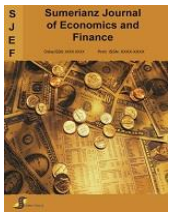
Sumerianz Journal of Economics and Finance, 2024, Vol. 7, No. 2, pp. 11-20
ISSN(e): 2617-6947, ISSN(p): 2617-7641
Website: https://www.sumerianz.com
DOI: https://doi.org/10.47752/sjef.72.11.20



Original Article Open Access

Digital Financial Development and Corporate Innovation

LI JIAYING
Universiti Tun Abdul Razak University (UNIRAZAK)
Email: li.jiaying@ur.unirazak.edu.my

XU RUYUE
Universiti Tun Abdul Razak (UNIRAZAK)
Email: xu.ruyue@ur.unirazak.edu.my

Yin Fah, Benjamin Chan*
Universiti Tun Abdul Razak University (UNIRAZAK)
Email: benjamin_chan@unirazak.edu.my

Article History

Received: 3 April, 2024

Revised: 10 May, 2024

Accepted: 2 June, 2024

Published: 5 June, 2024

How to Cite

LI JIAYING, XU RUYUE Yin Fah and Benjamin Chan, (2024). Digital Financial Development and Corporate Innovation. *Sumerianz Journal of Economics and Finance*, 7(2): 11-21.

Abstract

Over the last 10 years, digital banking has grown fast thanks to digital technologies such as big data, cloud computing, and blockchain. Its broad reach, low cost, and low threshold have the potential to boost innovation. Based on this backdrop, this paper investigates the impact and mechanism of digital financing on corporate innovation using data from China's A-share listed businesses from 2012 to 2022. At the same time, the institutional environment is employed as a regulatory variable to further investigate the link between digital finance and business innovation to encourage Digital finance is better for the actual economy.

Keywords: Digital finance; Corporate innovation;, institutional environment.

1. Introduction

As early as the 1990s, scholar Tapscott (1996) first proposed the concept of digital finance when discussing the new economic system that came randomly after the rapid spread of information and communication technologies in the United States, pointing out that digital finance is changing the way products and services are used. The production and operation model also promotes changes in the competition and activity patterns of enterprises . From the perspective of transforming e-commerce, Neal (1999) believes that digital finance means realizing the integration of Internet terminal equipment and digital information technology based on the basic architecture built by the Internet. From a general perspective, James and Paul (2001) expressed their own view: digital finance means a sustainable and equitable technological revolution. In recent years, with the further development of digital finance, scholars have paid more attention to the value generated in its definition. Turcan *et al.* (2014), believe that the key point of digital finance is that its development has brought new human social activities and products, especially digital information as the core factor of production. It has changed the way people produce and live and created new value.

Throughout the development of the fourth industrial revolution, "digital finance" has become a hot spot in economic activities and social life. Digital finance, represented by new technologies such as the Internet, Internet of Things, big data, and artificial intelligence, is constantly developing. Bring new vitality and impetus to the economy. Digital finance will obviously become the future development direction of the world, and every country or region is being affected by the development wave of digital finance. Therefore, many countries in the world have launched corresponding plans to ensure the development of digital finance, such as Canada, India, and the United States. As one of the major economic powers, China also pays great attention to the development of digital finance and has

achieved remarkable development results. Therefore, the core topic discussed in this article is the impact of global digital financial development on the innovation of Chinese listed companies and the underlying mechanisms.

2. Literature Review

Existing research has a relatively consistent view on the basic issue of digital finance's impact on corporate innovation investment. With a variety of data and research methods adopted, the analysis results tend to believe that digital finance has an stimulating effect on corporate innovation investment. Tang (2020), found through a study of A-share listed companies from 2011 to 2017 that the development of digital finance can have a positive driving effect on corporate innovation investment, and the driving effect is stronger in areas with relatively poor financial development levels. (Wang, 2021) used survey evidence from China's private enterprises to demonstrate that digital inclusive finance has a significant positive role in promoting corporate innovation of private enterprises. By weakening the "rent-seeking" intentions of private enterprises and reducing unnecessary expenditures, enterprises will More of the given resources are allocated to innovative research and development.

Li (2021), analyzed the mechanism by which digital financial development affects corporate innovation based on the perspective of equity pledge, and proposed that the development of digital finance can reduce the equity pledge rate of controlling shareholders, reduce agency conflicts between controlling shareholders and external small and medium-sized shareholders, and promote corporate innovation. Xie (2021), used an industry-time two-way fixed effects model to empirically test that the development of digital finance significantly promotes corporate innovation in NEEQ enterprises. They believe that the development of digital finance can promote the development of e-commerce, promote the upgrading and diversification of consumption structure, and improve The company's sales revenue, thereby improving corporate profitability and promoting corporate innovation.

