

The Impact of Banking Competition on Enterprise Digital Intelligence Transformation

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Abstract. Against the backdrop of a new wave of digital intelligence transformation, advancing the digitalization of enterprises in China to accelerate industrial upgrading and empower high-quality economic development has garnered significant attention. This study focuses on listed companies from 2002 to 2022 and finds that competition in the banking sector significantly promotes the digital intelligence transformation of enterprises by alleviating financing constraints. The easing of financing constraints induced by banking competition enhances the subjective willingness of enterprises to engage in research and development activities. Moreover, increased competition among banks facilitates maintaining favorable relationships between banks and enterprises, thereby helping enterprises gain more information and financial support during the process of digital intelligence transformation. Thus, it promotes the digital intelligence transformation of enterprises effectively.

Keywords: Banking competition, enterprise digital intelligence transformation, artificial intelligence.

1. Introduction

Since the beginning of the 21st century, a rapid global wave of digitalization has permeated various sectors of enterprises worldwide (Hu & Dai, 2024). One manifestation of enterprise digitalization is the widespread adoption of Enterprise Resource Planning (ERP) systems. As crucial tools for managing and optimizing resource allocation within enterprises, traditional ERP systems have shown limitations in meeting the complex and diverse needs of modern business operations and decision support (Jiang, 2024). In the era of digital economy, a suite of digital technologies such as artificial intelligence, blockchain, big data, and cloud computing has risen rapidly, making data another crucial production factor after land, labor, and capital (Kong et al., 2023). Therefore, enterprise digital intelligence transformation, known as “digital intelligence,” is becoming imperative. The emergence of digital intelligence represents a progression from digitalization to a higher developmental stage, where digitalization emphasizes the analysis and processing of big data, while intelligence focuses on technologies like machine learning and artificial intelligence (Luo & Chen, 2022). Digital intelligence utilizes emerging technologies such as big data, artificial intelligence, and cloud computing to deeply explore the malleable value of data, achieve intelligent analysis and management, thereby enhancing the application and efficiency of data, and optimizing existing business and management value chains. For instance, integrating Business Intelligence (BI) tools into traditional ERP systems enables better data visualization and analysis, thereby supporting decision-making and business development more effectively. Research on how to promote enterprise digital intelligence and the key factors influencing it contributes theoretically and practically to providing scientific foundations for using digital intelligence to promote high-quality economic development in China.

The banking sector, as a core component of China's financial system, plays an indispensable role and holds a significant position. Against the backdrop of rapid economic development in China, the banking sector provides substantial external funding for the development of the Chinese economy and corporate sectors. Since the reform and opening up, with the relaxation of banking regulations, the Chinese banking industry has diversified significantly. Foreign banks and urban commercial banks have been established, forming a multi-level banking institution system. Moreover, major banks have expanded across regions, intensifying competition within the banking industry (Zhang & Yang, 2023a). The intensified competition in the banking market has enhanced loan efficiency,

increased credit availability (Love & Martínez Pería, 2015), strengthened banks' information gathering and identification capabilities regarding enterprises, reduced information asymmetry between banks and enterprises (Schaeck & Cihák, 2012), and improved banking competition efficiency, as well as service efficiency and quality provided to enterprises.

Relative to existing literature, this paper may contribute innovatively in several aspects. The ongoing wave of digital intelligence revolution has drawn academic attention towards advancing enterprise digital intelligence transformation in China, accelerating industrial upgrading, and empowering high-quality economic development (Luo & Chen, 2022). However, current research on the factors influencing enterprise digital intelligence remains limited. The development and intensified competition within China's banking sector have improved loan efficiency and access to financing for enterprises, potentially facilitating the eruption of enterprise vitality. To some extent, this may significantly accelerate or inhibit the empowerment of high-quality economic development through digital intelligence.

This study on the impact of banking competition on enterprise digital intelligence transformation contributes theoretically by revealing the mechanisms through which the development and competition in China's banking sector influence enterprise digital intelligence. It enriches and enhances the theoretical framework of enterprise digital intelligence transformation, providing a new perspective on understanding the role of banking competition within it.

