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The Enhancement Effects and Mechanisms of Commercial Banks' Digital Transformation on Corporate Investment Efficiency

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Abstract

This paper focuses on the impact of commercial banks' digital transformation on corporate investment efficiency and its underlying mechanisms. Against the backdrop of the digital economy, the digital transformation of commercial banks has become an inevitable trend, as it optimizes service models through technologies such as big data and artificial intelligence, profoundly influencing corporate financing environments and investment decisions. Based on data from China's A-share listed companies from 2013 to 2023, this study constructs a panel regression model for empirical analysis. The findings reveal that the digital transformation of commercial banks can significantly reduce corporate inefficient investment levels and enhance investment efficiency. Mechanism tests indicate that digital transformation improves corporate investment efficiency by alleviating financing constraints, reducing agency costs, and mitigating financial misallocation. Heterogeneity analysis further reveals differences in the effects of digital transformation across various types of commercial banks and firms with different ownership structures and sizes. State-owned banks and joint-stock banks exhibit more pronounced inhibitory effects on corporate inefficient investment, while non-state-owned and small-scale enterprises benefit more from the digital transformation of commercial banks. This study provides new perspectives and empirical evidence for understanding how the digital transformation of commercial banks influences corporate investment efficiency through multiple mechanisms, while also offering theoretical insights for research on how financial services support the real economy in the context of the digital economy.

Keywords: digital transformation of commercial banks, investment efficiency, financing constraints, agency costs, financial misallocation

1. Introduction

In the current booming digital economy, the State Council and the People's Bank of China have successively introduced policies to promote the digital transformation of commercial banks. This transformation is not only a technological upgrade, but also a comprehensive change in operations, services, and risk management, profoundly affecting corporate investment and financing decisions, and becoming a core element in improving corporate investment efficiency. Deepening the relationship between banks and enterprises and integrating production and finance can further support the high-quality development of enterprises.

Enterprise investment efficiency is a key indicator for measuring its resource allocation and sustainable development capabilities. However, under the traditional financial model, the problem of information asymmetry between banks and enterprises is prominent. Banks find it difficult to obtain comprehensive information about enterprises, resulting in narrow financing channels and investment decisions that are prone to deviate from the optimal direction, leading to the risk of resource misallocation. Therefore, breaking down the information barriers between banks and enterprises and improving investment efficiency have become the top priority for enterprise development.

The digital transformation of commercial banks and the development of financial technology provide a new path to solve the above-mentioned problems. By relying on technologies such as big data and artificial intelligence, banks can more accurately collect and analyze enterprise data, significantly improve information transparency, reduce information asymmetry, accurately assess enterprise investment needs and risks, and provide appropriate financing support. At the same time, in order to align with the digital evaluation of banks, enterprises will also strengthen information management, improve governance structures, and optimize investment decisions. In addition, digital transformation can reduce agency costs for enterprises, broaden financing channels, effectively alleviate financing constraints, and comprehensively improve investment efficiency for enterprises.

Although existing research has conducted preliminary investigations into the relationship between commercial banks' digital transformation and corporate investment efficiency, current literature exhibits certain limitations. Firstly, most studies focus on macro-level analysis, with insufficient exploration of micro-level investment efficiency within enterprises. Secondly, no clear and comprehensive theoretical explanation has yet been established regarding the specific pathways through which commercial banks' digital transformation influences corporate investment efficiency via intermediary mechanisms. Against this backdrop, this study dissects the impact mechanism of commercial banks' digital transformation on corporate investment efficiency and empirically validates its causal pathways. Compared to existing research, the potential marginal contributions of this paper are as follows: (1) It expands the scope of research on the economic consequences of commercial banks' digital transformation. Existing literature, when examining the economic outcomes of banking digitalisation, typically pays scant attention to its micro-level effects on individual enterprises, particularly its specific impact on corporate investment efficiency. Through empirical research, this paper analyses this domain, revealing the association between commercial bank digital transformation and corporate investment efficiency. This study offers a fresh perspective on understanding how financial intermediaries utilise digital means to influence the real economy. (2) It broadens research on factors affecting corporate investment efficiency. While existing literature has explored multiple influencing factors in this field, the impact of commercial bank digital transformation—as an emerging factor—has not received sufficient attention. This paper incorporates commercial bank digital transformation as an influencing factor in corporate investment efficiency, theoretically demonstrating its positive role. This research offers a novel explanatory framework for understanding corporate investment decision-making. (3) It provides theoretical insights and empirical evidence for research on financial services supporting the real economy within the digital economy context. In the digital economy era, research on financial services supporting the real economy has gained increasing prominence. By constructing a theoretical model, this paper explores how commercial banks' digital transformation influences corporate investment efficiency through mechanisms such as alleviating financing constraints, reducing corporate agency costs, and improving financial mismatches. The development and empirical testing of this theoretical model provide theoretical insights and empirical evidence for research on how the financial sector, particularly in the digital context, can promote the development of the real economy, especially micro-enterprises.

2. Theoretical Analysis and Research Hypotheses

2.1 Direct Impact of Commercial Banks' Digital Transformation on Corporate Investment Efficiency

The role of digital finance in improving investment efficiency for enterprises is significant. The digital transformation of commercial banks is not simply about reducing business, but about using new technologies to deeply deconstruct and reshape traditional management models. In the process of transformation, by introducing new concepts, technologies, and methods, optimizing and innovating the existing business structure, operational methods, and management methods, while retaining the core elements of traditional business, fundamental changes are made in organizational form, operational mechanisms, and implementation strategies, achieving modernization and efficiency of business management, and promoting the transformation of business models from data-driven to data-driven[1].