Differences in institutional environments between regions will cause digital financial development to show varying degrees of support for corporate innovation (Zhong, 2017). First of all, in areas with relatively complete institutional environments, developed financial markets provide a good market environment for the development of digital finance (Yu, 2020). Abundant financial resources are also conducive to the development of digital finance, helping to leverage the technical advantages of digital finance and maximally alleviating corporate financing constraints. This also improves the possibility of companies obtaining external credit funds to a certain extent (Nie, 2021), providing opportunities for corporate innovation.

3. Research Hypotheses

3.1. Digital financial Development and Corporate Innovation

Digital finance is a new financial industry developed based on modern digital technology. The application of digital technology allows financial services to break the shackles of "credit" and traditional business models, bringing great vitality to the current financial development, making Finance can continue to promote the development of the real economy. First of all, digital finance can apply the new generation of big data technology to the classification and processing of information and data, and deeply explore the value contained in it. It can also effectively balance the actual operational information owned by all parties, greatly Improve the efficiency of financial intermediary information collection and processing. Secondly, the development of digital finance can efficiently, conveniently and accurately solve the personalized financial needs of different types of users, effectively correct the "credit mismatch" problem that exists in traditional finance (Shangguan and Li, 2023), and also expand the scope of financial services. The scale of the deposit and loan business of the industry has become closer, thereby making the connection between the financial industry and the real economy and society more closely, and thus allowing the "financial blood" to provide greater assistance to the real economic operation.

For enterprises, the R&D cycle of corporate innovation activities is very long, the risk of R&D failure is high, and the consumption of R&D is also high. Therefore, when enterprises carry out corporate innovation, they will definitely increase the company's operating costs, financial burdens and risk levels, which will cause companies to encounter many obstacles when carrying out corporate innovation. Digital finance based on big data technology can improve the quality of information disclosure based on "data" (Yu *et al.*, 2022), efficiently identify the company's operations and development, and help eliminate the distortion of rent-seeking on corporate innovation. Incentive (Huang *et al.*, 2023). Therefore, from a practical point of view, by improving the level of corporate risk-taking and motivating companies to be more actively involved in innovation activities (Chen *et al.*, 2023), it effectively alleviates the concerns of companies when conducting innovation, and is an important factor in promoting corporate innovation, especially high-quality companies.

An important intermediary of innovation (Li *et al.*, 2022). Digital finance can improve corporate capital allocation through three paths: easing financing constraints, correcting resource misallocation, and stimulating consumer demand (Wang *et al.*, 2023), and improving corporate capital allocation through market mechanisms and government regulation (Li and Liu, 2022). Both quantity and quality (Zhang, 2023) can significantly improve the innovation capabilities of enterprises (Wang *et al.*, 2023). The development of digital finance can, on the one hand, help ease corporate financing constraints and enable companies to obtain more innovative market resources; on the other hand, it can promote companies to increase R&D investment, thereby stimulating corporate innovation as a whole (Shen and Tan, 2022) .

Based on the above analysis, this article proposes hypothesis 1:

H1: Digital finance can promote corporate innovation.

3.2. The Impact of Institutional Environment on the Relationship between Executive Pay Gap and Corporate Innovation

In the article, corporate innovation is used as the explained variable and digital financial development is used as the explanatory variable. The direction of the correlation between the two may be regulated by the regional institutional environment, thus causing the process or results of digital financial development to affect corporate innovation to change.

In areas with a more favorable institutional environment , the level of enterprise innovation is higher (Xu, 2018). A good institutional environment can not only enable enterprises to clarify their innovation direction and reduce their information costs, but also provide sufficient legal support for their innovation results. Protection (Gu, 2020). Building an economic system dominated by a market economy is an inevitable choice for China to achieve modernization. Although China has achieved coordinated development among various regions, it is limited by the different characteristics and natural endowments between regions, resulting in uneven development in the institutional environment. As an external market factor, the institutional environment will have an important impact on the internal institutional arrangements and governance level of the enterprise. Therefore, this article analyzes the macro factor of institutional environment and studies its moderating effect on the relationship between digital financial development and corporate innovation.