Secondly, this research can provide practical insights into how to accelerate enterprise digital intelligence transformation, offering scientific foundations for the banking sector and business community. Enterprises can leverage the financing convenience brought by banking competition to expedite their digital transformation, enhance competitiveness, improve market position, promote deep cooperation between banks and enterprises, and collectively drive high-quality economic development in China.

2. Literature Review

(1) Conceptual Definitions

In the current digital age, enterprises face an urgent need for digital transformation and digital intelligence transformation to cope with constantly changing market environments and competitive pressures. Against this backdrop, enterprise digitalization, digital intelligence (DI), and intelligence automation have become focal points of academic and practical interest.

Digital transformation is defined as a significant change triggered by the combination of information technology, computing technology, communication technology, and connectivity technology, aiming to improve the processes of physical entities (Vial, 2001). This definition emphasizes the target entities, means and methods, scope and degree of transformation, and expected outcomes of digital transformation.

Yao Xiaotao (2022) constructs a dynamic process model for enterprise digital transformation and proposes corresponding management strategies. Wang Hecheng (2021), through literature research and expert reviews, develops the Digital Maturity Model (DMM) and explores segmented management systems for enterprise digitalization. Li Kedong (2008) discusses the mutual promotion and integration of digital learning and knowledge management, as well as the key issues in constructing enterprise digital learning systems. Zhou Wei (2024) finds that the digital transformation of Chinese multinational enterprises significantly promotes their innovation performance, and digital transformation strengthens the positive impact of their R&D investment on innovation performance.

Regarding digital intelligence (DI), the “2021 Research Report on the Development of China's Enterprise Digital Intelligence Transformation and Upgrading” defines DI as the use of new-generation digital and intelligent technologies, driven by algorithms and computing power based on data linkage, to advance enterprise transformation and upgrading. This meets the personalized needs centered around customer operations, enhances enterprise process efficiency, optimizes decision-

making, and empowers sustainable enterprise development. Essentially, DI combines "data + intelligence." While digitalization focuses on the digitalization of enterprise business processes, DI emphasizes the intelligent application of data. Currently, there is notably less literature on enterprise DI compared to enterprise digitalization. Zhou Enhua (2023) examines the digital intelligence transformation of the construction machinery industry, emphasizing continuous investment in R&D resources and leveraging digital, networked, and intelligent technologies to achieve smart management across the entire value chain.

In the realm of enterprise intelligence, the focus is on introducing smart devices and automation technologies to achieve intelligent and automated production, management, and service delivery, thereby enhancing the productivity and competitiveness of enterprises. Within the existing literature, most studies concentrate on the intelligent transformation of manufacturing enterprises. For example, Li Guangyu (2024) has developed an "Industrial Internet + Intelligent Security Management" framework to strengthen the establishment of intelligent security management within enterprises. He Jingqi (2024) argues that enterprises should prioritize the development of next-generation information infrastructure to support the development of device intelligence, ensuring sufficient resources to elevate the level of equipment intelligence within enterprises.

(2) Literature Review on Enterprise Digital Intelligence

Within the current scope of literature, enterprise digital intelligence is primarily influenced by several factors. First, it is affected by the development of supply chain finance within enterprises. Supply chain finance enhances corporate financing channels through various means, leveraging transaction data from credit financing and the application of digital technologies to alleviate financing constraints and increase innovation investments, thereby significantly impacting the transformation of enterprise digital intelligence (Chen et al., 2024).

Second, the transformation of enterprise digital intelligence is influenced by company size, ownership concentration, and operational capabilities. The degree of enterprise digital intelligence shows a significant positive correlation with company size, while it exhibits significant negative correlations with company age, ownership concentration, and operational capabilities. This suggests that newly established companies are more likely to achieve rapid digital intelligence transformation (Chen et al., 2024).