Firstly, through technologies such as big data and artificial intelligence, digital transformation has significantly enhanced commercial banks' capabilities in information screening and risk assessment for enterprises.[1] Under traditional models, commercial banks had relatively limited channels for obtaining enterprise information, with accuracy and timeliness often difficult to guarantee. Digital transformation enables commercial banks to integrate data from multiple sources, including corporate financial statements, transaction records, and market performance. Through advanced data analytics tools, banks gain a more comprehensive and in-depth understanding of enterprises' operational status and financial health. By leveraging digital transformation, commercial banks maximise the use of information processing and collection technologies to verify corporate information. This not only enhances their own operational efficiency but also contributes to enterprise development to a certain extent.[2] This precise information mining and analytical capability enables banks to more accurately identify enterprises' investment requirements and risk profiles, thereby providing more rational and efficient financing support. Commercial banks can predict enterprises' funding demand cycles through data analysis , arranging capital to prevent missed investment opportunities due to insufficient funds. Simultaneously, they can flexibly adjust financing limits and interest rates based on actual business conditions and market shifts, ensuring resources are not wasted through over-funding. This precise capital matching and efficient funding support directly reduces instances where investment efficiency is compromised by insufficient or surplus capital, thereby enhancing corporate investment efficiency. Based on this, Hypothesis 1 is proposed.

Hypothesis 1: The digital transformation of commercial banks enhances corporate investment efficiency.

2.2 Mechanisms for Alleviating Financing Constraints

Amidst today's complex and volatile international economic landscape and the accelerated transformation of China's domestic economic model, numerous enterprises face formidable financing challenges and multiple hurdles in upgrading and restructuring, rendering their development path fraught with difficulties. Commercial banks' digital transformation may partially alleviate these financing constraints.

Firstly, the digital transformation of commercial banks can dismantle information barriers between banks and enterprises, thereby easing financing constraints. Under traditional models, commercial banks primarily relied on manual review when processing vast quantities of highly complex, unstructured "soft information". This approach proved inefficient and hindered the full extraction and utilisation of the substantial value embedded within such information, consequently limiting banks' ability to obtain comprehensive enterprise data. However, digital transformation offers novel solutions to this challenge. By leveraging cutting-edge technologies such as big data, cloud computing, blockchain, and artificial intelligence, commercial banks can now deeply mine and process multi-dimensional enterprise information. These technologies enable more precise assessments of a company's operational health, creditworthiness, and potential risks. This not only facilitates more accurate lending decisions but also better supports corporate investment activities, thereby driving business growth. Secondly, innovative applications of digital technology can significantly enhance commercial banks' lending methodologies. Through intelligent analysis of digital footprints, big data is effectively transformed into more valuable insights, enabling the quantification of previously intangible "soft information". This approach allows commercial banks to digitally simulate and precisely characterise the corporate integrity of borrowing enterprises, thereby gaining a more accurate grasp of their true creditworthiness.[3] . This facilitates timely access to necessary capital for enterprises with substantial growth potential, thereby enhancing their investment activities and efficiency. Thirdly, digital transformation drives innovation in banking operational models. Through business process automation and the digitisation of service scenarios, commercial banks significantly reduce operational costs, creating scope for lowering lending rates. Concurrently, the widespread adoption of digital technologies dismantles temporal and spatial barriers to financial services, intensifying competition within the credit market. Under the influence of the Matthew Effect, banks are competing for market share through product innovation and service optimisation, launching more competitively priced credit products. This creates a positive feedback loop of "cost compression – interest rate reduction – supply expansion", effectively alleviating enterprises' financing difficulties[4] .

When financing constraints are effectively alleviated, enterprises gain smoother access to required capital, thereby creating conditions for expanding investment scale. This not only enables increased capital input but, crucially, allows precise allocation of funds towards projects with greater developmental potential and profitability. Such targeted capital deployment maximises the value of funds, prevents idleness and wastage, significantly enhances capital utilisation efficiency, and delivers higher returns alongside superior development opportunities for enterprises. Based on this, Hypothesis 2 is proposed.

Hypothesis 2: Commercial banks' digital transformation can enhance corporate investment efficiency by alleviating financing constraints.

2.3 Mechanism for Reducing Agency Costs

Increased agency costs can also significantly impact a firm's investment efficiency. Specifically, management may deviate from optimal investment decision-making pathways during the decision-making process due to heightened agency costs, leading to investment decision biases. Such deviations not only trigger irrational resource allocation and waste but also amplify operational risks for the enterprise[5] . For large enterprises, characterised by substantial investment scales and complex asset structures, diminished investment efficiency exerts profound effects on overall operations, undermining market competitiveness and profitability. Consequently, heightened agency costs represent not merely a financial concern but a critical factor influencing long-term corporate development.

The digital transformation of commercial banks plays a crucial role in reducing corporate agency costs and enhancing investment efficiency. Within traditional corporate governance structures, significant information asymmetry exists between management and shareholders, leading to elevated agency costs—including oversight and contractual expenses. These costs not only burden corporate operations but may also cause management's investment decisions to deviate from the objective of maximising corporate value, thereby diminishing investment efficiency. Commercial banks' digital transformation effectively mitigates these issues through multiple avenues. Firstly, leveraging big data analytics and real-time monitoring systems, commercial banks can provide enterprises with a more transparent information environment. Shareholders gain timely access to operational data and financial status, thereby reducing oversight costs. This transparency not only enhances shareholder trust in management but also curtails opportunistic behaviour, improving decision-making rationality and management's corporate

governance capabilities. High-calibre corporate governance significantly mitigates information asymmetry, alleviates principal-agent problems, reduces agency costs, and curbs opportunistic behaviours such as earnings management[6] , thereby improving corporate investment and financing activities. Moreover, enhanced precision in credit allocation and risk management represent crucial outcomes of digital transformation. Through big data analytics and credit scoring models, commercial banks can more accurately assess enterprises' creditworthiness and risk profiles, thereby providing more rational credit support. This not only reduces enterprises' agency costs but also minimises investment delays or abandonment stemming from financing difficulties, directly elevating corporate investment efficiency. Based on this, Hypothesis 3 is proposed.

Hypothesis 3: Commercial banks' digital transformation can enhance corporate investment efficiency by reducing agency costs.

2.4 Improving Financial Mismatch Mechanisms

Commercial bank digitalisation reduces corporate misallocation levels. Within traditional financial systems, information asymmetry and uneven resource distribution constitute primary causes of financial misallocation. Inefficient allocation of financial resources between state-owned and non-state-owned enterprises, as well as among enterprises within the same sector or industry, results in significant mismatches between capital and high-quality investment opportunities. Numerous private enterprises and small-to-medium-sized businesses possessing sound investment potential struggle to secure adequate credit support for various reasons, forcing them into suboptimal investment choices. Concurrently, some enterprises holding substantial financial resources find it difficult to identify high-quality investment opportunities precisely due to institutional constraints, resulting in inefficient resource utilisation and significant constraints on overall investment efficiency[7] . This phenomenon not only impedes normal business operations and development but also diminishes the resource allocation efficiency of the entire economic system.

