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A Study on the Impact of Banking Fintech on the Continuous Innovation of Specialized, Refined, Distinctive, and Innovative Enterprises

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Abstract. "Specialized, Refined, Distinctive, and Innovative" (SRDI) enterprises have long focused on niche markets, but their sustained innovation is often affected by external financing conditions, given their long R&D cycles, technological risks, and delays in commercializing research outcomes. As commercial banks increasingly integrate data, algorithms, and digital infrastructure into lending operations, the way they assess innovation-related information and allocate technology-related loans has changed. Research in this area has therefore moved beyond loan availability to examine loan terms, financing costs, and innovation quality. This paper distinguishes between regional digital finance, platform-based fintech, and bank-internal fintech. It reviews existing research on how bank fintech relates to the sustained innovation of SRDI enterprises, with particular attention to loan terms, risk pricing, and their applicable conditions. Existing research suggests that bank fintech can supplement traditional financial and collateral information, thereby improving financing conditions for asset-light enterprises; studies on "Specialized, Refined, Unique, and New" enterprises have found that digital finance and fintech organizations help sustain R&D activities and drive key technological breakthroughs. However, existing studies still face limitations in matching bank and enterprise data, identifying loan contracts, and measuring sustained innovation. Whether the application of fintech can generate long-term innovation returns through adjustments in loan terms and pricing requires further examination based on the integration of enterprise, bank, loan, and patent data.

Keywords: Bank Fintech, Specialized, Refined, Distinctive, and Innovative enterprises, Sustained Innovation, Loan Terms, Risk Pricing Introduction

1. Introduction

"Specialized, Refined, Distinctive, and Innovative" (SRDI) enterprises excel in specialization, refinement, distinctiveness, and innovation; they are a vital force in breaking through key technologies, addressing weaknesses in industrial chains, and enhancing the resilience of industrial chains [1, 2]. Continuous technological accumulation is the foundation for these enterprises to build a competitive advantage; however, the payback period for R&D investments is relatively long, and patents, software, talent, and proprietary processes are difficult to value according to traditional

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collateral rules. Fluctuations in external financing can easily disrupt the continuous progress of R&D activities [3, 4]. Banking fintech has expanded the sources of credit information and transformed the way commercial banks identify and serve asset-light enterprises [5, 6]. Examining how banking fintech affects the sustained innovation of specialized, refined, distinctive, and innovative enterprises is therefore important for improving technology-oriented credit services and supporting breakthroughs in key technologies.

Fintech and corporate innovation have received considerable attention in academic research. From a regional perspective, some scholars have examined how digital finance affects corporate financing, regional technological innovation, and total factor productivity. They argue that institutional quality, human capital, and industrial structure can modify its innovative effects [7-9]. Other scholars have turned to commercial banks, finding that the application of technology within banks affects liquidity creation, corporate access to loans, credit tenors, and financing efficiency [5, 10, 11, 6]. With growing research attention to "specialized, refined, distinctive, and innovative" (SED) enterprises, studies have begun to consider whether these firms can maintain innovation activities over the long term. Research indicates that digital finance can enhance the level of sustained innovation among SPEC enterprises, while technology-focused branches help deepen key digital technologies and promote entry into new technology fields [1, 12, 2].

Existing research has examined the relationship between fintech and corporate innovation through regional digital finance, the application of banking technology, and fintech organizations. These studies provide an important foundation for understanding financial support for specialized, refined, distinctive, and innovative enterprises. Regional digital finance, platform lending, and banking fintech differ, however, in their technological entities, funding sources, and risk-bearing mechanisms, and some studies leave the boundaries between these areas unclear [7, 13, 5]. Studies of corporate financing have mainly examined loan balances, the proportion of long-term loans, and average cost of debt. Less attention has been paid to how loan terms, interest rates, collateral, guarantees, and credit limits relate to one another [10, 11]. Relatively few studies directly use samples of "Specialized, Refined, Unique, and New" enterprises, and a systematic synthesis of the relationship between the application of internal banking technologies and sustained innovation is still lacking [1, 12, 2]. This paper therefore distinguishes among different fintech actors and reviews findings on the relationship between bank fintech and the continuous innovation of "Specialized, Refined, Unique, and New" enterprises. The review focuses on research conclusions and applicable conditions regarding credit maturity and risk pricing, aiming to clarify the connections within the existing literature and provide a reference for future research.