First, a poor institutional environment will inhibit the promotion effect of digital finance on corporate innovation. In an institutional environment with a low marketization process, due to large market frictions, it is difficult for corporate management to effectively convey true repayment ability information and credit status information. In this case, financial institutions' business development costs remain high, and it is difficult to provide guidance to enterprises. Provide effective financial support for innovation. In addition, in an institutional environment with more government intervention, the government has more say in resource allocation, and the market's ability to spontaneously allocate resources is more restricted. Enterprises are subject to a higher degree of resource misallocation and find it difficult to allocate sufficient resources. Invest in R&D and innovation. At the same time, in areas where the development of the non-state-owned economy is relatively poor, the survival and development of enterprises rely on the inherent relationship network of state-owned enterprises to a relatively high degree, and the growth and development of enterprises are more affected by the background relationships between enterprises than in areas where the development of the non-state-owned economy is relatively good. is larger, and is less affected by product market competition than in areas with relatively good non-state-owned economic development. This will result in the degree of market competition among enterprises in this region remaining at a low level, and there is not enough external competitive pressure to prompt enterprises to carry out new innovations.

Product research and development makes it difficult to increase corporate innovation investment. In addition, in areas with low product market development, technological R&D spillover losses are high, technological achievements are difficult to realize, and future profits are difficult to guarantee. An underdeveloped product market is not conducive to innovative companies safeguarding their rights and interests, making it difficult for R&D companies to effectively protect their own technological progress benefits and innovation output benefits, thereby reducing companies' willingness to invest in innovative R&D.

Secondly, a sound institutional environment is conducive to enhancing the role of digital finance in promoting corporate innovation. A perfect institutional environment means a fairer and more rational market competition atmosphere. This is the basis and guarantee for enterprises' innovation investments to exert their innovative added value effect. It can also ensure that the company obtains the most innovation when carrying out innovative R&D activities. profit. In addition, a good institutional environment can improve the allocation efficiency of innovation factors and ensure the innovation benefits that enterprises can obtain from innovative activities. At this time, the company's willingness and enthusiasm for innovation will increase, and the innovation benefits can reach a level that satisfies all parties (Hong, 2017). In areas with a better institutional environment, the degree of marketization is relatively high, the degree of government intervention is small, the quality of corporate information disclosure is higher, the company's internal management is more rational, the business development costs of financial institutions are also lower, and financial institutions The information asymmetry risk and credit risk faced by creditors are relatively small.

In addition, in areas with higher product market development, compared with areas with lower product market development, spillover losses from technological R&D can be reduced, and high profits generated by technological achievements in the future can also be guaranteed (Wu, 2016). A highly developed product market can help reduce infringement activities, help R&D companies protect the benefits of their own technological progress and innovation output, thereby increasing the region's overall willingness and enthusiasm for innovative R&D investment, and the level of innovation investment of enterprises in the region. will be improved.

Based on enterprise innovation theory, financial development theory and institutional theory, this article proposes hypothesis 2:

Hypothesis 2: The institutional environment will promote the positive correlation between digital financial development and corporate innovation. That is, the better the institutional environment, the higher the promotion effect of digital financial development on corporate innovation..

4. Research Design

4.1. Sample Selection and Data Sources

The study compared data from the Chinese CSMAR database to the World Economic Forum's "Global Information Technology Report," taking into account the continuity and availability of pertinent data. Finally, it

chose and gathered necessary data on China's A-share listed firms between 2012 and 2012, and used This acts as the study sample for creating balanced panel data. This article has performed the following data processing to avoid erroneous impacts on the empirical results: (1) Delete sample firms with a high number of missing major variables; (2) Remove ST, *ST, PT, and other organisations that are not in regular trading condition; and (3) Delete enterprises with severe outliers in the core data. Following data processing and matching, 14,370 samples were retrieved.

4.2. Variable Definition

4.2.1. Interpreted Variable

This article's described variable is corporate innovation. By sifting through the present literature, markers for assessing business innovation may be loosely classified into two groups. First, the natural logarithm of R&D investment and its intensity are employed to assess innovation investment. The second metric is innovation output, which is calculated using the number of patent applications and patent authorizations. This article measures business innovation by adding 1 to the number of patent applications filed by listed corporations before undergoing logarithmic processing. The robustness test is based on the number of patent authorizations and R&D spending.

4.2.2. Explanatory Variables

The explanatory variable in this article is digital finance. This article utilises the Peking University Digital Financial Inclusion Index to assess the state of digital finance development. The index, which is based on a complete assessment of the meaning and features of digital finance, represents the development level of banking, payment, investing, insurance, and other businesses. The digital financial index system has three dimensions: breadth of coverage, depth of usage, and degree of digitalization, as well as 33 particular indicators for measuring the amount of digital finance in various provinces, cities, and counties. The breadth of coverage reflects the scope of digital financial services that are not geographically limited; the depth of usage reflects the actual demand for digital finance based on the total volume and activity of business usage; and the degree of digitization reflects the low-cost and convenient advantages of digital finance. This article picks the province digital financial inclusion index as well as three sub-dimensional data and logarithmically processes them.