Digital transformation effectively mitigates this issue through multiple avenues. Firstly, the application of big data analytics and artificial intelligence enables banks to collect and analyse enterprises' operational data, financial status, and credit histories more comprehensively and accurately. These technologies can delve into the latent value and developmental potential of enterprises, assisting banks in more precisely assessing their risks and returns, thereby facilitating a more rational allocation of financial resources[8] . This precise evaluation not only enhances capital utilisation efficiency but also ensures funds flow to enterprises that most require and can most effectively utilise them, reducing misallocation caused by information asymmetry.

Secondly, the proliferation of digital platforms has significantly enhanced the accessibility of financial services, particularly for SMEs and enterprises in remote regions. Through online financial service platforms, these businesses can more readily access credit support and other financial services, mitigating financial exclusion caused by geographical distance or information barriers. This overcomes the traditional tendency in financial resource allocation to favour the wealthy over the less affluent.[9]. This expansion not only broadens the coverage of financial resources but also enhances the fairness and efficiency of financial services, enabling more enterprises to secure essential funding support for investment and expansion.

Moreover, digital technologies enable banks to monitor enterprises' operational status and fund utilisation in real time, allowing timely adjustments to credit limits and interest rates. This dynamic monitoring and adjustment mechanism grants banks greater flexibility in responding to market shifts, ensuring the continuous optimisation of financial resource allocation. Through real-time data feedback, banks can promptly identify and rectify financial mismatches, thereby enhancing the overall efficiency of financial resource utilisation.

In summary, commercial banks' digital transformation effectively mitigates corporate financial misallocation by enhancing information symmetry, enabling precision lending, improving financial service accessibility, and implementing dynamic monitoring and adjustment. These improvements not only boost the efficiency of financial resource allocation but also enhance corporate investment efficiency, fostering sustainable business development and providing robust support for economic growth. Based on this, Hypothesis 4 is proposed.

Hypothesis 4: Commercial banks' digital transformation can enhance corporate investment efficiency by mitigating financial mismatches.

3. Research Design

3.1 Model Construction

To examine the relationship between commercial banks' digital transformation and corporate investment efficiency, this study constructs the following panel regression model:

$$InefficInvest_{i,t}=\alpha+\beta Index_t+\sum_{k=1}^{K}\gamma_k Control_{i,t}^{k}+\mu_i+\theta_t+\varepsilon_{i,t} \quad (1)$$

Where: $InefficInvest_{i,t}$ denotes inefficient investment levels, with i representing enterprises and t denoting years; $Index_t$ serves as the core explanatory variable for commercial bank digital transformation levels, indicating the degree of digital transformation in year t; $Control_{i,t}^{k}$ represents control variables; μ_i and θ_t denote industry and year fixed effects respectively, controlling for unobservable factors within industries that do not vary over time and macroeconomic unobservable factors independent of individual entities. In the regression results, if the coefficient β is significantly negative, it indicates that commercial banks' digital transformation enhances corporate investment efficiency.

To verify the causal pathway through which commercial banks' digital transformation influences corporate investment efficiency, this paper constructs the following model:

$$Mediator_{i,t}=\alpha+\beta_1 Index_{i,t}+\sum_{k=1}^{K}\gamma_k Control_{i,t}^{k}+\mu_i+\theta_t+\varepsilon_{i,t} \quad (2)$$

$$InefficInvest_{i,t}=\alpha+\beta_2 Index_{i,t}+\beta_3 Mediator_{i,t}+\sum_{k=1}^{K}\gamma_k Control_{i,t}^{k}+\mu_i+\theta_t+\varepsilon_{i,t} \quad (3)$$

Where: $Mediator_{i,t}$ denotes the mediating variable, β_1 represents the direct effect of commercial banks' digital transformation level on the mediating variable, and β_2 indicates the effect of the commercial banks' digital transformation index on corporate investment efficiency after incorporating the mediating variable, reflecting the impact of the interaction between commercial banks' digital transformation and the mechanism variable on corporate investment efficiency. In model (3), β_3 denotes the coefficient of the mediating variable. Should this coefficient prove significant, and should β_2 exhibit a reduced coefficient value or become insignificant relative to model (1), this indicates that the mediating effect is statistically significant.

3.2 Variable Selection

3.2.1 Dependent Variable: Corporate Investment Efficiency

This study employs the level of inefficient investment as a proxy for corporate investment efficiency. Drawing upon methods for measuring corporate investment efficiency from Richardson[10], (2006), and Xu Qian[11], (2014), the model is constructed as follows:

$$Inv_t=\alpha_0+\alpha_1 Growth_{t-1}+\alpha_2 Lev_{t-1}+\alpha_3 Cash_{t-1}+\alpha_4 Age_{t-1}+\alpha_5 Size_{t-1}+\alpha_6 Ret_{t-1}+\alpha_7 Inv_{t-1}+\sum Industry+\sum Year+\varepsilon$$

Where: Inv_t denotes the company's actual new investment expenditure in year t = total investment - maintenance investment = cash paid for the acquisition of property, plant and equipment, intangible assets and other long-term assets + net cash paid for the acquisition of subsidiaries and other business units - net cash recovered from the disposal of property, plant and equipment, intangible assets and other long-term assets - net cash received from the disposal of subsidiaries and other business units - (Depreciation of fixed assets + Amortisation of intangible assets + Amortisation of deferred expenses) / Total assets at the beginning of the year; $Growth_{t-1}$ denotes the company's growth opportunities in year t-1, represented by Tobin's Q; Age_{t-1} denotes the company's age at year t-1, expressed as the number of years since listing = Observation year - IPO year; Lev_{t-1} $Cash_{t-1}$ denotes the company's financial leverage ratio in year t-1, expressed as the debt-to-equity ratio; indicates the company's cash flow status in year t-1, calculated as net cash flow from operating activities / total assets at the beginning of the year; $Size_{t-1}$ represents the company's asset scale in year t-1, expressed as the natural logarithm of total assets; Ret_{t-1} signifies the company's stock return rate in year t-1, represented by the annual individual stock return rate accounting for reinvested cash dividends; Inv_{t-1} denotes new investment expenditure in year t-1; $\sum Industry$ $\sum Year$ represents the industry dummy variable, categorised according to the CSRC 2012 industry standards: two-digit codes for manufacturing (C-prefixed) and one-digit codes for other industries; denotes the year dummy variable; ε represents the residuals estimated by the model.

