The Impact of Digital Inclusive Finance on Innovation of Construction Enterprises

Li Xinwen*, Cao Wuteng

Jishou University Business School, Xiangxi Autonomous Prefecture, China
*245220652@qq.com

Abstract: Digital inclusive finance injects new vitality into the innovation of construction enterprises. Based on the data from six construction enterprises, namely China National Chemical Engineering Co., Ltd., China Railway Construction Corporation Limited, China Railway Group Limited, China State Construction Engineering Corporation (CSCEC), China Energy Engineering Corporation (CEEC), and China Communications Construction Company Limited (CCCC), from 2012 to 2021, this paper delves into the role of digital inclusive finance in fostering innovation within construction enterprises. The research findings demonstrate that digital inclusive finance not only significantly contributes to fostering innovation in construction enterprises but also exhibits sustainability. Finally, recommendations are proposed to promote the impact of digital inclusive finance on innovation in construction enterprises, encompassing aspects of policy formulation, corporate management, and financial institutions.

Keywords: Digital Inclusive Finance, Enterprise Innovation, Construction Enterprises

1. Introduction

In 2023, the "Opinions on Promoting the High-Quality Development of Inclusive Finance" was issued by the State Council of China, integrating inclusive finance with green, low-carbon development, particularly evident in the construction sector as green site construction. From initial planning to project management, and further to construction and equipment manufacturing, the extensive application of digitized and intelligent technologies has reduced carbon emissions. In this context, centrally-owned enterprises such as China State Construction Engineering Corporation (CSCEC), China Energy Engineering Corporation (CEEC), and China Railway Construction Corporation Limited (CRCC) have emerged as industry leaders, spearheading the intelligent development in China's construction sector. In recent years, with the integration of digital technology, the economy and society have been propelled forward, while the new model of digital financial services in the banking sector has furthered the development of inclusive digital finance. Centrally-owned enterprises recognized the significance of Internet Plus and new business models in the internet finance sector early on, benefiting from the background of state-owned enterprises. They took the lead and actively promoted innovative transformation within the industry.

The rise of inclusive digital finance is not only a trend in China but also globally, disrupting operational models across various industries, including construction. However, there are certain differences in research methodologies and focal points in assessing the development of digital

inclusive finance domestically and internationally. Foreign research institutions and scholars usually introduce digital indicators based on existing inclusive finance indices to assess the digital inclusive finance status of different countries. For instance, Indian economist Sarma (2012) employed linear efficiency functions and Euclidean distance methods, measuring the inclusive finance situations of various countries based on indicators such as bank coverage, accessibility to financial services, and usage conditions. Lyman and Lauer (2015) put forward core indicators for digital inclusive finance, including digital transaction platforms, digital infrastructure operators, and digital tools. In contrast, domestic research focuses more on exploring the demand situation for digital inclusive finance, constructing a multi-dimensional inclusive finance index system comprising indicators such as accessibility to financial services, usage conditions, and service quality. For example, Jiao Jinpu et al. (2015) studied non-banking financial services, establishing a comprehensive indicator system considering multiple aspects. In 2020, the G20 meeting passed the "G20 High-Level Principles for Digital Inclusive Finance," widely acknowledging the unique role of digital technology in promoting inclusive finance. Guo Feng et al. (2020) assessed the development of digital inclusive finance by constructing the "Peking University Digital Inclusive Finance Index" from various dimensions such as the breadth of digital financial coverage, depth of usage, and level of inclusivity in financial digitization.

Research indicates a significant causal relationship between the digital economy and enterprise innovation. Hu Shan et al. (2022) found that the digital economy fosters innovation within enterprises, providing critical impetus for breakthrough innovations. Meanwhile, Wang Gang et al. (2023) suggest that inclusive digital finance aids in resolving financing issues, reducing financing costs, and thereby driving technological innovation among small and medium-sized enterprises (SMEs). Technological advancements have spurred the demand for innovation within enterprises, aligning with the transformation and upgrade requirements of China's financial system. Enterprises should actively seek policy support, drive the development of digital infrastructure, and promote the deepening of the digital financial system. Against the backdrop of continual technological progress, the demand for innovation within enterprises has steadily increased, complementing the demands of China's financial system transformation and upgrade, compelling enterprises to actively respond. In this context, enterprises should leverage their inherent innovative potential, enhance competitiveness, strive for policy support, drive the development of digital infrastructure, and facilitate the deepening of the digital financial system. This viewpoint finds support from Ming Chengzhi (2023), advocating those enterprises actively pursue policy support for inclusive digital finance, promote the construction of digital infrastructure, and facilitate the deepening of the digital financial system. These developments not only guide the direction of enterprise innovation but also provide valuable experiences for the construction of China's digital financial system.