Third, within the manufacturing sector, the degree of enterprise digital intelligence is influenced by research and development (R&D) investments, corporate financing conditions, and the educational level of senior management. China's open and inclusive financing environment allows listed companies to access more financing opportunities and allocate more resources to R&D, increasing the likelihood of achieving intelligence transformation. However, the educational level of senior executives has a relatively minor impact on the intelligence transformation of manufacturing enterprises compared to the first two factors, indicating that even with lower educational qualifications among senior management in some companies, their digital intelligence efforts may still be substantial (Yuan & Zhang, 2023).

(3) Literature Review on Banking Industry Competition

According to existing literature, competition within the banking industry influences several aspects. Banking industry competition positively impacts corporate innovation by enhancing the identification of efficient enterprises and reallocating innovation resources, thereby stimulating overall innovation output (Dai et al., 2020). Moreover, increased competition improves financial accessibility for small and micro-enterprises, reducing their financing constraints and promoting higher investment levels (Zhang & Yang, 2023b). Furthermore, competition among county-level banks enhances rural households' access to finance, fostering innovation and entrepreneurship among farmers and contributing to income growth and reduced income disparities (Wang & Zhao, 2023). Additionally, banking competition plays a role in promoting corporate pollution reduction by facilitating effective

pollution control through technological advancements and lowering financing costs for environmental initiatives (Yu & Ma, 2024).

3. Theoretical Analysis and Research Hypotheses

Financial constraints have profound impacts on corporate activities, particularly in investment and innovation. The transformation of enterprises into intelligent entities requires substantial funding, with external financing being a crucial source to drive innovations and digital transformation. Among these, bank loans serve as the primary financing channel for enterprises, playing an irreplaceable role (Cai et al., 2020). With the gradual relaxation of banking regulations, there has been a significant increase in the number of bank branches, the entry of foreign banks, and the emergence of diverse new types of banking institutions such as urban commercial banks, collectively forming a multi-tiered and diversified banking system. Meanwhile, state-owned large commercial banks, joint-stock commercial banks, and some large-scale urban commercial banks have begun to implement strategies for regional expansion, intensifying competition among various banks. This has led to a more complex and diverse market landscape, which is conducive to promoting high-quality development in inclusive finance (Yang, 2023), thereby enhancing the accessibility of credit for enterprises.

Therefore, banking competition can bring a series of promotion effects to enterprise digital intelligence. Firstly, banking competition helps alleviate the financing constraints faced by enterprises. Increased competition among banks lowers the threshold for collateral and reduces the cost of bank credit, thereby enhancing the accessibility of credit for enterprises, alleviating financing constraints, increasing research and development (R&D) investment, boosting innovation capabilities, and accelerating digital intelligence transformation. Secondly, the easing of financing constraints due to banking competition can enhance the subjective willingness of enterprises for R&D. In a relatively relaxed external financing environment, fund acquisition becomes easier and less costly for enterprises. This environment fosters a more optimistic attitude towards cash flow conditions. However, excessive concern over funding shortages may lead enterprises to overly focus on short-term financial risk control at the expense of long-term strategies for digital intelligence transformation and development (Tang et al., 2022). Thus, when financing constraints are eased, enterprises can focus on longer-term goals, thereby strengthening their subjective awareness of increasing R&D efforts. Finally, heightened banking competition is conducive to maintaining good relationships between banks and enterprises. Increased competition and the expansion of bank branches bring banks closer to enterprises geographically. This geographical proximity enables banks and enterprises to interact more conveniently using their geographic advantages, facilitating the establishment and maintenance of closer banking-enterprise relationships (Li Kai, 2024). With the recent surge in digital intelligence technology, many enterprises have realized the importance of digital intelligence transformation in enhancing competitiveness. This awareness helps correct short-sighted behaviors among corporate management, prompting managers to focus more on long-term development planning and allocate more funds to R&D and innovation. Through close cooperation with enterprises, banks can gain deeper insights into their innovative R&D projects and obtain soft information about enterprises (Maria Herrera & Minetti, 2007). Such information is crucial for banks in assessing loan risks and formulating more reasonable loan policies, thereby increasing the accessibility of financing for enterprises, enhancing their innovation drive and capabilities, and promoting digital intelligence transformation.