Perform annual OLS regression on model (4) to obtain residuals. The absolute value of the model-estimated residual represents a company's degree of inefficient investment. A larger absolute residual indicates higher

inefficient investment, signifying lower investment efficiency. Positive residuals denote overinvestment, while negative residuals indicate underinvestment.

3.2.2 Core Explanatory Variable: Commercial Bank Digital Transformation Index

This paper employs the Peking University China Commercial Bank Digital Transformation Index to measure the degree of digital transformation within banks. This dataset encompasses the digital transformation levels of 246 banks from 2010 to 2023, offering considerable representativeness. To match the Commercial Bank Digital Transformation Index with each enterprise, this paper adopts the methodology proposed by Jia Yaru[12]and (2023). Using the proportion of annual loans from each commercial bank as weights, the Peking University China Commercial Bank Digital Transformation Index is weighted and summed on an enterprise-by-enterprise basis. The logarithm of this weighted sum yields the core explanatory variable (Index) for this study.

3.2.3 Mediating Variables

① Financing Constraints: This study employs the absolute value of the SA Index to measure corporate financing constraints, where a higher index value indicates greater financing constraints.

② Agency Costs: Following the methodology of Liu Zhiwei[13]and (2024), this study employs the management expense ratio (Meff) to gauge internal agency costs faced by enterprises.

③ Financial Mismatch: Drawing upon the research of Zhou Yuhao and Zhang Shengyong[14] (2014), financial mismatch (FM) is measured by the level of financial mismatch burden. This represents the deviation between a firm's cost of capital utilisation and the average cost of capital utilisation within its industry (industry average interest rate). A greater deviation indicates a higher degree of financial mismatch borne by the firm.

3.2.4 Control Variables

The firm-level control variables in this study comprise firm size (Size), return on assets (ROA), financial leverage (Lev), cash flow ratio (Cashflow), revenue growth rate (Growth), and inventory ratio (INV). Variable definitions are presented in Table 1.

Table 1.Variable Definitions

	Variable Name	Variable Symbol	Variable Definition
Dependent Variable	Corporate Investment Efficiency	InefficInvestDegree	Level of Inefficient Investment
Explanatory Variable	Commercial Bank Digital Transformation Index	Index	Weighted sum of the Peking University China Commercial Bank Digital Transformation Index per enterprise, weighted by the proportion of annual loans from each commercial bank, then taking the logarithm
Intermediate Variable	Financing Constraints	SA	SA Index Absolute Value
	Agency costs	Meff	Corporate management expense ratio
	Financial Mismatch	FM	Deviation of capital utilisation costs from the industry average
Control Variable	Enterprise scale	Size	Natural logarithm of total assets
	Return on assets	ROA	Net Profit / Average Balance of Total Assets
	Financial leverage	Lev	(Net profit + Income tax expense + Finance costs) / (Net profit + Income tax expense)
	Cash Flow Ratio	Cashflow	Net cash flow from operating activities / Total assets
	Revenue Growth Rate	Growth	(Current Year Revenue / Previous Year Operating Revenue) - 1
	Inventory Ratio	INV	Net inventory / Total assets

3.3 Data Explanation

This study examines Chinese A-share listed companies from 2013 to 2023, with data primarily sourced from the CSMAR database, CNRDS database, and the National Bureau of Statistics. To ensure the reliability of empirical

results, the data underwent pre-processing: (1) exclusion of samples with severe data missingness; (2) exclusion of financial sector enterprises; (3) Exclusion of ST, ST*, and PT companies; (4) Linear interpolation for partially missing data; (4) Truncation of major continuous variables. This yielded 15,554 sample observations from 1,414 companies.

4. Empirical Analysis

4.1 Benchmark Regression Results

Prior to regression analysis of the benchmark model, variance inflation factors (VIF) were examined for core explanatory and control variables. Results indicate all VIF values are below 2.5, confirming no multicollinearity issues exist among variables. Subsequently, the Hausman test rejected the random effects model at the 1% significance level. Consequently, a two-way fixed effects model controlling for both industry and time effects was adopted. Table 2 presents the test results for Model (1). Columns (1) and (2) display regression results without and with control variables, respectively, but without controlling for fixed effects. These results indicate that the coefficient for Index is significantly negative at the 1% significance level. Columns (3), (4), and (5) present regression results with fixed effects progressively controlled. The results indicate that the coefficient for Index remains significantly negative at the 1% significance level. This demonstrates that commercial banks' digital transformation exerts a significant negative impact on firms' inefficient investment ( ), meaning that higher levels of digital transformation by commercial banks correlate with lower levels of inefficient investment by firms, thereby enhancing investment efficiency. This validates Hypothesis 1 of this study.

Table 2. Baseline Regression Results

	(1)	(2)	(3)	(4)	(5)
	Inefficient Investment Degree	Inefficacy of Investment Degree	InefficInvestDegree	InefficInvestDegree	InefficInvestDegree
Index	-0.0188***	-0.0134***	-0.0139***	-0.0057**	-0.0063***
	(0.0015)	(0.0016)	(0.0016)	(0.0022)	(0.0022)
Size		-0.0047***	-0.0047***	-0.0048***	-0.0048***
		(0.0005)	(0.0005)	(0.0005)	(0.0005)
ROA		0.0506***	0.0535***	0.0523***	0.0553***
		(0.0120)	(0.0120)	(0.0118)	(0.0119)
Lev		0.0170***	0.0249***	0.0183***	0.0264***
		(0.0037)	(0.0039)	(0.0037)	(0.0038)
Cashflow		-0.0337***	-0.0471***	-0.0361***	-0.0498***
		(0.0094)	(0.0095)	(0.0093)	(0.0094)
Growth		0.0271***	0.0273***	0.0260***	0.0262***
		(0.0016)	(0.0016)	(0.0016)	(0.0016)
INV		-0.0574***	-0.0682***	-0.0571***	-0.0668***
		(0.0042)	(0.0055)	(0.0041)	(0.0054)
_cons	0.1199***	0.2007***	0.2051***	0.1600***	0.1637***
	(0.0066)	(0.0112)	(0.0123)	(0.0130)	(0.0139)
Industry	No	No	Yes	No	Yes
Year	No	No	No	Yes	Yes
N	15554	15554	15554	15554	15554
AdjR^2	0.0099	0.0464	0.0546	0.0712	0.0797

Note: * p < 0.1, ** p < 0.05, *** p < 0.01. Values in parentheses denote t-statistics; the same applies to the table below.