4.2.3. Adjustment Variables

This article introduces the regional institutional environment (Index) as a regulating variable in studying the impact of digital finance on corporate innovation. Based on the previous review, the relationship between the government and the market (Rel), the development of the non-state-owned economy (Del), and products in the institutional environment are selected. The three dimensions of market development (Pmd) are used to analyze the impact on corporate innovation. Among them, the 2011-2019 data comes from the China Provincial Marketization Index Database, while the 2020 data is obtained by multiplying the 2019 data by the arithmetic average growth rate from 2011-2019.

The market institutional environment in which enterprises operate is affected by differences in regional economic systems. Therefore, academic circles hold different research viewpoints on the measurement of institutional environment. The measurement methods of the three dimensions of institutional environment in this article come from Wang Xiaolu and Fan Gang. The "China Provincial Marketization Index Report 2020" provides a comprehensive and continuous observation and comparative study of the degree of marketization in each province. The higher the regional institutional environment index, the better the regional institutional development level. A higher regional institutional development level can identify enterprises with development potential and allocate financial resources to them to meet and promote the enterprise's development strategy, thereby improving the level of enterprise innovation.

4.2.4. Control Variables

Enterprise size (size) and asset size are major elements in determining enterprise innovation. The asset-liability ratio (lev) represents the company's capacity to leverage debt, while return on assets (ROA) measures profitability. The enhancement of corporate profitability can help create more profits, improve asset utilization efficiency, and provide financial support for innovative activities. Fixed assets (FA) , fixed assets held by enterprises can be used as credit collateral to provide financing for innovative activities. However, a higher proportion of fixed assets will reduce the efficiency of corporate capital use and is not conducive to innovation investment. Growth (growth) is an intuitive reflection of the operating status of an enterprise .

The better the operating conditions, the more conducive it is to the development of corporate innovation activities. However, high-growth companies have greater capital needs, and the risk of liquidity shortages will inhibit investment in innovative projects with long cycles and risks. Operating cash flow (CF) , operating cash flow reflects the company's profitability and income status, and is an important guarantee for the company's investment and financing activities and operations. Strong operating cash flow is conducive to corporate innovation and sustainable development. Proportion of independent directors (Indd) . As an important part of the corporate governance system, independent directors can participate in corporate business decision-making and governance, thereby affecting the implementation of innovation strategies. Equity concentration (Tops) , equity concentration reflects the internal equity structure of the enterprise and will affect the corporate governance system and management strategies. More concentrated ownership can stimulate corporate innovation willingness by alleviating agency problems, but too concentrated ownership can lead to conflicts of interest between controlling shareholders and small and medium-sized shareholders, thereby inhibiting corporate R&D investment.

Economic development level (GDP): The greater the regional economic development level, the more comprehensive the external environment for firm innovation. This article measures economic development by taking the natural logarithm of regional GDP per capita. Industrial structure (IS) optimisation promotes free circulation and appropriate resource allocation.

Table-1. Variable symbols and definition

Variable type	variable name	symbol	Metrics	
Explained variable	Enterprise innovation	TI	Ln (1+number of patent applications of listed companies)	
Explanatory variables	digital finance	DF	Peking University Digital Financial Inclusion Index	
	breadth of coverage	DFc		
	Use depth	Dfu		
	degree of digitalization	DF		
Moderator	environment system	MI	marketization index	
control variables	Enterprise size	size	ln(total assets)	ln(total assets)
	Assets and liabilities	lev	Total liabilities divided by total assets	
	return on assets	ROA	Net profit / total assets	
	fixed assets	FA	Net fixed assets divided by total assets	
	Growth	growth	(current year's operating income minus the prior year's operating income) divided by the previous year's operating income	
	operating cash flow	CF	Net operational cash flow to total assets	
	Proportion of independent directors	Indd	Number of independent directors divided by the total number of board members	
	ownership concentration	Tops	The greatest shareholder's shareholding ratio is calculated using	
	The level of economic development	GDP	ln (gross regional product per capita)	
	Industrial structure	IS	Secondary Industry Output Value/Regional GDP	

4.3. Model design

The paper investigates how digital financial development affects the innovation of small and medium-sized firms. Among them, the core explained variable in the benchmark model is the enterprise innovation investment variable (IT), and the core explanatory variable is digital financial development (DF). Controls is the relevant control variable added in the model regression, and the industry effect (Ind) and time are fixed. Effect (year).