2. Definition of core concepts

2.1. The essence and models of fintech in banking

Banking fintech refers to the financial service capabilities developed by commercial banks through the use of digital technologies—such as big data, cloud computing, artificial intelligence, and blockchain—to transform customer identification, credit assessment, credit approval, risk pricing, and post-loan management [5, 14]. Relevant studies primarily use indicators such as investment in technology funding and personnel, fintech patents, annual report text, bank-tech collaborations, and the establishment of technology-focused branches to measure fintech adoption [15, 16, 12]. Investments in technology reflect the digital resources allocated by banks; fintech patents focus on technological reserves; annual report texts reflect banks' strategic focus on related businesses; and bank-tech collaborations and the establishment of technology-focused branches reflect the degree of

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integration between technology and organizational structures [15, 16, 12]. Indicators correspond to different business processes, and time lags may occur in resource allocation, technological reserves, and actual credit application even within the same bank. Differences in measurement criteria can therefore influence research conclusions [15, 14]. Given the information-producing and supervisory functions of commercial banks, technology must ultimately demonstrate its value in credit decision-making and risk management [17]. The main approaches through which commercial banks adopt fintech are in-house development, bank-fintech collaboration, and specialized operations [16, 14, 12]. By drawing on their capital, talent, and customer data to build systems in-house, large banks can retain control over model development and data usage. System development and business transformation, however, take a relatively long time [14]. Collaboration with technology firms allows regional banks to acquire algorithms, platforms, and scenario capabilities quickly, although the effectiveness of these applications depends on how data interfaces, model interpretation, and risk liability are arranged [16].

In terms of measurement, research on banking fintech has begun to link the application of banking technology to actual corporate lending [10, 6]. One study measured technology adoption using 123 keywords—including artificial intelligence, blockchain, cloud computing, big data, digitalization, and mobile technology—drawn from bank annual reports, and compiled 38,772 banking fintech patents to measure technological innovation; the authors then weighted the bank indices according to each lending bank's share of total corporate loans and matched them to the firm level [10]. This indicator simultaneously incorporates technology adoption, technological innovation, and actual bank-enterprise relationships [10]. Another study integrated corporate and bank digitalization into a single framework and found that substantive synergy, as measured by inventive digital patents, significantly increased corporate loans, whereas superficial, low-level synchronization did not produce the same effect [6]. The overall technological level of banks and the degree of digital alignment between banks and firms reflect technology supply and technology use, respectively, and the implications of fintech associated with these two concepts differ [10, 6].

Specialized operations are also reflected in organizational and product arrangements. Technology-focused branches operate based on dedicated systems, specialized talent, targeted performance evaluations, specialized risk control, exclusive support, and direct communication channels, and they evaluate technology flows based on patent quality, technological maturity, R&D teams, and the ability to commercialize research outcomes [12]. Intellectual property pledge loans, R&D loans, talent loans, and science and technology innovation credit loans utilize intangible assets, R&D investments, and talent information, respectively, as the basis for credit approval, while medium- to long-term loans and risk compensation are designed for projects with long cycles and high risks [2].

2.2. The essence and characteristics of continuous innovation in "Specialized, Refined, Unique, and New" enterprises

For "Specialized, Refined, Distinctive, and Innovative" (SRDI) enterprises, continuous innovation involves consistently engaging in R&D investment, technological experimentation, knowledge accumulation, and the commercialization of research outcomes over an extended period [1]. The emphasis in continuous innovation is on whether knowledge from earlier R&D can be incorporated into subsequent technological iterations and whether changes in financing and personnel turnover interrupt R&D [1, 18]. Higher R&D investment in a single year or patent applications concentrated in a specific period capture only current innovation activities. The continuity of a firm's

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technological accumulation is better reflected in continuous R&D investment, sustained patent output, and the absence of innovation disruptions [1].