4.2 Robustness Tests

First, replacing the dependent variable: this paper employs the Chen model and Biddle model to substitute the indicator measuring corporate inefficient investment levels from the Richardson model. Second, lagging core explanatory variables by one period. Considering the time lag in the impact of commercial banks' digital transformation on enterprises, this study opts for regression using core explanatory variables lagged by one period.

Columns (1) and (2) of Table 3 present regression analyses using the Chen model and Biddle model respectively. Results indicate that the coefficient for Index is negative at the 1% significance level. Column (3) presents the regression analysis with the core explanatory variable lagged by one period, where the regression result remains negative at the 1% significance level. Following these robustness tests, the conclusions drawn earlier remain unchanged.

Table 3.Robustness Tests

	(1)	(2)	(3)
	Inveffi_Chen	Inveffi_Biddle	InefficInvestDegree
Index	-0.0053***	-0.0056***	
	(0.0012)	(0.0012)	
L.Index			-0.0084***
			(0.0024)
Size	-0.0010***	-0.0011***	-0.0047***
	(0.0003)	(0.0003)	(0.0006)
ROA	0.0227***	0.0153**	0.0561***
	(0.0063)	(0.0063)	(0.0127)
Lev	0.0182***	0.0181***	0.0263***
	(0.0020)	(0.0020)	(0.0041)
Cashflow	-0.0002	0.0015	-0.0486***
	(0.0050)	(0.0050)	(0.0101)
Growth	0.0141***	0.0144***	0.0260***
	(0.0009)	(0.0009)	(0.0017)
INV	-0.0268***	-0.0272***	-0.0667***
	(0.0029)	(0.0029)	(0.0058)
_cons	0.0817***	0.0864***	0.1716***
	(0.0073)	(0.0074)	(0.0150)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	15554	15554	15554
AdjR^2	0.0747	0.0749	0.0798

4.3 Endogeneity Test

The regression results above preliminarily validate the role of commercial banks' digital transformation in curbing inefficient corporate investment, thereby enhancing investment efficiency. However, given that enterprises proactively select lending banks and commercial banks tend to favour servicing larger firms, the model may suffer from selection bias. Furthermore, as unobservable omitted variables and reverse causality may affect the benchmark regression results, this study employs instrumental variables and propensity score matching to address endogeneity.

(1) Instrumental Variables. Following the methodology of Ma Yaming (2024)[15] , this study employs the Digital Financial Inclusion Index (DFI) as an instrumental variable. The DFI measures the advancement of digital finance, while commercial banks' digital transformation leverages digital technologies to expand financial service coverage and enhance service efficiency, thereby driving digital financial inclusion. Consequently, this index exhibits strong correlation with commercial banks' digital transformation indices and lacks direct relationship with corporate investment efficiency. As shown in Column (1) of Table 4, the first-stage regression coefficient is significantly positive at the 1% level. The fitted values (X) from the first-stage regression are employed in the second-stage regression. As demonstrated in Column (2) of Table 4, the second-stage regression coefficient is significantly negative at the 1% level. This indicates that, even after accounting for potential endogeneity issues within the model, commercial banks' digital transformation continues to exert a positive effect on corporate investment efficiency, confirming the robustness of the benchmark regression results.

(2) Propensity Score Matching. This study employs propensity score matching to address sample selection bias. A dummy variable BDI is constructed based on whether the Index exceeds the sample mean. Control variables from the baseline regression model serve as covariates, with a 1:1 nearest neighbour matching method determining the

control group. As shown in column (3) of Table 4, the regression coefficient for BDI is significantly negative, confirming that the baseline regression conclusions remain valid after controlling for sample selection bias.

Table 4. Endogeneity Test

	Instrumental Variables Method (2SLS) Estimation		Propensity Score Matching
	(1)	(2)	(3)
	Stage One	Second Stage	Inefficient Investment Degree
DFI	1.4238***		
	(0.0029)		
X		-0.0142***	
		(0.0027)	
BDI			-0.0198***
			(0.0011)
_cons	-3.7528***	-0.0448	0.0480***
	(0.0364)	(0.0423)	(0.0008)
Contral	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	15554	15554	15554
AdjR^2	0.9726	0.0147	0.0207

5. Mechanism Testing

The benchmark regression results have demonstrated that commercial banks' digital transformation can enhance corporate investment efficiency. Concurrently, theoretical analysis indicates that such transformation improves corporate investment efficiency by alleviating financing constraints, reducing agency costs, and diminishing financial mismatch. Hence, this paper employs a mediation model to examine the aforementioned mechanisms, with the empirical model presented in Equation (2) (3). The degree of corporate financing constraints is measured using the absolute value of the SA index, where a higher SA index value indicates greater financing constraints. Agency costs are gauged by the management expense ratio (Mfee), with a higher Mfee value signifying greater agency costs. The degree of financial mismatch is assessed by the absolute value of the FM index, where a higher FM value indicates greater financial mismatch.

5.1 Financing Constraint Mechanism

To examine the impact of financing constraints on corporate investment efficiency, this study first investigates the effect of commercial banks' digital transformation on corporate financing constraints. Column (1) of Table 5 shows that the regression coefficient for commercial banks' digital transformation on corporate financing constraints is -0.3905 at the 1% significance level. This indicates that commercial banks' digital transformation alleviates corporate financing constraints. Column (2) reveals that the regression coefficient for financing constraints on inefficient investment is 0.0068 at the 1% significance level, suggesting that greater financing constraints correlate with higher levels of inefficient investment. Commercial banks' digital transformation reduces financing constraints, thereby lowering inefficient investment levels and enhancing corporate investment efficiency. Concurrently, incorporating the mediating variable of financing constraints renders the coefficient for commercial bank digital transformation non-significant, confirming the mediating effect. This validates Hypothesis 2.

