innovation investment.

Theoretical Grounding

The proposed relationship can be explained through Financial Constraint Theory, Resource-Based View, and Information Asymmetry Theory. Financial Constraint Theory provides a direct explanation for why digital financial inclusion may influence SME technological innovation. SMEs frequently face difficulties in obtaining external financing, particularly when innovation projects are uncertain and lack immediate financial returns. Improved access to external financial resources can reduce financing constraints and allow SMEs to maintain investment in research and development and technological upgrading. Resource-Based View provides a complementary explanation by emphasizing that enterprise performance depends on the availability and effective utilization of valuable resources (Mailani et al., 2024). Financial resources constitute an important input into technological innovation. Digital financial inclusion can potentially expand SMEs' access to financial resources and allow them to combine financial capital with human, technological, and organizational resources to develop innovation capabilities.

Information Asymmetry Theory focuses on information differences between SMEs and financial institutions (Wang et al., 2022). SMEs generally possess more information about their operations, projects, and future prospects than external financiers. At the same time, financial institutions may have limited information about small firms. Digital technologies can collect and process transaction, payment, operational, and other information, potentially reducing information asymmetry and improving financial decision-making. Together, these theories suggest that digital financial inclusion can influence technological innovation through financial, resource, and informational channels. Financial Constraint Theory explains the financing channel, Resource-Based View explains the resource channel, and Information Asymmetry Theory explains the information channel. Their integration provides a theoretical foundation for examining digital financial inclusion as an enabling mechanism for SME technological innovation.

Conceptual Development And Proposed Propositions

Direct Effect of Digital financial inclusion on Technological Innovation

Digital financial inclusion can potentially play an important role in promoting technological innovation among small and medium-sized enterprises (SMEs) (L. Zhang et al., 2023). Technological innovation generally requires continuous investment in research and development, advanced equipment, technical personnel, knowledge acquisition, product development, and commercialization. Compared with large enterprises, SMEs often operate with more limited internal financial resources and may face greater difficulties in obtaining external financing. As a result, insufficient access to financial resources can prevent SMEs from undertaking innovation projects even when potentially valuable technological opportunities exist. Digital financial inclusion can potentially alleviate this problem by expanding SMEs' access to financial services. Digital banking, online lending, mobile payment systems, digital credit platforms, and other technology-enabled financial services can reduce some of the geographical, procedural, and informational barriers associated with traditional financial services (X. Zhang et al., 2023). SMEs may therefore have more opportunities to obtain external financial resources without relying exclusively on conventional bank lending. Greater financial accessibility can provide firms with additional resources for research and development, technology acquisition, equipment upgrading, and innovation-related

human capital investment.

The relationship can be explained from the perspective of Financial Constraint Theory. SMEs are particularly vulnerable to financing constraints because external financiers may perceive them as relatively risky borrowers. Innovation projects further increase financing difficulties because their outcomes are uncertain and the benefits may only emerge over a relatively long period. When SMEs cannot obtain sufficient external financing, they may reduce innovation expenditure, postpone research projects, or avoid technologically uncertain investments. Digital financial inclusion may reduce these constraints by providing additional financing channels and improving the accessibility of external capital. Resource-Based View provides another explanation. Financial capital is an important organizational resource that allows firms to acquire and combine other resources necessary for innovation. Technological innovation rarely depends on financial resources alone. Instead, financial capital must be combined with skilled employees, technological knowledge, organizational capabilities, and physical assets. Digital financial inclusion can therefore contribute to innovation by increasing SMEs' ability to mobilize and combine these complementary resources.

The potential influence of digital financial inclusion also extends beyond the simple availability of credit. Digital financial services can reduce transaction costs, improve payment efficiency, and facilitate financial management. These improvements may allow SMEs to allocate more managerial and financial resources toward productive and innovation-oriented activities (Dai et al., 2023). For example, easier access to digital payment and financing services may improve cash-flow management, allowing firms to maintain more stable investment in research and development. Information Asymmetry Theory further suggests that digital finance can improve the financial environment in which SMEs operate. Traditional financial institutions may have limited information about SMEs' operating conditions, business prospects, and innovation capabilities. This information gap can increase perceived lending risks and restrict access to financing. Digital financial platforms can potentially use transaction records, payment information, business data, and other digital information to improve the assessment of SME creditworthiness. Reduced information asymmetry may therefore improve the possibility of obtaining external financing for innovative activities.