Empirical measures of sustained innovation track how inputs and outputs accumulate over time. Using a sample of national-level "Specialized, Refined, Distinctive, and Innovative" ("Little Giant") enterprises from 2011 to 2022, one study measured sustained innovation inputs by combining current and prior-period R&D expenditures and sustained innovation outputs by aggregating current and prior-period invention patent counts. This approach prevents high values in a single year from masking fluctuations in R&D activity across different periods [1]. In research on key digital technologies, invention patents, forward citations, and the proportion of invention patents are used to measure the quantity and quality of innovation, with a distinction between the refinement of existing technologies and the first entry into new fields [2]. The first type of measure highlights intertemporal continuity, while the second focuses on technological achievements; sustained innovation therefore encompasses time, quality, and direction [1, 2].

Specialized, Refined, Unique, and Innovative (SRUI) enterprises generally concentrate on a few niche technologies over the long term. Equipment parameters, process expertise, R&D personnel knowledge, and customer feedback must be accumulated gradually over multiple rounds of experimentation [1, 2]. Strong path dependence characterizes the technological accumulation of "Specialized, Refined, Unique, and Innovative" enterprises. External financing shocks can affect the survival of innovative firms and the mobility of inventors, while early-stage financing influences prototype development, patent formation, and subsequent financing [18, 19]. In "Specialized, Refined, Unique, and New" enterprises, key technological innovations involve both further deepening existing technological fields and entering previously unexplored technological categories. These correspond, respectively, to the intensive margins of technological accumulation and the expansion of capability boundaries [20, 2].

3. The multidimensional impact of banking fintech on the continuous innovation of Specialized, Refined, Distinctive, and Innovative enterprises

3.1. R&D expenditures and their stability

R&D activities are characterized by upfront investments, delayed returns, and uncertain outcomes; R&D expenditures by firms facing tight financing constraints are more sensitive to cash flow and the supply of external capital [4]. A study of Chinese industrial firms found that competition in the banking sector can enhance firm innovation by alleviating financing constraints [21]. A study of a sample of specialized, refined, distinctive, and innovative enterprises found that digital finance can increase sustained innovation investment, which is composed of both current and prior R&D expenditures [1].

Supply chain finance enabled by digital finance promotes innovation investment more effectively than traditional supply chain finance, with the quality of supply chain relationships serving as a key channel [22]. Price competition among banks can alleviate overall financing constraints for enterprises by lowering loan costs and improving credit availability, while also increasing the supply of credit for R&D projects by raising risk tolerance; these effects are more pronounced following the deregulation of interest rates and among private enterprises [23]. Existing research on specialized, refined, distinctive, and innovative enterprises has found that digital finance primarily enhances sustained innovation capabilities by alleviating factor mismatches, promoting value co-creation, and strengthening innovation collaboration [1]. Specifically, the factor mismatch channel involves access to capital and talent; the value co-creation channel relies on consumption, payments, and market

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feedback to identify niche demands; and the innovation collaboration channel leverages digital platforms to connect upstream and downstream enterprises, universities, and research institutes [1]. The impact of regional digital finance on sustained innovation also encompasses changes in market information and innovation networks, with its scope extending beyond adjustments to commercial bank loan contracts [1]. Research on supply chain relationships and bank pricing primarily explains changes in annual R&D expenditures; however, there remains a lack of direct evidence regarding whether firms can sustain R&D expenditures across time periods [22, 23].

In terms of investment composition, following the establishment of technology-focused branches, "Specialized, Refined, Distinctive, and Innovative" (SRDI) enterprises increased their investment in software, information resources, and related hardware, while also expanding the recruitment and utilization of digital talent [2]. Enterprises with higher levels of pre-capitalized R&D investment received more significant support in the form of credit loans, indicating that R&D information has already been incorporated into the allocation process of certain specialized credit products [2]. A study based on commercial bank fintech patents from 2010 to 2018 found that technological progress in the banking sector primarily led to increased credit loans for growth-oriented enterprises and the expansion of positions in production, management, finance, and sales; changes in the number of R&D personnel, technical staff, and employees with master's degrees did not reach a statistically significant level [24]. Increases in lending and corporate scale expansion do not directly indicate sustained innovation; research on "Specialized, Refined, Unique, and New" enterprises still needs to examine intertemporal changes in R&D personnel, R&D expenditures, and patent outcomes [24, 1].