To verify H1, build the model:

$$IT_{i,t} = \beta_0 + \beta_1 \times DF_{i,t} + \beta_2 \times \sum Controls_t + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (1)$$

To determine if the regional institutional environment (represented by Index) has a moderating effect on digital finance in promoting corporate innovation investment, the regression model is shown in Equation 2. The interaction term between digital finance (DF) and the regional institutional environment (Index) is introduced into the basic model. If the coefficient β2 of the interaction term between digital finance (DF) and regional institutional enviro Digital finance has a lower influence as the environment improves..

To verify H2, build the model:

$$Mediator_{i,t} = \beta_0 + \beta_1 \times DF_{i,t} + \beta_2 \times \sum Controls_t + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (2)$$

5. Empirical Analysis

5.1. Descriptive Statistics

Table 2 depicts the descriptive statistical data for the key factors. The average value of corporate innovation is 3.197, the highest value is 7.296, the minimum value is 0, and the standard deviation is 1.681, showing that there are differences in corporate innovation levels among organizations. The average value of the digital finance index is 5.321, with maximum and minimum values of 3.381 and 6.038, respectively, suggesting that the amount of digital finance development varies across China. The statistical findings of the three sub-dimensional indicators highlight the unequal growth of digital finance throughout China's regions. The data description of enterprise-level control variables reveals a significant disparity in the development level of Chinese firms, including major variances in

enterprise size, profitability, revenue, and so on. Possible explanations include the impact of regional economic development and institutional environment, industrial development. The circumstances differ.

Table-2. Descriptive statistic

Variable	Obs	Mean	Std. Dev.	Min	Max
TI	14370	3.197	1.681	0	7.296
DF	14370	5.321	0.597	3.381	6.038
DFc	14370	5.213	0.661	2.706	5.982
DF	14370	5.348	0.553	3.439	6.102
DF	14370	5.498	0.737	2.816	6.112
size	14370	22.165	1.213	19.658	25.675
lev	14370	0.423	0.207	0.051	0.969
ROA	14370	0.032	0.066	-0.279	0.197
FA	14370	0.238	0.144	0.01	0.642
growth	14370	0.147	0.391	-0.575	2.499
CF	14370	0.044	0.067	-0.157	0.233
Indd	14370	0.374	0.053	0.333	0.571
Tops	14370	32.911	14.01	8.48	71.24
GDP	14370	11.272	0.525	9.928	12.153
IS	14370	43.704	10.826	16.2	66.99

5.2. Correlation Analysis

Table 3 displays the correlation coefficients between the key variables. The correlation coefficients between variables are all less than 0.6, indicating that there is no multicollinearity concern. The correlation coefficients between the primary variables are all over the 1% significance threshold, and the variable selection is more logical. Among these, there is a strong association between the digital inclusive finance index (DF), the breadth of digital inclusive finance coverage (DF-C), and the depth of digital inclusive finance use (DF-U). The major determinant is the extent of digital inclusive finance coverage (DF-C). -C) and the depth of usage of digital financial inclusion (DF-U) are sub-indices of the digital financial inclusion index (DF) and must have a sufficiently consistent connection. This article does a multicollinearity test on the major variables, and the VIF value is less than 5, suggesting that there is no multicollinearity concern.

Table-3. correlation analysis

	TI	DF	size lev	ROA	FA
TI	1.000				
DF	0.321***	1.000			
size	0.527***	0.323***	1.000		
lev	0.177***	0.009	0.398*** 1.000		
ROA	0.121***	- 0.069***	0.091*** - 0.421***	1.000	
FA	- 0.119***	- 0.045***	0.119*** 0.168***	- 0.120***	1.000
growth	0.039***	- 0.061***	0.041*** 0.002	0.239***	- 0.059***
CF	0.102***	0.131***	0.161*** - 0.139***	0.382***	0.202***
Indd	0.002	0.061***	0.020** 0.002	- 0.052***	- 0.020**
Tops	0.052***	- 0.121***	0.173*** 0.010	0.141***	0.039***
GDP	0.235***	0.428***	0.104*** - 0.024***	- 0.005	- 0.155***
IS	- 0.134***	- 0.370***	- 0.109*** 0.005	0.031***	0.177***
		Continuation table 3 Correlation coefficient table			
	growth	CF	Indd Tops	GDP	IS
growth	1.000				
CF	0.009	1.000			
Indd Tops	- 0.019 0.031***	- 0.027** 0.089***	1.000 0.043*** 1.000		
GDP	- 0.003	0.040***	0.038*** - 0.011	1.000	
IS	- 0.001	0.006	- 0.050***	- 0.268***	1.000

			- 0.028***		

Note: ***, ** and * represent significance levels at 1%, 5% and 10% respectively.