Results (3) and (4) present regression outcomes for overinvesting and underinvesting enterprises respectively. indicates that the regression coefficient for financing constraints on underinvesting enterprises is 0.0088 at the 1% significance level, suggesting the financing constraint mitigation mechanism primarily impacts underinvesting enterprises, with negligible effects on overinvesting enterprises. This may stem from underinvesting firms typically facing capital shortages that prevent investment opportunities from being realised. Alleviating financing constraints can enhance these firms' access to capital, thereby improving their investment efficiency. Conversely,

overinvesting firms may already be overextended and grapple with internal governance issues. Consequently, easing financing constraints has a limited impact on their investment efficiency.

Table 5. Financing Constraint Mechanism

	(1)	(2)	(3)	(4)
	SA	Inefficient Investment Degree	InefficInvestDegree	InefficInvestDegree
		(Full Sample)	(Overinvestment)	(Underinvestment)
Index	-0.3905***	-0.0036	-0.0075	0.0001
	(0.0078)	(0.0024)	(0.0049)	(0.0020)
SA		0.0068***	0.0052	0.0088***
		(0.0023)	(0.0047)	(0.0019)
Size	0.0841***	-0.0053***	-0.0036***	-0.0073***
	(0.0019)	(0.0006)	(0.0012)	(0.0005)
ROA	-0.4962***	0.0587***	0.0066	0.0911***
	(0.0418)	(0.0119)	(0.0269)	(0.0094)
Lev	-0.2274***	0.0280***	0.0406***	0.0152***
	(0.0135)	(0.0039)	(0.0083)	(0.0031)
Cashflow	0.1117***	-0.0506***	-0.0462**	-0.0503***
	(0.0330)	(0.0094)	(0.0200)	(0.0076)
Growth	0.0253***	0.0261***	0.0503***	0.0032**
	(0.0057)	(0.0016)	(0.0032)	(0.0014)
INV	0.0223	-0.0670***	-0.1095***	-0.0318***
	(0.0191)	(0.0054)	(0.0112)	(0.0045)
_cons	-4.0060***	0.1908***	0.1602***	0.2257 ***
	(0.0488)	(0.0166)	(0.0342)	(0.0140)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	15554	15554	6561	8993
Adjusted R-squared [2]	0.3092	0.0801	0.0850	0.1512

5.2 Agency Cost Mechanism

Column (1) of Table 6 presents the test results for the impact of commercial banks' digital transformation on corporate agency costs. The regression findings indicate that the regression coefficient for the relationship between commercial banks' digital transformation and corporate management expense ratios is -0.0179 at the 1% significance level. This demonstrates that commercial banks' digital transformation can significantly reduce corporate agency costs. Column (2) reveals that the regression coefficient for agency costs on inefficient investment levels is positive at the 1% significance level. This indicates that higher agency costs correlate with increased inefficient investment levels. As commercial bank digital transformation reduces agency costs, it consequently lowers inefficient investment levels and enhances investment efficiency. It is evident that incorporating the mediator variable agency costs (Mfee) into the model reduces the coefficient value of the commercial bank digital transformation index (Index) and diminishes its significance level, confirming the presence of a significant mediation effect. This validates Hypothesis 3 of this paper.

Columns (3) and (4) present the test results for overinvesting and underinvesting enterprises. The regression findings indicate that the regression coefficient for agency costs on overinvesting enterprises is 0.1781 at the 1% significance level, while that for underinvesting enterprises is 0.0599 at the 1% significance level. This indicates that agency costs exert a greater influence on overinvesting firms than on underinvesting firms. This may stem from overinvesting firms' management frequently pursuing non-shareholder-oriented investments to advance personal interests and expand corporate scale, directly leading to substantially increased agency costs. Concurrently, overinvestment enlarges corporate scale and heightens management complexity, exacerbating information asymmetry between management and shareholders and further elevating oversight costs. By contrast, underinvesting firms are more influenced by factors such as management conservatism, joint decision-making, external market conditions, and financing constraints. While these also increase agency costs, the impact is less

pronounced. Thus, differences in managerial motivations and corporate governance environments between overinvesting and underinvesting firms result in varying degrees of agency cost effects.

Table 6. Agency Cost Mechanism

	(1)	(2)	(3)	(4)
	Mfee	Inefficient Investment Degree	InefficInvestDegree (Underinvestment)	InefficInvestDegree (Overinvestment)
Index	-0.0179***	-0.0043*	-0.0062	-0.0022
	(0.0019)	(0.0022)	(0.0045)	(0.0019)
Mfee		0.1077***	0.1781***	0.0599***
		(0.0095)	(0.0207)	(0.0076)
Size	-0.0106***	-0.0036***	-0.0012	-0.0060***
	(0.0005)	(0.0005)	(0.0011)	(0.0005)
ROA	-0.2122***	0.0782***	0.0419	0.0995***
	(0.0101)	(0.0120)	(0.0270)	(0.0095)
Lev	-0.0817***	0.0352***	0.0526***	0.0185***
	(0.0032)	(0.0039)	(0.0083)	(0.0032)
Cash Flow	-0.0704***	-0.0422***	-0.0338*	-0.0450***
	(0.0079)	(0.0094)	(0.0199)	(0.0076)
Growth	-0.0134***	0.0277***	0.0520***	0.0045***
	(0.0014)	(0.0016)	(0.0031)	(0.0014)
INV	-0.0711***	-0.0592***	-0.0950***	-0.0275***
	(0.0046)	(0.0054)	(0.0113)	(0.0045)
_cons	0.4474***	0.1155***	0.0565*	0.1647***
	(0.0118)	(0.0144)	(0.0295)	(0.0121)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	15554	15554	6561	8993
AdjR^2	0.3413	0.0873	0.0952	0.1551

5.3 Financial Mismatch Mechanism

Column (1) of Table 7 presents the test results for the impact of commercial banks' digital transformation (Index) on corporate financial mismatch (FM). The regression findings indicate that the regression coefficient for commercial banks' digital transformation on corporate financial mismatch is negative at the 1% significance level, suggesting that commercial banks' digital transformation can reduce the degree of corporate financial mismatch.