3.2. Innovation disruption and knowledge continuity

Changes in bank credit supply can alter firms' innovation activities, with capital-intensive firms and private R&D firms exhibiting more pronounced responses to bank shocks [25, 26]. When bank-firm relationships are disrupted, the survival rate of innovative firms declines, and the turnover of inventors increases; furthermore, a contraction in financing affects subsequent innovation through R&D teams and organizational knowledge [18]. Digital finance promotes both sustained innovation investment and sustained innovation output among specialized, refined, distinctive, and innovative enterprises [1].

3.3. Innovation in quality and technology

Bank credit shocks can alter the number of patents held by firms, patent citations, and innovation paths [25, 26]. Other studies have found that digital finance is associated with total factor productivity, firms' financial asset allocation, and environmental, social, and governance (ESG) performance [9, 27, 28]. Productivity, use of funds, and governance outcomes reflect firm behavior following improved access to financing; however, as they operate at a different level from intertemporal R&D activities, they cannot directly serve as substitutes for indicators of sustained innovation [9, 27, 28].

Related research has shifted further from patent quantity to patent quality and technological direction: technology-driven branches can increase forward citations of patents for key digital technologies, as well as the number and proportion of invention patents; enterprises with a relevant technological foundation primarily demonstrate continued deepening in their existing technological fields, while those previously lacking relevant patents show entry into new technology categories [2]. The Patent Citation ACD Index, constructed based on the complex network of global patent

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citations, indicates that fintech primarily generates cross-sectoral effects by entering international patent classification categories previously unexplored by enterprises, while the deepening effect in existing high-frequency technology fields has not reached a significant level; digital patents generated by non-digital enterprises exhibit a higher degree of breakthrough innovation [20]. Research on green innovation distinguishes between green invention patents and green utility model patents based on the World Intellectual Property Organization's Green List. Fintech has a stronger promotional effect on the former, with the related impact concentrated in regions with stricter environmental regulations, a higher concentration of financial institutions, highly polluting industries, and firms facing tighter financing constraints [29].

4. Research on the relationship between loan tenure and risk pricing

Incomplete information can lead to credit rationing for some firms with sound projects, and higher interest rates may exacerbate adverse selection and moral hazard [30]. Commercial banks reduce financing frictions through information production and monitoring [17], while digital footprints and alternative data provide new sources of information for identifying firms lacking collateral [31, 32]. Existing research has primarily examined changes in loan contracts following improvements in information from the perspectives of term structure and risk pricing [10, 33].

4.1. Research on credit maturity

Corporate R&D typically spans multiple phases, from prototype development to commercialization. Financing constraints can affect corporate R&D investment, while early-stage funding influences prototype development, patent formation, and subsequent financing [4, 19]. Relationship-based lending relies on long-term interactions to accumulate soft information about a firm, thereby increasing credit limits for small businesses and reducing information frictions [34, 33]. A deterioration in banking relationships reduces the survival rate of innovative firms and increases the turnover of inventors, indicating that stable bank-firm relationships are crucial for the continuity of R&D teams and organizational knowledge [18].

While existing research has measured firms' maturity structures using the proportion of long-term loans, there has been relatively little examination of credit commitments, repayment schedules, and loan renewal arrangements [10]. Data-driven loans are more sensitive to changes in transaction and network scores and are relatively less dependent on the value of real estate collateral [35]. Firm-level studies have found that bank fintech can extend credit maturities, with more pronounced improvements in maturity for firms with high R&D intensity, asset-light firms, and private enterprises [10]. Research on fintech branches provides evidence on the maturity of "specialized, refined, distinctive, and innovative" enterprises. The establishment of technology-focused branches significantly increases the scale of firms' long-term borrowings and the proportion of long-term borrowings in total loans; the innovation-promoting effect is more pronounced among firms that previously relied heavily on "short-term debt for long-term use" [2]. Another study found that technology-focused branches increased total borrowings and long-term borrowings, while their impact on short-term borrowings was not statistically significant; only firms with high growth in long-term borrowings experienced a significant increase in key digital technology innovation [12]. Bank fintech also extends corporate loan maturities by intensifying interbank competition, enhancing liquidity creation, and alleviating information asymmetry between banks and enterprises [10]. The extension of loan maturities did not significantly increase corporate operational risk or the level of financialization; while bank fintech generally promotes new-quality productive forces in