5.3. Regression Analysis

This article employs Model 1 to validate Hypothesis 1. The particular regression findings are presented in Table 4. Columns 1 and 2 show the regression findings for digital finance on business innovation. The former does not include control variables. It is clear that digital finance has a considerable beneficial influence on business innovation, both before and after control factors are added. Column (2) demonstrates that for every one unit increase in digital finance, the degree of corporate innovation improves by 0.302 units, supporting hypothesis 1. Digital finance may help to remove information barriers, ease corporate information and financial flows, and infuse money into manufacturing businesses' innovative operations. Simultaneously, financial institutions employ digital tools to improve their data screening, identification, and analysis skills, improve resource allocation efficiency, and increase investment in high-quality industrial innovation projects. As a result, digital finance may encourage corporate innovation in manufacturing businesses.

(3), (4), and (5) show the regression findings for the three sub-dimensional indicators of digital finance on corporate innovation, namely breadth of coverage (DFc), depth of usage (DFu), and degree of digitalization (DFd). The coefficients of coverage breadth and utilization depth are 0.086 and 0.445, respectively, and the significance level test demonstrates that these two can enhance corporate innovation. On the one hand, businesses profit from increased financial service coverage and may get adequate finances for creative operations, resulting in increased innovation output.

On the other hand, using big data, cloud computing, and other technologies, digital finance can provide enterprises with more diverse and precise financial services, such as credit, investment strategy analysis, and credit evaluation, thereby helping to improve enterprises' financing capabilities and innovation enthusiasm. Column (5) shows that the coefficient of digitalization is 0.025 but not significant, indicating that, while the mobility, credit, and convenience provided by digital finance can reduce manufacturing companies' financing costs and assist them in promoting innovative projects, it has not significantly benefited enterprises. The above research demonstrates that the process of digital finance fostering business innovation is accomplished by combining several components. It is vital to enable manufacturing businesses use digital finance in detail to improve their own innovative capabilities.

Table-4. Benchmark regression results of the impact of digital finance on manufacturing enterprise innovation

			TI		
	(1)	(2)	(3)	(4)	(5)
DF	0.564***	0.302***			
	(6.95)	(3.79)			
DFc			0.086*		
			(1.85)		
DF				0.445***	
				(7.29)	
DF					0.025
					(0.45)
size		0.791***	0.791***	0.791***	0.791***
		(70.48)	(70.38)	(70.63)	(70.27)
lev		- 0.409***	- 0.423***	- 0.385***	- 0.434***
		(-5.77)	(-5.96)	(-5.44)	(- 6.13)
ROA		1.818***	1.821***	1.800***	1.825***
		(8.12)	(8.13)	(8.04)	(8.15)
FA		- 0.496***	- 0.493***	- 0.506***	- 0.488***
		(-5.06)	(-5.02)	(-5.18)	(-4.97)
growth		- 0.024	- 0.024	- 0.023	- 0.025
		(-0.75)	(-0.76)	(-0.72)	(-0.78)
CF		0.676***	0.700***	0.634***	0.710***
		(3.36)	(3.48)	(3.16)	(3.53)
Indd		- 0.765***	- 0.764***	- 0.768***	- 0.763***
		(-3.69)	(-3.68)	(-3.71)	(-3.67)
Tops		- 0.0008	- 0.0008	- 0.0008	- 0.0008
		(-0.93)	(-0.89)	(-0.93)	(-0.86)
GDP		0.108***	0.133***	0.072***	0.152***
		(4.02)	(5.13)	(2.74)	(6.38)
IS		0.0005	- 0.0001	0.0007	- 0.0007
		(0.46)	(-0.11)	(0.56)	(-0.57)
_cons	0.195	- 16.670***	- 15.760***	- 17.050***	- 15.630***
	(0.45)	(-35.54)	(-40.20)	(-40.95)	(-31.09)
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes

N	14370	14370	14370	14370	14370
adj. R^2	0.215	0.493	0.493	0.495	0.493

Note: ***, ** and * represent significance levels at 1%, 5% and 10% respectively

5.4. Analysis of Moderating Effects

According to prior research, the regional institutional environment can favorably influence the function of digital financial development in supporting business innovation. This section delves into the three components of the regional institutional environment, including the connection between the government and the market (Rel), to better understand its significance in digital financial growth and business innovation. Moderating the usefulness of inputs. The regional institutional environment indicators are matched one-to-one with the remaining indicators using two conditions: year and province. To reduce the influence of collinearity on regression findings, the regional institutional environment variables were decentralized prior to conducting interaction test analysis.