At the same time, the relationship between digital financial inclusion and technological innovation should not be interpreted as an automatic transformation of financial access into innovation outcomes. SMEs must possess the organizational and managerial capabilities necessary to use financial resources effectively. Financial resources may support innovation only when they are appropriately allocated toward research and development, technology acquisition, employee training, and other productive activities. Thus, digital financial inclusion provides an enabling financial environment, while enterprise-level capabilities determine how effectively these resources can be transformed into technological innovation (Zulqarnain et al., 2023). Based on these theoretical arguments, digital financial inclusion is expected to provide SMEs with greater financial accessibility, reduce constraints on innovation investment, and strengthen their capacity to mobilize resources for technological development. Therefore, the following proposition is proposed.

P1: Digital financial inclusion positively influences technological innovation among SMEs.

Mechanisms Linking Digital financial inclusion to Technological Innovation

Digital financial inclusion may influence technological innovation among SMEs through several interconnected mechanisms, particularly financing accessibility, information transparency, and resource allocation efficiency. These mechanisms reflect different but complementary ways through which digital financial services can affect the innovation activities of SMEs.

First, financing accessibility represents an important channel through which digital financial inclusion can support SME technological innovation (Wang et al., 2023). SMEs often face difficulties in obtaining external financing because of limited collateral, short operating histories, relatively small business scale, and insufficient credit records. These constraints are particularly relevant to technological innovation because R&D activities usually require substantial upfront investment while generating uncertain and relatively long-term returns. Digital financial inclusion can expand SMEs’ access to formal financial services through digital banking, online

credit platforms, mobile payment systems, and technology-enabled lending. By reducing geographical, procedural, and transaction barriers, digital financial services may provide SMEs with additional funding for R&D, technology acquisition, equipment upgrading, and product development. From the perspective of Financial Constraint Theory, improved financing accessibility can therefore reduce the extent to which external funding limitations restrict firms' innovation investment.

Second, information transparency provides an important informational mechanism. Information asymmetry between SMEs and financial institutions may prevent potentially innovative firms from obtaining adequate financial resources (Lin et al., 2023). Traditional credit assessment often relies heavily on collateral, historical financial statements, and established credit records, which may disadvantage younger or smaller enterprises. Digital financial inclusion can generate and utilize transaction records, payment histories, online business activities, and other forms of digital information, thereby improving the availability of information about SME operations and financial behavior. Greater information transparency may enable financial institutions to evaluate firms more accurately and reduce uncertainty surrounding lending decisions. At the same time, improved information availability can help SMEs identify suitable financial services and make more informed investment decisions. Consistent with Information Asymmetry Theory, the reduction of information gaps may consequently facilitate the allocation of financial resources toward innovative activities.

Third, resource allocation efficiency constitutes another mechanism linking digital financial inclusion with technological innovation. Access to finance alone does not necessarily produce innovation if financial resources are inefficiently allocated or used for non-productive purposes. Digital financial technologies can improve the speed, accuracy, and convenience of financial information processing, while digital platforms can facilitate more efficient matching between financial resources and enterprise needs (Xie et al., 2024). For SMEs, these improvements may reduce transaction costs, improve financial management, and enable limited resources to be directed toward higher-value activities such as R&D, technological upgrading, and product innovation. From the perspective of the Resource-Based View, the value of financial resources depends not only on their availability but also on the firm's ability to deploy them effectively. Digital financial inclusion may therefore contribute to innovation by improving the efficiency with which financial and organizational resources are allocated.

These three mechanisms are not necessarily independent. Financing accessibility provides SMEs with additional financial resources, information transparency reduces the informational barriers surrounding those resources, and resource allocation efficiency determines how effectively the resources are transformed into innovation-oriented activities. Together, they explain why the influence of digital financial inclusion on technological innovation may extend beyond the simple provision of credit. Based on these arguments, the following propositions are proposed:

P2: Financing accessibility mediates the relationship between digital financial inclusion and technological innovation among SMEs.

P3: Information transparency mediates the relationship between digital financial inclusion and technological innovation among SMEs.

P4: Resource allocation efficiency mediates the relationship between digital financial inclusion and technological innovation among SMEs.

Boundary Conditions of the Relationship

Although digital financial inclusion may create opportunities for SME technological innovation, its effects are unlikely to be identical across all enterprises and institutional environments. The extent to which SMEs benefit from digital financial services depends not only on the availability of financial resources but also on their ability to utilize these resources and the institutional conditions surrounding them. Accordingly, digital financial literacy and institutional support are proposed as two important boundary conditions that may strengthen the relationship between digital financial inclusion and SME technological innovation.