2. Sample and Data Analysis

2.1. Sample Selection and Data Source

Considering data availability, data from the period 2012 to 2021 for six central enterprises within China's top 500 engineering and construction companies, as highlighted in the 2023 "Fortune" report, were selected. These include China National Chemical Engineering, China Railway Construction Corporation Limited, China Railway Group Limited, China State Construction Engineering Corporation, China Energy Engineering Corporation, and China Communications Construction Company. Specifically, the Digital Inclusive Finance Index was obtained from Peking University for the mentioned period. Enterprise-related variables were sourced from the Wind and CSMAR databases, and truncation was applied to the sample.

2.2. Variable Definitions

In order to more reasonably define corporate innovation, this paper considers the explained variables from the perspectives of both innovation input and output, enriching the connotation of innovation. The innovation input draws from studies by Adhikarti (2016), Pan Yue et al. (2015), while innovation output is referenced from the literature of Zheng Manni et al. (2016), employing the entropy weight method to calculate the comprehensive score of innovation. The explanatory variable, Digital Inclusive Finance, is defined based on Peking University's Digital Inclusive Finance Index, encompassing breadth of coverage, depth of usage, and level of digitization. The mediating variables, referring to SA in Xiang Dong et al. (2023), define financing constraints. Control variables include enterprise scale, asset-liability ratio, net profit on total assets, return on equity, proportion of independent directors, and Tobin's Q ratio. Specific definitions of variables can be found in Table 1.

Table 1. Definition of Key Variables

RD1	Proportion of annual R&D expenditure to total assets of the company
RD2	Proportion of annual R&D expenditure to operating income of the company
Patent1	Total number of applications for invention patents, utility models, and design patents, plus the natural logarithm of 1
Patent2	Total number of applications for invention patents, utility models, and design patents, plus the natural logarithm of 1, with weights of 3:2:1 for the three types of patents
Innovation	Comprehensive score calculated using the entropy weight method for RD and Patent
Index	
Breadth	
Depth	Beijing University's Digital Inclusive Finance Index
Digitial	
SA	SA=-0.737*Size+0.043*Size^2-0.040*Age
Size	Natural logarithm of total annual assets
Lev	Year-end total liabilities divided by year-end total assets
Roa	Net profit divided by average total assets
Roe	Net profit divided by average owner's equity
Indep	Net profit divided by average owner's equity
TobinQ	(Market value of outstanding shares + Number of non-tradable shares * Net asset value per share + Book value of liabilities) divided by total assets

3. Empirical Analysis

3.1. Correlation Analysis

This paper conducted Pearson correlation tests on variables. The conclusions drawn from Table 2 are as follows: Firstly, the correlation coefficient between the Digital Inclusive Finance Index and the six companies is positively 0.855, indicating that with a 99% probability, digital inclusive finance has a positive impact on corporate innovation. Secondly, the correlation coefficient between the Digital Inclusive Finance Index and the financing constraints of these six sampled companies is negatively 0.892, suggesting that with a 99% probability, digital inclusive finance alleviates financing constraints for enterprises. Lastly, the correlation coefficient between financing constraints and enterprise innovation is negatively 0.765, indicating that with a 99% probability, financing constraints hinder enterprise innovation activities.

Table 2.Correlation Analysis

	Innovation	Index	SA	Size	Lev	Roa	Roe	Indep	TobinQ
Innovation	1								
Index	0.855***	1							
SA	-0.765***	-0.892***	1						
Size	0.340***	0.585***	0.497***	1					
Lev	-0.489***	-0.431***	0.386***	0.377***	1				
Roa	-0.258**	-0.254*	0.310**	-0.505***	-0.408**	1			
Roe	-0.631***	-0.554***	0.575***	-0.291**	0.208	0.787**	1		
Indep	-0.380***	-0.372***	0.312**	-0.408***	-0.101	0.442**	0.464**	1	
TobinQ	-0.440***	-0.610***	0.495***	-0.696***	0.023	0.294*	0.285*	0.256**	1

t-statistics in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

3.2. Regression Analysis

This paper refers to the approach of Wang Qianying et al. (2016), using the bootstrap Hausman test to examine the selection between using the random effects model or the fixed effects model, and the test results are presented in Table 3.

Table 3.bootstrap Hausman test

	F	Prob > F
bootstrap Hausman test	151.71	0.00

From the results, it is evident that the model passes the bootstrap Hausman test; therefore, this paper should use the fixed effects model.

This paper, referencing Li Rongjin et al.'s study (2023), employs a bidirectional fixed effects model considering time and industry, constructing Model (1). In this model, enterprise innovation and the inclusive finance index serve as explanatory variables, measuring the overall effect of digital inclusive finance on innovation within construction enterprises. If positive, it indicates that the development of digital inclusive finance has a positive impact on construction enterprises. Time effects are represented as control variables.

$$\text{Inovation}_{it} = \text{cons} + \partial_1 Index_{it} + \partial_2 Controls_{it} + \sum Year + \sum Industry + \delta_{it} \quad (1)$$

First, without adding control variables and solely controlling for time, an examination is conducted on the dependent and explanatory variables. The regression results are shown in Table 3, Column (1). Then, after adding control variables at the enterprise level, another regression is conducted, and the results are displayed in Table 4, Column (2).