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enterprises, the mediating role of maturity extension has not been significantly supported [10]. Existing studies at the bank level have examined the effects of technological pathways on operational efficiency, the impact of digitalization on liquidity creation, and the influence of liability conditions on the transmission of credit to small and micro enterprises, but have not yet incorporated these factors and corporate loan maturities into a single analysis [14, 5, 36].

4.2. Research on risk pricing

The impact of fintech on risk pricing is primarily reflected in changes to the foundation of bank credit assessments. Traditional credit assessments rely primarily on financial statements, credit histories, and tangible collateral, with asset-light enterprises being more subject to collateral constraints [35]. Digital footprints and alternative data provide informational value that complements traditional credit reporting, enhancing credit scoring and default prediction capabilities [31, 32]; data-driven loans are less sensitive to the value of real estate collateral and respond more markedly to changes in transaction and network scores [35]. Research on domestic technology-focused branch banks incorporates patent quality, R&D teams, product diversity, and technology commercialization capabilities into technology flow assessments, providing a practical basis for the innovation capabilities of specialized, refined, distinctive, and innovative enterprises to be factored into bank credit decisions [12].

Research on digital collaboration between banks and enterprises further distinguishes between pre-loan information collaboration and post-loan governance collaboration. Once an enterprise's operational systems are aligned with bank data standards, banks can make better use of the enterprise's soft information, and the earnings forecasts made by joint analysts become more accurate, thereby improving the pre-loan information environment [6]. Once corporate financial shared services, direct bank-enterprise connectivity, and cash management systems are integrated, banks can continuously monitor loan usage and cash flow. Digital collaboration between banks and enterprises weakens the positive relationship between corporate debt and risk-taking and reduces the tendency to substitute assets after borrowing [6]. Digital collaboration between banks and enterprises also increases actual lending and optimizes the overall credit structure; the collaborative effects are stronger at a moderate level of digitalization than when both parties' digitalization processes are slow [6]. Whether banking technology can improve risk assessment also depends on the degree of integration between corporate data systems and banking business processes [6].

Research on the Technology Branch also provides additional evidence on risk pricing based on loan types and collateral arrangements. Following the establishment of the Technology Branch, both pledged loans and unsecured loans to enterprises increased significantly; enterprises with higher ex ante intangible assets received more pledged financing, while those with higher capitalized R&D expenditures received stronger unsecured support [2]. The Technology Branch also reduced enterprises' guarantee fees, and growth in long-term borrowing was primarily observed among enterprises with a higher frequency of guarantees and larger guarantee amounts; the effect of increased long-term lending was concentrated among firms with high patent citation rates and high-quality technology [12]. Pledges, unsecured loans, guarantees, and technology evaluations reflect different contractual terms, and average borrowing costs cannot adequately account for these differences [2, 12].

Risk-sharing arrangements are also a key component of how technology-focused branches adjust risk pricing. These branches enable the government, banks, guarantee institutions, and insurance companies to jointly bear innovation risks, and incorporate metrics such as the outstanding balance of technology loans, the coverage rate of technology enterprises, and the volume of intellectual

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property-backed loans into their performance evaluations; the tolerance for non-performing loans among small and micro technology enterprises may be moderately increased compared to general loans [12]. Such mechanisms reduce the extent to which banks bear the losses from innovation failures on their own. However, existing research lacks transaction-by-transaction analysis of the relationship between risk compensation ratios, actual loss sharing, and loan interest rates [12].