Digital financial literacy refers to the ability of SME managers and employees to understand digital financial products, evaluate financial information, identify appropriate financial services, manage digital financial risks, and effectively use technology-enabled financial tools (Zaimovic et al., 2025). The availability of digital financial services does not necessarily ensure that all SMEs can benefit from them equally. SMEs with higher levels of digital financial literacy may be better able to identify suitable financing opportunities, compare financial products, understand digital credit requirements, and manage the costs and risks associated with different financing channels (Diptyana et al., 2022). These capabilities can improve the efficiency with which digital financial resources are obtained and allocated. Moreover, digitally financially literate managers may be more capable of integrating digital financial services with financial management, cash-flow planning, and innovation investment, thereby facilitating the transformation of financial resources into technological innovation.

The innovation effects of digital financial inclusion are also influenced by the broader institutional environment. Institutional support encompasses government policies, financial regulations, innovation programs, digital infrastructure, credit guarantee systems, intellectual property protection, and other forms of external assistance available to SMEs (Prasannath et al., 2024). Such support can complement digital financial inclusion by reducing financing risks, lowering innovation costs, improving access to technological resources, and creating a more favorable environment for innovation activities. For example, government guarantees can facilitate SME financing, innovation subsidies can reduce research and development costs, and public technology programs can provide access to knowledge and technical resources. In contrast, weak institutional support, inadequate digital infrastructure, limited intellectual property protection, and insufficient innovation services may restrict SMEs' ability to transform financial resources into technological innovation.

Taken together, these two boundary conditions highlight that the relationship between digital financial inclusion and SME technological innovation depends on both firm-level capabilities and the external institutional environment. Higher digital financial literacy can improve SMEs' ability to identify, access, and utilize digital financial resources, while stronger institutional support can provide complementary resources and reduce external barriers to innovation. Based on these arguments, the following propositions are proposed:

P5: Digital financial literacy positively moderates the relationship between digital financial inclusion and SME technological innovation.

P6: Institutional support positively moderates the relationship between digital financial inclusion and SME technological innovation.

CONCEPTUAL FRAMEWORK

Development of the Conceptual Framework

The conceptual framework developed in this study integrates the theoretical arguments and propositions presented in the previous sections to explain how digital financial inclusion may influence technological innovation among SMEs. The framework positions digital financial inclusion as the independent variable and technological innovation among SMEs as the dependent variable. It further incorporates three mediating mechanisms, namely financing accessibility, information transparency, and resource allocation efficiency, together with two moderating factors, namely digital financial literacy and institutional support. At the center of the framework is the relationship between digital financial inclusion and SME technological innovation. Digital financial inclusion represents a technology-enabled financial environment in which SMEs can obtain financial services through digital platforms and information systems. Compared with traditional financial services, digital financial inclusion can potentially reduce geographical and procedural barriers, improve financial service accessibility, and expand financing opportunities for smaller firms. The direct relationship reflects the argument that improved access to digital financial resources can provide SMEs with greater capacity to invest in technological innovation. SMEs can use financial resources to support research and development, purchase advanced equipment, introduce new technologies, recruit skilled employees, and commercialize innovative products. Therefore, digital financial inclusion may provide an important external resource that complements

firms' internal innovation capabilities.

However, the framework does not assume that digital finance automatically produces innovation. Instead, it emphasizes the mechanisms through which financial access is transformed into innovation capability. The first mechanism is financing accessibility. When digital finance makes financial services more accessible, SMEs may be better able to overcome financial constraints and obtain funds for innovation investment. The second mechanism is information transparency. Digital financial systems can generate and process information about SME business activities and financial conditions. Improved information transparency can reduce information asymmetry and potentially increase the willingness of financial institutions to provide financing to SMEs (Vasilescu, 2014). This creates an informational pathway connecting digital finance with innovation. The third mechanism is resource allocation efficiency. Digital financial technologies can facilitate faster information processing, financial transactions, and credit assessment. These functions may improve the efficiency with which financial resources are allocated and allow SMEs to direct more resources toward productive and innovation-oriented activities.