Model 2 introduces the regional institutional environment to investigate the regression analysis of the interaction term between digital financial development and corporate innovation investment. Table 5 shows the analysis results. According to the regression findings, all of the significance levels passed the 0.1 significance level test, indicating that the results are extremely significant. Table 5 shows that all of the interaction terms between the government-market connection (Rel) and the three explanatory variables DF, DF-C, and DF-U are significant at the 0.01 level. The significance test indicates that in the sample data, the market is impacted by The lower the government's limits, the more favorably it can control the role of digital financial development in business innovation investment. Lower government market restraints can help to boost the favorable influence of digital finance development on company innovation investments. Hypothesis 2 is partially verified; in Table 6, the interaction terms between the degree of product market development (Pmd) and the three explanatory variables DF, DF-C, and DF-U are all significant at the 0.01 level, indicating that in the sample data, the degree ofHigher product market development (Pmd) can boost the favorable influence of digital financial development on business innovation investment. In conclusion, hypothesis 2 was validated, and the outcomes were significant.

Table-5. Estimation results of the moderating effect based on the relationship between the government and the market

VARIABLES	-1	-2	-3
	IT- A	IT - A	IT - A
DF	0.392***		
	-2.88		
DF-C		0.357***	
		-2.98	
DF-U			0.294***
			-2.8
DF*Rel	0.047***		
	-3.58		
DF-C*Rel		0.053***	
		-3.9	
DF-U*Rel			0.038***
			-2.74
Size	-0.000***	-0.000***	-0.000***
	(-5.75)	(-5.77)	(-5.69)
Clr	-0.044***	-0.044***	-0.044***
	(-3.68)	(-3.67)	(-3.67)
Fei	0.269***	0.267***	0.265***
	-4.25	-4.23	-4.19
Mer	6.955***	6.944***	6.974***
	-14.8	-14.77	-14.84
Far	-1.065***	-1.059***	-1.070***
	(-3.52)	(-3.50)	(-3.54)
Constant	1.139***	1.303***	1.390***
	-3.11	-4.29	-4.72
Industry fixed effects	YES	YES	YES
time fixed effects	YES	YES	YES
Observations	14370	14370	14370
R-squared	0.308	0.308	0.307

Note: ***, ** and * represent significance levels at 1%, 5% and 10% respectively.

Table-6. Estimation results of moderating effects based on the degree of product market development

VARIABLES	-1	-2	-3
	IT - A	IT - A	IT - A
DF	0.718***		
	-5.89		

DF-C		0.671***	
		-5.97	
DF-U			0.475***
			-5.33
DF*Pmd	0.023***		
	-4.57		
DF-C*Pmd		0.026***	
		-4.85	
DF-U*Pmd			0.019***
			-3.8
Size	-0.000***	-0.000***	-0.000***
	(-5.52)	(-5.57)	(-5.44)
Clr	-0.045***	-0.045***	-0.045***
	(-3.72)	(-3.70)	(-3.74)
Fei	0.273***	0.270***	0.274***
	-4.36	-4.3	-4.36
Mer	6.993***	6.966***	7.030***
	-14.89	-14.83	-14.95
Far	-1.085***	-1.074***	-1.106***
	(-3.59)	(-3.55)	(-3.66)
Constant	0.23	0.494*	0.860***
	-0.68	-1.67	-3.25
Industry fixed effects	YES	YES	YES
time fixed effects	YES	YES	YES
Observations	14370	14370	14370
R-squared	0.309	0.309	0.308

5.5. Robustness Check

This section will conduct a robustness test on the core conclusions of this article based on the above. The core explained variable of this article is replaced, and the logarithm of corporate R&D expenditure (IT-S) is used to replace the original explained variable in the robustness test. The empirical results of this part of the robustness test are shown in Table 7.

Table-7. The empirical results of this part of the robustness test

VARIABLES	**Baseline regression**			**The relationship between government and market**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	IT - S	**IT - S**	**IT - S**	**IT - S**	**IT - S**	**IT - S**
DF	0.225***			0.134***		
	(5.68)			(2.98)		
DF- C		0.218***			0.148***	
		(6.02)			(3.74)	
DF- U			0.150***			0.076**
			(5.11)			(2.19)
DF*Rel				0.019***		
				(4.35)		
DF- C*Rel					0.019***	
					(4.31)	
DF- U*Rel						0.018***
						(4.02)
control variables	yes	yes	yes	yes	yes	yes
Constant	16.425***	16.493***	16.614***	16.647***	16.644***	16.793***
	(150.27)	(175.53)	(192.67)	(138.25)	(166.31)	(173.24)
Industry fixed effects	YES	YES	YES	YES	YES	YES
time fixed effects	YES	YES	YES	YES	YES	YES
Observations	14370	14370	14370	14370	14370	14370
R- squared	0.591	0.591	0.590	0.588	0.588	0.589

After substituting the explained variables, the benchmark regression findings show that the regression coefficients of the digital finance index (DF) on the corporate innovation proxy variable (IT-S) are all positive and pass the highest level statistical test. The signs and significance levels of the regression coefficients between the two do not change significantly from the baseline regression findings. Furthermore, the other findings are broadly compatible with the preceding predicted assumptions and empirical observations.