Studies of loan contracts typically examine banks' risk pricing through the lens of interest rates, collateral, guarantees, credit limits, and restrictive clauses [33]. There is now relatively concrete evidence regarding the impact of banks' internal fintech capabilities on leverage and loan structure. For every 1% increase in a bank's fintech level, the leverage ratio of state-owned enterprises decreases by approximately 1.04%, while that of private enterprises increases by approximately 1.06%; the share of secured loans decreases, while that of unsecured loans increases, indicating that banks' information screening and risk control methods alter the credit structures obtained by enterprises under different ownership structures [37]. This effect is more pronounced among firms that receive less market attention but have higher-quality information disclosure, as well as in regions with a higher level of external fintech development [37]. Other studies using loan-level data have found that bank fintech can improve the financing efficiency of real economy enterprises, with greater improvements observed among non-state-owned, small and medium-sized, and highly digitized enterprises [11].

The literature on non-bank fintech provides relatively clear measures of pricing. Studies that use interest expenses as a percentage of the sum of short-term and long-term borrowings to measure borrowing costs have found that for every 10% increase in the level of regional non-bank fintech development, the borrowing costs of listed companies decrease by an average of 1.6 percentage points, with a greater decline observed in regions with stronger banking competition; commercial banks' non-performing loan ratios and operating expenses also decrease accordingly [13]. This conclusion encompasses both competitive pressure and information spillovers, and its technological focus and research subjects differ from those of fintech within the banking sector [13, 5].

Fintech influences green innovation through credit allocation and post-loan monitoring, and the operational and risk effects of banks' investments in technology also exhibit time lags [29, 15]. Existing literature has paid little attention to how order fulfillment, R&D expenditures, and capital flows trigger adjustments to credit limits, interest rates, or guarantees, and there is a lack of comparisons between automated decision-making, manual review, and phased grace periods.

Risk pricing is also influenced by bank competition and risk-sharing mechanisms. Some scholars have found that price competition among banks can alleviate firms' financing constraints and promote R&D investment [23]; other studies have pointed out that the impact of bank competition on innovation actors and innovation outcomes varies with market structure [38]. There is an inverted U-shaped relationship between the market structure of the banking sector and the supply of credit to small and micro enterprises, and the development of fintech increases the optimal level of competition that is conducive to the supply of credit to small and micro enterprises [39]. Banking reforms and changes in credit supply have a significant impact on corporate innovation [40, 25], while differentiated performance evaluations, risk compensation, and specialized assessments for technology-focused branches help banks bear the R&D risks associated with long-cycle technology projects [12, 2].

5. Research heterogeneity in the impact of fintech on banks

Existing research indicates that the role of fintech in banking varies depending on firm characteristics, bank type, regional conditions, and the stage of innovation.

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5.1. Differences in corporate characteristics

A firm's existing financing constraints influence the extent to which bank fintech is effective. Bank fintech has a more pronounced effect on improving credit terms for private, asset-light, and R&D-intensive firms [10]; this finding is consistent with international evidence showing that small firms are more susceptible to financing and institutional barriers [3, 41]. A study based on 92,414 individual loan records from listed manufacturing firms between 2013 and 2023 found that the role of banking fintech in enhancing financing efficiency is more pronounced among non-state-owned enterprises, small and medium-sized enterprises, and highly digitized firms [11]. Research on digital synergy between banks and enterprises has found that substantive synergy is more effective than strategic synergy; when the bank-enterprise relationship is weaker or the lending bank relies more heavily on soft information, synergy has a greater positive impact on credit access [6].

5.2. Differences in bank types and technological approaches

Bank size and technological approaches have an interactive effect on the outcomes of fintech adoption. Large banks, with their extensive customer data, robust computing power, and low cost of funds, can spread the costs of system development across a large scale of operations; while fintech generally reduces bank risk, the risk reduction is weaker for small and medium-sized banks, and when large banks expand their lending to small and micro enterprises, they may also attract the high-quality customers previously served by small and medium-sized banks [42]. Regional banks rely heavily on local customer relationships and soft information; long-term interactions between banks and enterprises help improve credit conditions for small businesses [34, 33]. Strategic partnerships between banks and technology firms can enhance innovation capabilities, operational performance, and credit risk management; however, the impact of in-house R&D and collaborative innovation on operational efficiency varies across banks of different sizes [16, 14]. External fintech collaborations play a stronger role in promoting credit structure adjustments for regional banks than for national banks [43]. In terms of loan composition, external technology collaborations can increase banks' total loans and unsecured loans, significantly boost personal loans, while their impact on the growth of secured loans and corporate loans does not reach statistical significance; Adjustments to the credit structure are primarily concentrated in regional banks [43]. Fintech collaboration also improves the net interest margin; after the application of technology expands coverage of long-tail customers, banks can still maintain lending business profits through risk premiums [43].