Based on this, the study proposes Hypothesis 1: Banking competition significantly promotes enterprise digital intelligence transformation.

4. Variable Definition and Model Selection

(1) Data Source

This study utilizes annual data from 2002 to 2022 for A-share listed companies in the Shanghai and Shenzhen stock markets. The data primarily originates from the CSMAR databases. Financial sector companies, ST or *ST designated firms were excluded, and missing values in the sample were removed, resulting in a total of 50,711 valid sample observations. Additionally, regional-level data is sourced from CSMAR databases and prefectural-level statistical yearbooks.

(2) Model Construction

To examine how banking competition influences enterprise digital intelligence transformation, this study specifies the following regression model:

$$DIGINT_{it} = \beta_0 + \beta_1 CR5_{it} + X_{it}\psi + \gamma_i + \lambda_t + \varepsilon_{it}$$

where subscript *i* denotes individual firms and subscript *t* denotes years. DIGINT is the dependent variable representing enterprise digital intelligence transformation. CR5 is the explanatory variable representing the level of banking competition. *X* represents a series of control variables. γ_i and λ_t denote individual and year fixed effects, respectively. ε_{it} represents the error term. This study selects FIN, ROA, Lev, TOP10, Growth, and LNGDP as control variables. Based on this, a panel model is constructed using robust standard errors for modeling.

(3) Variable Definitions

The dependent variable in this study is digital intelligence transformation of enterprises (DIGINT), measured as the average of standardized scores of digitalization and intelligence. The independent variable is banking industry competition (CR5), measured by the concentration of the top five banks. Following previous studies, the control variables selected include regional financial development level (FIN), ownership concentration, leverage (Lev) calculated as total liabilities divided by total assets, return on assets (ROA) calculated as net profit divided by average total assets, revenue growth rate (Growth) calculated as the ratio of revenue growth to total revenue of the previous year, and economic conditions (LNGDP) measured as the natural logarithm of GDP.

Table 1. Variable Definition

Variable Types	Variable Names	Variable Symbol	Variable Description
Dependent Variable	Enterprise digital intelligence	DIGINT	(Digitalization + Intelligence) / 2
Independent Variable	Banking industry competition	CR5	Concentration of the top 5 banks
Control Variables	Regional financial development level	FIN	Logarithm of the loan balance of financial institutions at the prefecture level
	Ownership concentration	TOP10	Shareholding proportion of the top 10 shareholders
	Leverage structure	Lev	Debt-to-asset ratio
	Return on assets	ROA	Net profit / Average total assets
	Economic conditions	LNGDP	Ln(1+GDP)
	Revenue growth rate	Growth	Ratio of revenue growth to total revenue of the previous year

5. Empirical Analysis

(1) Descriptive Statistical Analysis

Table 2 presents the descriptive statistics of the main variables. From Table 2, it is observed that the mean of enterprise digitalization (DIGINT) is -0.039, with a minimum of -10.640 and a maximum of 704.385. The mean of banking industry competition (CR5) is 0.400, with a minimum of 0.000 and a maximum of 1.000, and a standard deviation of 0.163. This indicates significant variations in banking industry competition across different cities.

Table 2. Descriptive Statistical Analysis

Variable	Obs	Mean	Std.Dev.	Min	Max
DIGINT	50711	-0.039	25.523	-10.640	704.385
CR5	45311	0.400	0.163	0.000	1.000
FIN	38906	3.825	1.692	0.56	13.530
ROA	47926	0.036	0.063	-.373	0.257
Lev	47926	0.426	0.204	0.027	0.908
TOP10	47926	56.740	18.568	0.000	91.616
Growth	47926	0.167	0.415	-0.690	4.124
LNGDP	38906	2.502	0.060	2.171	2.643

(2) Correlation Analysis

The correlation analysis in Table 3 shows that there is no multicollinearity and a preliminary correlation exists between the independent variables and the dependent variable before.