Column (2) reveals that the regression coefficient for corporate financial mismatch (FM) on inefficient investment levels is 0.0019 at the 1% significance level. This indicates that higher levels of financial mismatch correlate with increased inefficient investment levels. Commercial bank digital transformation can reduce inefficient investment levels by mitigating corporate financial mismatch, thereby enhancing investment efficiency. Concurrently, incorporating the moderator variable FM into the model reduces both the regression coefficient and significance level of commercial bank digital transformation, confirming the moderating effect. This validates Hypothesis 4.

Columns (3) and (4) present separate regressions for overinvesting and underinvesting firms. Results indicate that financial mismatch (FM) exhibits a significantly positive regression coefficient for underinvesting firms, whereas its impact on overinvesting firms is insignificant. This may stem from underinvesting firms typically facing capital scarcity constraints, leading to frequent misallocation of funds. By alleviating financing constraints, misallocated funds are channelled into high-return projects, thereby substantially boosting investment. For overinvesting firms, however, the core driver stems from agency issues rather than capital availability. Given their ample funding, additional misallocated capital struggles to translate into tangible investments, failing to significantly alter their overinvestment status.

Table 7. Financial Mismatch Mechanism

	(1)	(2)	(3)	(4)
	FM	Inefficient Investment Degree	InefficInvestDegree (Overinvestment)	InefficInvestDegree (Underinvestment)
Index	-0.4311***	-0.0055**	-0.0087*	-0.0023
	(0.0263)	(0.0022)	(0.0046)	(0.0019)
FM		0.0019***	0.0023	0.0022***
		(0.0007)	(0.0014)	(0.0006)
Size	-0.0675***	-0.0046***	-0.0030***	-0.0064***
	(0.0064)	(0.0005)	(0.0011)	(0.0005)
ROA	-0.9384***	0.0570***	0.0047	0.0894***
	(0.1406)	(0.0119)	(0.0268)	(0.0094)
Lev	-0.0634	0.0265***	0.0396***	0.0132***
	(0.0452)	(0.0038)	(0.0082)	(0.0031)
Cashflow	0.5847***	-0.0509***	-0.0464**	-0.0509***
	(0.1108)	(0.0094)	(0.0200)	(0.0076)
Growth	-0.0411**	0.0263***	0.0505***	0.0035**
	(0.0191)	(0.0016)	(0.0032)	(0.0014)
INV	-0.3011***	-0.0662***	-0.1090***	-0.0306***
	(0.0641)	(0.0054)	(0.0112)	(0.0045)
_cons	4.0148***	0.1560***	0.1304***	0.1815***
	(0.1639)	(0.0141)	(0.0286)	(0.0119)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	15554	15554	6561	8993
AdjR^2	0.0949	0.0801	0.0852	0.1507

6. Heterogeneity Analysis

6.1 Bank Heterogeneity

To examine the impact of different types of commercial banks on corporate investment efficiency, this study incorporates the digital transformation indices of city commercial banks, joint-stock banks, state-owned banks, and rural commercial banks into separate regression analyses. Results indicate that digital transformation across all commercial bank categories exerts a significant negative effect on corporate inefficient investment levels. From Table (8), it can be seen that the regression coefficient for state-owned banks' digital transformation on corporate inefficient investment is -0.0090 at the 1% significance level, indicating the most pronounced impact. Shareholding banks follow with a coefficient of -0.0089. Rural commercial banks and urban commercial banks exhibit relatively weaker effects, with coefficients of -0.0062 and -0.0050 respectively.

Regarding the depth of digital transformation and technological capabilities, state-owned banks and joint-stock banks possess substantial capital strength and mature technology. Their digital transformation extends beyond basic operational digitisation to encompass core functions such as big data risk control and intelligent credit approval. By constructing enterprise operational data models, they can precisely identify inefficient corporate behaviours like overinvestment or underinvestment. They then proactively intervene through measures like credit limit adjustments and capital flow monitoring, thereby exerting a more pronounced curbing effect on inefficient investment. Conversely, city commercial banks and rural commercial banks, constrained by scale and resources, often confine their digital transformation to simplifying business processes. They lack the capacity for deep data mining into corporate investment behaviour, resulting in weaker precision in risk identification and intervention. Consequently, their influence on corporate investment efficiency is correspondingly limited.

Table 8. Bank Heterogeneity

	(1)	(2)	(3)	(4)
	Degree of Inefficient Investment	InefficInvestDegree	InefficInvestDegree	InefficInvestDegree
City Commercial Banks	-0.0050***			
	(0.0018)			
Shareholding Commercial Banks		-0.0089***		
		(0.0032)		
State-owned banks			-0.0090***	
			(0.0032)	
Rural Commercial Banks				-0.0062***
				(0.0022)
_cons	0.1565***	0.1774***	0.1791***	0.1606***
	(0.0127)	(0.0169)	(0.0174)	(0.0133)
Contral	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	15554	15554	15554	15554
AdjR^2	0.0797	0.0797	0.0797	0.0797

6.2 Corporate Heterogeneity

Non-state-owned enterprises, however, face persistent financing constraints and pronounced information asymmetry. By alleviating financing constraints and optimising resource allocation, commercial banks' digital transformation proves more effective in curbing inefficient investment among these firms, hence the higher coefficient.

Considering that commercial banks' digital transformation may exhibit heterogeneity across enterprises of different scales, this paper calculates the average enterprise size across the entire sample. Enterprises above this average are classified as large-scale, while those below are classified as small-scale. Columns (3) and (4) of Table 9 present the regression results. It can be observed that the regression coefficient for commercial banks' digital transformation on inefficient investment levels is significantly negative for small-scale enterprises, whereas the effect on large-scale enterprises is not significant. A plausible explanation is that small enterprises face stronger financing constraints and pronounced information asymmetry. Commercial banks' digital transformation, leveraging big data technology to overcome traditional credit limitations, enables precise matching of funding needs and constrains irrational investment, thereby enhancing their investment efficiency. Large enterprises, however, possess diversified financing channels, high information transparency, and low reliance on bank credit. Moreover, their inefficient investment often stems from agency cost issues, hence the lack of significant impact.