5.3. Differences in the regional institutional environment

There is still no consensus on the impact of regional institutional conditions on the innovation effects of fintech. The regional innovation effects of digital finance are constrained by institutional quality, human capital, and industrial structure [7, 8], and the role of banking competition in promoting corporate innovation is more pronounced in regions with higher levels of marketization and the rule of law [21]. The role of banking fintech in extending credit terms is concentrated in regions with well-developed new infrastructure but a poor external governance environment [10]. The long-term marginal effect of digital finance in promoting sustained innovation among specialized, refined, distinctive, and innovative enterprises tends to decline; improvements in the business environment can mitigate this decline, and this effect is more pronounced in central and western regions [1]. The role of banking fintech in promoting green credit is also related to data

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infrastructure, talent pools, and bank competitiveness [44]. Due to differences in the research subjects and outcome variables across existing studies, it remains difficult to make a unified comparison [7, 21, 10].

5.4. Differences in innovation stages and types of innovation

The role of innovative financing varies across different stages of R&D. Early-stage funding plays a significant role in promoting prototype development, patent acquisition, revenue generation, and follow-on financing for firms facing tight financing constraints [19], while technology-focused branches have a stronger effect on promoting key digital technologies for firms in the growth stage, those with a small market share, and those with a high quality of existing innovation [12]. Another study on "Specialized, Refined, Unique, and New" (SRUN) enterprises found that firms with higher technological maturity and a broader product portfolio benefited more significantly, as evidenced by both the deepening of existing technologies and the introduction of new technologies [2]. Research on breakthrough innovation examines the expansion of firms' technological boundaries through cross-domain technology search, while research on green innovation distinguishes between green invention patents and green utility model patents [20, 29]. Relevant findings also address the timing of financing, firm growth stages, and types of innovation; however, existing evidence is insufficient to determine the relative strength of the role played by banking fintech at different stages of the R&D chain.

The role of technology-focused branches will also evolve in tandem with external innovation resources. When there are a large number of national key laboratories in the vicinity of a company, these branches play a stronger role in promoting innovation in key digital technologies, as specialized financial capital complements local knowledge, talent, and research equipment [12]. Long-term lending decisions by technology-focused branches also convey signals about the quality of a company's technology to the government; technology firms that secure loans receive more innovation subsidies, and financial support is further extended to bridge the gap between credit and fiscal funds [12].

6. Research gaps and future directions

6.1. A shift from measuring at the bank level to measuring bank-enterprise relationships

Existing studies have measured fintech using bank investment in technology, bank-tech collaboration, and the establishment of technology-focused branches, making it difficult to determine whether a specific technology has been incorporated into the credit decision-making process for "specialized, refined, distinctive, and innovative" enterprises [15, 16, 12]. Future research could match banks' technology deployments with firms' actual loan relationships and credit outcomes to examine the specific applications of fintech in loan origination, contract adjustments, and post-loan management.

Research that directly examines "Specialized, Refined, Unique, and Innovative" enterprises also faces differences in data granularity. Digital finance studies that match national-level "Little Giant" enterprises in this category using city indices can observe firms' sustained inputs and outputs but cannot identify the specific lending banks [1]; Studies on technology-focused bank branches can identify the establishment of specialized organizational units and key digital technology innovations but rarely address general-purpose technological systems within banks [12, 2]. Research on bank fintech and bank-enterprise digital collaboration has linked actual loan relationships, but the samples

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primarily come from general listed companies [10, 6, 11]. The aforementioned studies have not yet established a continuous link between bank technology, corporate loans, and sustained innovation outcomes [1, 10, 12].