Table 3. Correlation analysis

	DIGINT	CR5	FIN	ROA	Lev	TOP10	Growth	LNGDP
DIGINT	1							
CR5	-0.122	1						
FIN	0.156	-0.112	1					
ROA	-0.00420	-0.0152	-0.0181	1				
Lev	-0.0712	0.0292	-0.00990	-0.296	1			
TOP10	0.0246	-0.114	0.0500	0.171	-0.117	1		
Growth	-0.00890	0.0239	-0.00520	0.269	0.0688	0.0410	1	
LNGDP	0.221	-0.366	0.433	0.0280	-0.0977	0.0510	-0.0290	1

(3) Baseline Regression

Table 4 shows the baseline regression results. Model (1) does not control for fixed effects, Model (2) controls for time fixed effects, and Model (3) controls for both time fixed effects and standard errors. The results indicate that for CR5, all three models are significant at the 0.01 level, and the regression coefficients are negative. A higher CR5 indicates higher market concentration in the banking industry, meaning lower competition. Therefore, the significantly negative regression coefficients suggest that

banking competition has a significant positive impact on enterprise digital transformation. Thus, Hypothesis 1 is confirmed.

Table 4. Baseline Regression

	(1)	(2)	(3)
	DIGINT	DIGINT	DIGINT
CR5	-6.4194*** (0.87)	-2.5465*** (0.87)	-2.5465*** (0.65)
FIN	1.1979*** (0.08)	0.9374*** (0.08)	0.9374*** (0.08)
ROA	-6.4756*** (2.20)	-1.9474 (2.17)	-1.9474 (2.23)
Lev	-8.4332*** (0.65)	-7.0360*** (0.64)	-7.0360*** (0.57)
TOP10	-0.0702*** (0.01)	-0.0694*** (0.01)	-0.0694*** (0.01)
Growth	1.4164*** (0.31)	1.4197*** (0.31)	1.4197*** (0.24)
LNGDP	70.8203*** (2.48)	37.3442*** (3.12)	37.3442*** (2.25)
CONS	-1.7e+02*** (6.25)	-93.3405*** (7.48)	-93.3405*** (5.58)
<i>N</i>	38697	38697	38697
<i>R</i> ²	0.060	0.089	0.089
adj. <i>R</i> ²	0.060	0.088	0.088
YEAR	NO	YES	YES

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(4) Robustness Checks

Since enterprise digital transformation consists of digitization and intelligence, Table 5 shows Models 1 and 2 regressing digitization and intelligence separately. To reduce the impact of omitted variables, Model 3 in Table 5 adds more control variables, and Model 4 uses fixed effects regression. Considering that the measurement indicators of variables might affect the regression results, Models 5 and 6 in Table 5 respectively replace the measurement indicators of the independent and dependent variables. The results show that regardless of the robustness checks applied, the regression results consistently support Hypothesis 1.