The framework further incorporates two contextual variables. Digital financial literacy represents the enterprise-level capability to understand and use digital financial services. SMEs with stronger digital financial literacy may be better able to benefit from digital financial opportunities and transform them into productive investment. Institutional support represents the external environment surrounding SMEs. Government policies, digital infrastructure, financing support, innovation programs, and regulatory institutions may influence the extent to which SMEs can transform financial access into technological innovation. Stronger institutional support is therefore expected to reinforce the relationship between digital financial inclusion and innovation. The framework consequently combines direct effects, mediating mechanisms, and moderating conditions within a single theoretical model. This structure allows future empirical studies to examine not only whether digital financial inclusion affects SME technological innovation but also how and under what conditions such an effect occurs.

Proposed Conceptual Framework

The proposed conceptual framework is presented below. The model illustrates the expected relationship between digital financial inclusion and technological innovation among SMEs while incorporating the three mediating mechanisms and two moderating variables identified in the theoretical development.

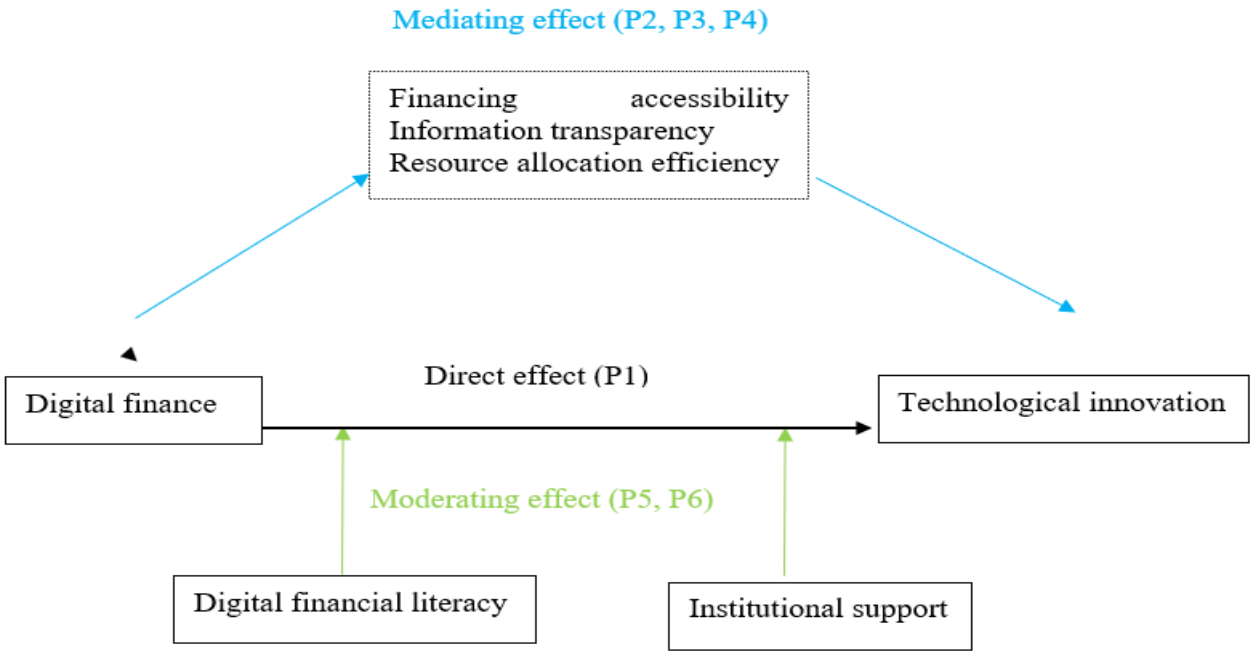


Figure 1. Conceptual framework of the research

As shown in Figure 1, digital financial inclusion represents the starting point of the proposed framework. The direct path from digital financial inclusion to technological innovation reflects P1. This path represents the central theoretical assumption that improved access to digital financial services can provide SMEs with financial conditions that support technological innovation. The first mediating pathway is financing accessibility. Digital financial inclusion can potentially expand SMEs' access to external financial resources and reduce some of the financing barriers associated with traditional financial systems. When SMEs can obtain financial resources more easily, they may have greater capacity to invest in research and development and other innovation activities. This pathway corresponds to P2. The second pathway is information transparency. Digital financial platforms can generate and process business and financial information, potentially reducing information asymmetry between SMEs and financial institutions. Better information may improve credit assessment and facilitate the matching of SMEs with appropriate financial resources. This informational mechanism corresponds to P3. The third pathway is resource allocation efficiency. Digital financial technologies can improve the processing and allocation of financial resources. SMEs may therefore be able to use financial capital more efficiently and direct a greater proportion of available resources toward productive and innovation-oriented activities. This pathway corresponds to P4.