Existing studies have used samples of national-level "Little Giant" enterprises designated under the Specialized, Refined, Distinctive, and Innovative (SRDI) program and listed SRDI enterprises from 2011 to 2022, respectively, resulting in differences in sample scope [1, 2]. Future research should distinguish between the timing and level of designation and control for firms' innovation foundations prior to designation.

6.2. Strengthening the documentation and analysis of loan contracts

Corporate financial statements reflect the aggregate debt resulting from multiple loans, making it difficult to identify the specific technological applications and contractual changes of individual banks [10, 11]. Research on bank-enterprise matching still needs to address the issue of two-way selection: enterprises with stronger innovation capabilities may choose banks with higher levels of digitalization, while banks may prioritize deploying systems in regions where technology companies are concentrated [10, 6]. The time lags resulting from bank-tech firm collaborations and the phased establishment of technology-focused branches provide opportunities to identify the relationship between technology adoption and changes in credit [43, 16, 12]. If additional data on bank-firm matching can be obtained, loan contracts obtained by the same firm from different banks can be used to compare differences in banks' technological capabilities; studies on banking reforms and credit supply shocks also provide a reference for identifying causal relationships between changes in financial supply and firm innovation.

6.3. Establishing a dynamic evaluation system for continuous innovation

Existing studies have characterized innovation in "Specialized, Refined, Unique, and New" (SRUN) enterprises from the perspectives of innovation continuity, output quality, and technological direction [1, 20, 2]. However, these different dimensions have not yet been fully integrated within a single study. Given the time lags associated with banks' technology investments and the role of innovation financing [15, 19], future research should extend the observation period to examine how R&D continuity, the quality of outcomes, and the accumulation of key technologies evolve in response to changes in financing.

Existing research has reached inconsistent conclusions regarding the risks of credit expansion. Fintech pilot programs may induce firms to borrow excessively, while bank-led fintech initiatives may also promote the return of capital to the real economy by curbing financialization [45, 27]. External fintech literature also indicates that platform entry alters funding sources, bank competition, and financing coverage for constrained firms [46-50]. Future research should distinguish between sources of funding and risk-bearers, while also examining long-term innovation returns and debt risks.

7. Conclusion

This paper reviews the literature on fintech in the banking sector and the sustained innovation of "specialized, refined, distinctive, and innovative" (SRDI) enterprises, while distinguishing between regional digital finance, platform-based fintech, and in-house bank fintech. Research indicates that banks can use technology to supplement traditional financial and collateral information, improve

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firms' access to credit, and alter loan maturities and credit structures. Studies of fintech in the banking sector suggest that it can extend the duration of corporate loans. Research on technology-oriented branches also reports a correlation between increased long-term borrowing and improvements in key digital technology innovations. Changes in risk pricing concern borrowing costs as well as the information used for credit assessment, collateral and guarantee requirements, and innovative risk-sharing arrangements. Assessing fintech's role in supporting corporate innovation therefore requires a closer examination of specific loan arrangements alongside the scale of financing, particularly whether the provision of funds is adapted to R&D cycles and technological risks.

Studies of SRDI firms find that digital finance helps maintain R&D investment and innovation output, while technology-oriented branches promote the deepening of existing technologies and expansion into new technological fields. Regional digital finance, however, also works through changes in market information and innovation networks, and technology-oriented branches incorporate specialized evaluation and organizational arrangements. Their impacts cannot therefore be treated as equivalent to the effects of technology adoption within banks. Across the existing literature, improvements in financing and innovation outcomes vary with firm characteristics, bank types, regional conditions, and the stage of innovation. Higher loan amounts, longer loan terms, or more patents within a single period do not, on their own, establish an improvement in sustained innovation capacity. The literature thus supports the view that bank fintech can improve financing conditions for innovation. Further examination is still needed to determine whether specific adjustments to loan contracts can sustain long-term R&D and technological accumulation. Future research should combine data on bank-firm relationships with loan-level information and examine R&D continuity, innovation quality, and debt risk to assess the long-term impacts of changes in financing conditions.

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