Table 5. Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)
	DIG1	INTEL1	DIGINT	DIGINT	DIGINT	DIGINT1
CR5	-0.0018*** (0.00)	-4.9395*** (1.75)	-2.6544*** (0.87)	-1.5902** (0.69)		-0.2891*** (0.03)
FIN	0.0006*** (0.00)	1.8592*** (0.17)	0.9402*** (0.08)	2.8599*** (0.10)	0.3669*** (0.11)	0.0549*** (0.00)
ROA	-0.0044*** (0.00)	-3.2666 (4.35)	-1.3985 (2.18)	-0.0204 (1.22)	3.9573*** (1.19)	0.0194 (0.08)
Lev	-0.0061*** (0.00)	-14.0479*** (1.28)	-6.6905*** (0.65)	8.0743*** (0.55)	6.3113*** (0.54)	-0.5699*** (0.02)
TOP10	-0.0000*** (0.00)	-0.1395*** (0.02)	-0.0685*** (0.01)	-0.1703*** (0.01)	-0.1219*** (0.01)	-0.0015*** (0.00)
Growth	0.0009*** (0.00)	2.8649*** (0.62)	1.3756*** (0.31)	0.4452*** (0.15)	0.2479* (0.15)	0.0858*** (0.01)
LNGDP	0.0211*** (0.00)	75.9075*** (6.24)	36.8386*** (3.12)	38.2434*** (1.98)	-11.2198*** (3.92)	2.5659*** (0.12)
Board			-2.1789*** (0.61)			
Competition					-2.5908*** (0.68)	
CONS	-0.0433*** (0.00)	-1.7e+02*** (14.99)	-87.4383*** (7.66)	-99.8239*** (5.05)	26.6027*** (9.41)	-6.8090*** (0.29)
<i>N</i>	38761	38825	38697	38697	38697	38697
<i>R</i> ²	0.229	0.089	0.089	0.114	0.179	0.332
adj. <i>R</i> ²	0.228	0.089	0.089	0.008	0.080	0.332
YEAR	NO	NO	NO	NO	NO	YES

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Research Conclusions and Policy Recommendations

(1) Research Conclusions

Amid the new wave of the digital intelligence revolution, advancing the digital intelligence transformation of enterprises in China, accelerating industrial upgrading, and empowering high-quality economic development have garnered significant attention. This study, focusing on listed companies from 2002 to 2022, reveals that banking competition significantly promotes the digital intelligence transformation of enterprises. This promotion effect occurs through the alleviation of financing constraints. The alleviation of financing constraints brought about by banking competition

can, to some extent, enhance the subjective willingness of enterprises to invest in R&D. Furthermore, increased banking competition helps maintain good relationships between banks and enterprises, thereby assisting enterprises in obtaining more informational support and financial aid during their digital intelligence transformation process, ultimately promoting enterprise digital intelligence transformation.

(2) Policy Recommendations

First, the government should play a crucial guiding and supportive role in promoting the digital intelligence transformation of enterprises. Initially, in terms of digital infrastructure development, the government should increase investments to promote the construction of high-speed networks, data centers, and cloud computing platforms, ensuring that enterprises can access efficient and stable digital services. Secondly, to address the shortage of digital and digital intelligence talents, the government should collaborate with enterprises and educational institutions to jointly conduct digital intelligence skills training programs, enhancing the digital skill levels of the workforce to meet the talent needs for enterprise digital intelligence transformation. In terms of financial support, the government can establish a dedicated digital intelligence transformation fund to provide necessary financial support to small and medium-sized enterprises and innovative companies, alleviating their financial pressures during the transformation process. Additionally, the government can further reduce the costs and risks of digital intelligence transformation by implementing tax incentives and providing loan guarantees.

Second, strengthening cooperation and communication between banks and enterprises is crucial for promoting enterprise digital intelligence transformation. Banks should establish long-term and stable cooperative relationships with enterprises, jointly formulating digital intelligence transformation plans and providing comprehensive financial service support. Furthermore, banks should establish information-sharing mechanisms with enterprises to promptly understand their production, operations, and funding needs, thereby offering more precise financial services. Lastly, banks can offer customized financial service solutions based on the specific needs of enterprises, such as tailored financing plans and financial consulting services.

Third, the government should encourage the development and competition of the banking industry to promote enterprise digital intelligence transformation. Based on the findings of this study, increased banking competition helps drive enterprise digital intelligence transformation. Therefore, the government can further encourage banking competition through policies. By easing market entry restrictions and encouraging the entry of foreign banks, the government can optimize the market structure of the banking industry and increase the level of competition. Concurrently, regulatory authorities should strengthen their guidance and supervision of the banking industry, encouraging banks to develop innovative businesses under controllable risks to support enterprise digital intelligence transformation. Finally, the banking industry itself should also promote its own digital and digital intelligence transformation to enhance digital service levels, thereby better supporting the digital intelligence transformation of enterprises.

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