The framework also includes digital financial literacy as a moderator. This variable is positioned at the enterprise level because the effectiveness of digital financial inclusion depends partly on SMEs' ability to understand and use digital financial services. Firms with greater digital financial literacy may be better able to identify suitable financial opportunities, manage digital financial risks, and integrate digital finance into their innovation activities. This moderating relationship corresponds to P5. Institutional support represents the external contextual moderator. Government policies, financial support systems, innovation programs, digital infrastructure, and institutional arrangements can influence SMEs' ability to utilize financial resources for technological innovation. Stronger institutional support may therefore strengthen the transformation of digital financial access into innovation outcomes. This relationship corresponds to P6.

The framework thus presents digital financial inclusion as a multidimensional mechanism rather than merely an alternative source of credit. Its potential contribution to SME technological innovation may arise from three interconnected functions: expanding access to financial resources, improving the information environment, and enhancing resource allocation efficiency. At the same time, the realization of these potential benefits depends on enterprise-level digital financial capabilities and the surrounding institutional environment. Taken together, the conceptual framework provides an integrated explanation of the digital finance–innovation relationship. It connects the financial resource dimension emphasized by Financial Constraint Theory, the resource utilization perspective of Resource-Based View, and the informational perspective of Information Asymmetry Theory. The framework can therefore serve as a theoretical foundation for future empirical research examining the relationship across different SME industries, regions, and institutional environments

DISCUSSION AND IMPLICATIONS

Theoretical Contributions

This conceptual study contributes to the literature on digital financial inclusion and SME technological innovation in several ways. First, it shifts attention from the general financial inclusion effects of digital finance toward its potential role in supporting technological innovation among SMEs. Existing research has extensively examined digital financial inclusion in relation to financial accessibility, household welfare, entrepreneurship, consumption, and firm performance. However, technological innovation requires not only access to financial resources but also the ability to transform those resources into productive and innovation-oriented activities. By positioning digital financial inclusion as an important antecedent of SME technological innovation, this framework emphasizes that the development of digital financial systems may have implications beyond financial access and may contribute to firms' technological upgrading and innovation capabilities. Second, this study extends the understanding of the mechanisms linking digital finance with SME technological innovation. Rather than assuming a simple direct relationship, the proposed framework identifies financing accessibility, information transparency, and resource allocation efficiency as three complementary mediating mechanisms. Financing accessibility reflects the financial channel through which SMEs can obtain resources for R&D and

technological investment. Information transparency represents the informational channel through which digital financial technologies may reduce information asymmetry between SMEs and financial institutions. Resource allocation efficiency reflects the organizational and financial channel through which SMEs may use available resources more effectively. This multi-mechanism perspective provides a more comprehensive explanation of how digital financial inclusion may be transformed into innovation outcomes.

Third, the framework integrates Financial Constraint Theory, Resource-Based View, and Information Asymmetry Theory to provide a broader theoretical explanation of the relationship. Financial Constraint Theory explains why improved access to external financing may enable SMEs to overcome resource limitations associated with innovation investment. Resource-Based View emphasizes that financial resources need to be combined with other organizational resources and capabilities to generate technological innovation. Information Asymmetry Theory explains how digital information collection and processing may improve transparency and facilitate more effective financial decision-making. Combining these perspectives allows the framework to explain the relationship from financial, resource, and informational perspectives rather than relying on a single theoretical argument. Fourth, this study incorporates digital financial literacy and institutional support as boundary conditions of the digital financial inclusion–technological innovation relationship. The availability of digital financial services does not necessarily produce identical outcomes across SMEs. Firms with stronger digital financial literacy may be better able to identify appropriate financial services, manage digital financial risks, and integrate financial resources into innovation activities. Similarly, institutional support may provide complementary financing, infrastructure, policy, and innovation resources that enable SMEs to transform digital financial access into technological outcomes. By incorporating these contextual factors, the framework recognizes that the innovation effects of digital financial inclusion depend not only on financial availability but also on firms' capabilities and their institutional environment. Moreover, this study supplies explicit operational definitions and measurement indicators for all constructs, lowering the barrier for follow-up empirical testing.