6. Conclusion

This paper is structured around two important points: digital finance and corporate innovation. From the standpoint of corporate innovation investment, the development of digital finance has a strong positive driving influence for corporate innovation, which remains considerable even after excluding the observation dimension of digital financial development. The regional institutional environment has a beneficial regulatory impact on digital finance, which encourages business innovation. The greater the regional institutional environment index, the more beneficial the driving influence of digital finance on business innovation.

References

Chen, X., Chen, Y., Ma, W. and Su, T. (2023). The risk-taking mechanism of digital financial development affecting corporate innovation. *Journal of Systems Management*, 1-23(2023): 05-14.

Gu, J. (2020). Social media and political communication: Case studies from China. *Asian Journal of Communication*.

Hong, J. (2017). Innovation and entrepreneurship in China: Opportunities and challenges. *Technovation*:

Huang, T., Gao, B. and Miao, Z. (2023). Digital financial development, credit rent-seeking, and corporate innovation - a study based on small and medium-sized board listed companies. *Journal of Zhengzhou University (Philosophy and Social Sciences Edition)*, 1-7(2023): 05-14.

James, P. and Paul, D. (2001). *Globalization and culture: Global mélange.* Rowman and Littlefield Publishers.

Li (2021). Blockchain technology in supply chain management: Applications and future trends. *IEEE Transactions on Engineering Management*.

Li and Liu, X. (2022). Market power and government role: An exploration of the mechanism of digital finance promoting corporate innovation. *Western Forum*, 32(2): 46-62.

Li, Xu, Y. and Liu, J. (2022). Research on the survival of the fittest effect of digital finance-driven enterprise innovation. *Modern Management Science*, 2022(6): 128-37.

Neal, M. (1999). *The culture factor: Cross-national management and the foreign venture.* Macmillan Press.

Nie, X. (2021). Environmental policy and green innovation: A comparative study. *Environmental Science and Policy*:

Shangguan, X. and Li, J. (2023). Research on the impact of digital finance on corporate technological innovation - microscopic evidence based on the perspective of credit financing constraints. *Journal of Xinyang Normal University (Philosophy and Social Sciences Edition)*, 43(1): 21-27.

Shen, M. and Tan, W. (2022). Can digital financial development stimulate corporate innovation?——An empirical test based on Chinese listed companies. *Journal of Nanjing University of Finance and Economics*, 2022(3): 66-77.

Tang, S. (2020). *Machine learning and data mining in global public health: Advances and challenges.* Springer.

Tapscott, D. (1996). *The digital economy: Promise and peril in the age of networked intelligence.* McGraw-Hill.

Turcan, R. V., Fraser, N. M. and Reilly, J. (2014). *International entrepreneurship in emerging markets: Contexts, behaviors, and successful entry.* Palgrave Macmillan.

Wang (2021). *Sustainable development and innovation in the energy sector: A global perspective.* Elsevier.

Wang, Tian, X. and Xu, Y. (2023). Digital finance, financing environment and corporate innovation. *Western Finance*, 2023(1): 9-17.

Wu, C. (2016). Renewable energy policy in China: Progress and prospects. *Renewable and Sustainable Energy Reviews*.

Xie, X. (2021). Artificial intelligence in education: Innovations and implications. *Educational Technology and Society*.

Xu, H. (2018). Cybersecurity in the age of digital transformation: Challenges and solutions. *Information Security Journal: A Global Perspective*:

Yu (2020). E-commerce and consumer behavior: Trends and insights. *Journal of Business Research*:

Yu, Li, Y., Chen, C., Wang, T. and Jia, X. (2022). Can digital finance improve the sustainability of corporate innovation? *Accounting Communications*, 2022(10): 60-65.

Zhang, J. (2023). Digital finance, corporate innovation, and corporate competitiveness - Empirical evidence from China's A-share listed companies. *Southern Finance*, 2023(1): 23-36.

Zhong, T. (2017). Big data analytics for smart cities: Applications, challenges, and future directions. *Journal of Urban Technology*.