Table 4.Regression analysis

Variables	(1) Innovation	(2) Innovation
Index	0.179***	0.199***
	-0.014	-0.033
Size		-0.186**
		-0.078
Lev		2.072**
		-0.851
Roa		15.619**
		-6.417
Roe		-5.236**
		-1.770
Indep		-0.001*
		-0.002
TobinQ		-0.230*
		-0.196
Constant	-0.129**	3.497*
	-0.047	-1.808
YEAR	YES	YES
INDUSTRY	YES	YES
Observations	60	60
Number of id	6	6
R-squared	0.73	0.83

t-statistics in parentheses*** p<0.01, ** p<0.05, * p<0.1

Through the analysis of the regression results, it can be observed that the regression coefficient between the digital inclusive finance index and corporate innovation is significantly positive at the 1% level, which is 0.179. This indicates that digital inclusive finance has a positive impact on innovation in the sample enterprises. For each unit increase in the digital inclusive finance index, there is an increase of 0.179 units in the number of patent applications for small and medium-sized

enterprises. Even after incorporating enterprise control variables, although there is a change in the regression coefficient, it remains significantly positive at the 1% level. This continues to demonstrate the promoting effect of digital inclusive finance on innovation in sample enterprises.

3.3. Robustness Test

To enhance the reliability of the results, this study adopts the Tobit model for robustness testing, and uses the least squares method to handle heteroscedasticity, reducing data errors. Analyzing lag effects can help understand the long-term impact of digital inclusive finance policies or industry development on corporate innovation.

Table 5.Robust outcome statistics

Test Item	Test Statistic	p-value	Conclusion
Tobit	Z = 3.07	p = 0.002	Significant
OLS	t = 6.96	p = 0.00	Processed
Hysteresis effect	t = 5.15	p = 0.00	Significant

Analysis indicates that in the Tobit model, $p = 0.002$ ($p < 0.05$), indicating the significant role of digital inclusive finance in enterprise innovation. This reflects that digital inclusive finance provides companies with more flexible and convenient financing channels, prompting increased investment in research and development, product innovation, and improvement in business models. Considering heteroscedasticity when handling the data, the adoption of the ordinary least squares method to eliminate heteroscedasticity improves the model's stability, allowing for a more accurate capture of the impact of digital inclusive finance on enterprise innovation. The significance of the lag effect with a result of $p = 0.00$ ($p < 0.05$) demonstrates the sustained effect of digital inclusive finance over time. This implies that the earlier development of digital inclusive finance will continue to have a lasting innovative effect in the later period. This implies that the earlier development of digital inclusive finance will continue to have a lasting innovative effect in the later period.

4. Conclusion and Recommendations

4.1. Conclusion

In general, digital inclusive finance has promoted innovation in construction enterprises. Through Pearson correlation tests, fixed-effects models, and robustness tests of Tobit models, this paper has found a significant promotion effect of digital inclusive finance on innovation within construction enterprises. The development of digital inclusive finance has provided enterprises with more convenient and flexible financing pathways, driving companies to increase their investments in research and development (R&D), implement product innovation, and improve business models. Furthermore, the research demonstrates that the impact of digital inclusive finance is not merely temporary but sustained over time. Early-stage development in digital inclusive finance will lead to sustained innovative effects in later stages. This indicates that companies, under the impetus of digital inclusive finance policies, continuously enhance their competitiveness and innovation capabilities through technological upgrades and product innovation.

4.2. Recommendations

In terms of policy formulation, government departments should continually devise policies that encourage the development of digital inclusive finance while maintaining stability in the policy implementation process. This includes measures such as providing fiscal support, tax incentives, etc., to reduce the costs for enterprises in using digital inclusive finance tools and stimulate their more active participation in innovation activities. Additionally, governments should also encourage the application of digital inclusive finance in sustainable development projects, such as supporting innovative initiatives in fields like green construction and clean energy undertaken by construction companies, to promote eco-friendly industry development.

In terms of enterprise management, construction companies should proactively incorporate digital inclusive finance into their strategic planning. Management can utilize the convenient financing pathways offered by digital inclusive finance to increase investments in research and development (R&D), technological improvements, and other areas. Construction companies can leverage digital inclusive finance tools to better respond to changing market demands, anticipate industry trends in advance, and drive the development of innovative products and services. Additionally, management in construction companies should focus on establishing an innovative culture, encouraging employees to propose new ideas and suggestions, and integrating innovative concepts across all levels of the enterprise.

In terms of financial institutions, providers of digital inclusive finance services need to continually innovate their products and services. Financial institutions can develop customized financial products tailored for construction companies, providing flexible financing solutions based on the specific needs of these enterprises. Simultaneously, financial institutions should strengthen cooperation with construction companies, providing specialized financial advisory services to assist enterprises in clarifying their future development directions, optimizing their capital structure, and enhancing financial performance. Furthermore, financial institutions can organize industry seminars, training courses, etc., to encourage construction companies to gain a deeper understanding of the application scenarios and operational methods of digital inclusive finance, thereby better utilizing these financial tools to drive innovation.

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