Managerial Implications

The proposed framework provides several implications for SME managers, entrepreneurs, and financial decision-makers. First, SME managers should recognize that digital financial inclusion represents more than an additional source of external financing. Digital banking, online lending, digital payment systems, and other technology-enabled financial services can potentially improve financing accessibility, information management, and resource allocation. Managers should therefore actively evaluate suitable digital financial services and integrate them into broader financial management and innovation strategies. Appropriate use of digital financial resources may help SMEs maintain investment in R&D, technology acquisition, equipment upgrading, and product development. Second, SMEs should strengthen their digital financial literacy. The availability of digital financial services does not guarantee effective utilization. Managers and employees need sufficient knowledge to evaluate digital financial products, understand financing conditions, manage digital financial risks, and select appropriate financing channels. Strengthening digital financial capabilities can help SMEs make more informed financing decisions and improve the efficiency with which financial resources are transformed into innovation-oriented investment.

Third, SME managers should improve internal information management and resource allocation capabilities. Digital financial inclusion may provide greater access to financial resources, but innovation outcomes depend on how these resources are used. Firms should establish appropriate systems for financial information management, investment planning, R&D budgeting, and performance evaluation. Better internal information and resource allocation practices can help firms direct limited financial resources toward high-value technological projects rather than short-term or non-productive activities. Finally, SMEs should strengthen their interaction with the broader institutional and innovation environment. Government-supported financing programs, innovation subsidies, credit guarantees, digital infrastructure, technology platforms, and intellectual property services may complement digital financial resources. SME managers should therefore identify relevant institutional resources and integrate them with digital financial services. Such an approach can improve the firm's ability to convert financial accessibility into sustained technological innovation.

Regulatory Implications

The conceptual framework also provides implications for regulators and policymakers seeking to promote SME innovation through digital financial development. First, policymakers should continue to improve the accessibility and inclusiveness of digital financial services for SMEs. Regulatory policies can encourage the development of responsible digital lending, digital banking, online financing platforms, and other financial technologies while reducing unnecessary geographical and procedural barriers (Chaturvedi & Sinha, 2024). Particular attention should be given to SMEs that remain underserved by conventional financial institutions. Second, regulators should strengthen the digital financial infrastructure and information environment supporting SME financing. Reliable digital transaction systems, appropriate data-sharing mechanisms, credit information systems, and secure digital identification can improve the availability and quality of information used in financial decision-making. Such measures may help reduce information asymmetry between SMEs and financial institutions while improving the efficiency of credit allocation. At the same time, data protection, cybersecurity, and responsible data-use requirements should be incorporated into the development of digital financial systems.

Third, policymakers should strengthen institutional support for SME technological innovation. Digital financial inclusion may provide financial resources, but SMEs may still face technological, organizational, and knowledge-related barriers. Government innovation subsidies, credit guarantee programs, public technology services, digital infrastructure, R&D support, and intellectual property protection can provide complementary conditions that enable SMEs to transform financial resources into innovation outcomes. Policies should therefore coordinate digital financial development with broader SME innovation-support systems. Finally, regulatory authorities should pay attention to differences among SMEs and avoid assuming that digital financial services will generate uniform innovation effects. SMEs vary in terms of industry, size, technological capabilities, digital financial literacy, and regional institutional conditions. Policymakers can therefore combine common principles for digital financial inclusion with targeted support for firms and regions facing greater financing and innovation constraints. A coordinated policy approach involving digital financial accessibility, information infrastructure, financial literacy, innovation support, and institutional protection can create a more favorable environment for SMEs to convert digital financial opportunities into technological innovation.

CONCLUSION

Main Conclusions

This conceptual study develops an integrated framework to explain how digital financial inclusion may influence technological innovation among small and medium-sized enterprises (SMEs). Rather than viewing digital financial inclusion simply as an alternative source of external financing, the study positions it as a technology-enabled financial mechanism that can improve financial accessibility, information conditions, and resource utilization. By reducing financial and informational barriers, digital financial inclusion may provide SMEs with improved access to the resources required for research and development, technology acquisition, equipment upgrading, and product innovation. The framework therefore suggests that digital financial inclusion may serve as an important external enabling mechanism for SME technological innovation.

The framework further identifies financing accessibility, information transparency, and resource allocation efficiency as three mechanisms linking digital financial inclusion with technological innovation. Improved financing accessibility may help SMEs overcome financial constraints and obtain resources for innovation investment. Greater information transparency may reduce information asymmetry between SMEs and financial institutions and facilitate more appropriate financing decisions. Resource allocation efficiency may enable SMEs to deploy limited financial resources toward productive and innovation-oriented activities. In addition, digital financial literacy and institutional support are proposed as two boundary conditions that may strengthen the relationship. SMEs with stronger digital financial literacy may be better able to identify, access, and utilize digital financial services, while stronger institutional support may provide complementary resources and reduce external barriers to innovation. Overall, the framework integrates Financial Constraint Theory, Resource-Based View, and Information Asymmetry Theory to demonstrate that digital financial inclusion should be understood not merely as a financial access mechanism but as a broader financial and informational mechanism connecting

resource accessibility, information improvement, resource allocation, and SME technological innovation. Explicit operational definitions and measurement indicators are provided for all core constructs to guide future empirical validation.

Limitations

Despite its theoretical contributions, this study has several limitations. First, this research is conceptual in nature and does not provide empirical evidence to test the proposed propositions. The relationships among digital financial inclusion, financing accessibility, information transparency, resource allocation efficiency, digital financial literacy, institutional support, and SME technological innovation remain theoretical expectations that require validation through quantitative or qualitative empirical studies. The strength and statistical significance of the proposed relationships therefore cannot be established solely from the conceptual framework. Second, the framework focuses on three mediating mechanisms and two moderating factors, while other potentially relevant variables are not incorporated. Factors such as firm size, firm age, ownership structure, industry characteristics, managerial capabilities, human capital, technological capabilities, market competition, and regional digital infrastructure may also influence SMEs' ability to transform digital financial resources into technological innovation. The omission of these variables may limit the explanatory scope of the proposed framework.

Third, the study treats digital financial inclusion as a relatively integrated construct, whereas differences in the specific forms and quality of digital financial services are not explicitly examined. Digital credit, digital banking, online lending, digital payment systems, and technology-enabled financial information services may influence SMEs through different channels. Similarly, differences in service accessibility, affordability, reliability, and digital infrastructure may generate different innovation outcomes. Future research should therefore consider the multidimensional characteristics of digital financial inclusion. Finally, the framework does not distinguish among different forms of technological innovation. SMEs may engage in product innovation, process innovation, technological adoption, incremental innovation, or radical innovation, each of which may involve different levels of financing requirements, technological uncertainty, and organizational capabilities. The effects of digital financial inclusion may therefore vary according to the type and quality of innovation outcomes. More detailed investigation is needed to determine whether the proposed relationships apply consistently across different forms of SME technological innovation.

Future Research

Several directions for future research emerge from this study. First, future studies should empirically test the proposed framework using panel data, survey methods, case studies, or mixed-method approaches. Researchers may examine whether digital financial inclusion significantly influences SME technological innovation and test the mediating roles of financing accessibility, information transparency, and resource allocation efficiency, together with the moderating effects of digital financial literacy and institutional support. The measurement indicators offered in this study can be directly adapted for questionnaire design or secondary-data construction. Such empirical research would provide evidence for evaluating the propositions and determining the relative importance of the proposed mechanisms. Second, future research could distinguish between different dimensions and forms of digital financial inclusion. Researchers may separately examine digital credit, digital banking, online lending, digital payment services, and digital financial information systems to determine whether different financial technologies generate different innovation effects. Future studies could also examine whether the accessibility, affordability, convenience, service quality, and technological sophistication of digital financial services produce heterogeneous effects on SME innovation.

Third, cross-industry and cross-regional comparisons would provide valuable insights into the contextual conditions influencing the digital financial inclusion–technological innovation relationship. Differences in industrial structure, regional financial development, digital infrastructure, institutional quality, government support, and market conditions may affect SMEs' ability to utilize digital financial resources. Future studies could therefore compare technology-intensive and traditional industries, different geographical regions, and different institutional environments to identify potential sources of heterogeneity. Fourth, future research could examine different dimensions of technological innovation and distinguish between innovation inputs and

innovation outputs. For example, researchers could investigate R&D expenditure, patent applications, patent quality, product innovation, process innovation, technological adoption, and commercialization performance. Such analyses would provide a more nuanced understanding of how digital financial inclusion contributes to the technological upgrading and long-term competitiveness of SMEs and would further clarify the conditions under which digital financial development can be effectively transformed into innovation outcomes.

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