Table 9. Enterprise Heterogeneity

	(1)	(2)	(3)	(4)
	Degree of Inefficiency in Investment	Inefficacy of Investment Degree	InefficInvestDegree	InefficInvestDegree
	(State-owned enterprise)	(Non-state-owned enterprises)	(Large-scale enterprises)	(Small-scale enterprises)
Index	-0.0058**	-0.0074**	-0.0051	-0.0051**
	(0.0027)	(0.0034)	(0.0042)	(0.0025)
_cons	0.1401***	0.1672***	0.0698**	0.3013***
	(0.0165)	(0.0223)	(0.0319)	(0.0230)
Contral	Yes	Yes	Yes	Yes

Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	7008	8476	6944	8540
AdjR^2	0.0776	0.0875	0.0647	0.1064

7. Conclusions and Recommendations

This paper conducts an in-depth empirical analysis of the impact of commercial banks' digital transformation on corporate investment efficiency and its underlying mechanisms. The study finds that digital transformation in commercial banks can significantly reduce firms' inefficient investment levels and enhance investment efficiency. Mechanism tests reveal that digital transformation optimizes corporate investment efficiency by alleviating financing constraints, lowering agency costs, and improving financial misallocation. Heterogeneity analysis further reveals differences in the effects of digital transformation across various types of commercial banks, as well as among firms of different ownership types and sizes. State-owned banks and joint-stock banks exhibit more pronounced effects in curbing firms' inefficient investments, while non-state-owned enterprises and small-scale firms benefit more from digital transformation due to persistent financing constraints and information asymmetry. These findings provide new perspectives and empirical evidence for understanding how commercial banks' digital transformation influences corporate investment efficiency through multiple mechanisms, while also offering theoretical insights for research on how financial services support the real economy in the context of the digital economy.

The following policy implications emerge from this research. Firstly, commercial banks must sustainably increase capital and resource allocation towards digital technologies, deeply integrating cutting-edge applications such as big data and artificial intelligence with operational scenarios. This will comprehensively enhance information integration and processing efficiency alongside quantitative risk assessment capabilities. Concurrently, leveraging digital means to transcend traditional service boundaries will broaden financial service coverage, tangibly improving accessibility and equity to ensure more groups benefit from quality financial services. Secondly, enterprises should focus on strengthening internal governance systems by establishing robust, transparent information disclosure mechanisms and refined internal control processes. Improving institutional frameworks can effectively reduce information asymmetry between management and shareholders, fundamentally minimising agency cost losses and laying a solid governance foundation for corporate financing and long-term development. Thirdly, governments and regulatory bodies must introduce targeted supportive policies. Whilst encouraging commercial banks to accelerate digital transformation, they should spearhead the development of data interoperability and collaborative mechanisms across financial, tax, and industrial sectors. Policy implementation must fully account for regional economic disparities and corporate heterogeneity, prioritising increased investment in digital infrastructure within central and western regions. Policy orientation for state-owned enterprises should be optimised, with dedicated efforts to address financing constraints and information asymmetry challenges faced by non-state-owned and small-scale enterprises. These measures will further harness the positive impact of digital transformation to propel high-quality enterprise development.

References

[1] Xu, H. (2022). Objectives and directions of banking digital transformation. *China Finance*, (13), 46–48.

[2] Lee, H. H., Yang, S. A., & Kim, K. (2019). *The role of fintech in mitigating information friction in supply chain finance* (Asian Development Bank Economics Working Paper No. 574). Asian Development Bank. https://doi.org/10.22617/WPS190574-2

[3] Fuster, A., Plosser, M., Schnabl, P., & Vickery, J. (2019). The role of technology in mortgage lending. *The Review of Financial Studies, 32*(5), 1854–1899. https://doi.org/10.1093/rfs/hhz018

[4] Song, K., Guo, Y., & Xu, L. (2024). Does the Matthew Effect exist in bank digital transformation? An empirical interpretation based on banking functions. *China Industrial Economics*, (12), 62–79.

[5] Zhao, Y., & Fu, M. (2025). Short-term borrowing for long-term investment, agency costs and investment efficiency in heavy asset enterprises. *Journal of Nanjing Audit University, 22*(04), 67–79.

[6] Huang, J., & Fu, T. (2025). Digital transformation, corporate governance levels and accounting information quality of enterprises. *Accounting and Finance Bulletin*, (15), 26–30. https://doi.org/10.16144/j.cnki.issn1002-8072.2025.15.002

[7] Yang, J., & Su, Q. (2025). Can banking fintech exert investment governance effects? *Modern Economic*

Research, (05), 35–50. https://doi.org/10.13891/j.cnki.mer.2025.05.003

[8] Li, X., & Ran, G. (2021). How does digital finance development influence technological innovation quality? *Modern Economic Research*, (09), 69–77. https://doi.org/10.13891/j.cnki.mer.2021.09.008

[9] Liu, Y., & Hua, G. (2023). Can fintech promote sustainable corporate innovation by alleviating financial mismatch? Empirical evidence from listed companies in strategic emerging industries. *China Science and Technology Forum*, (04), 122–132. https://doi.org/10.13580/j.cnki.fstc.2023.04.002

[10] Richardson, S. A. (2006). Over-investment of free cash flow. *Review of Accounting Studies, 11*(2-3), 159–189. https://doi.org/10.1007/s11142-006-9012-1

[11] Xu, Q. (2014). Uncertainty, equity incentives and inefficient investment. *Accounting Research*, (03), 41–48, 95.

[12] Jia, Y., Chen, Y., & Guo, P. (2023). Bank digital transformation, financing constraints and borrower firm performance. *Journal of Yunnan University of Finance and Economics, 39*(05), 62–76. https://doi.org/10.16537/j.cnki.jynufe.000865

[13] Liu, Z., & Zhang, Q. (2024). Research on data element empowerment of corporate investment efficiency: A quasi-natural experiment based on public data openness. *Economist*, (09), 42–52.

[14] Zhou, Y., & Zhang, S. (2014). Financial mismatch, asset specificity and capital structure. *Accounting Research*, (08), 75–80, 97.

[15] Ma, Y., Ma, L., & Yu, B. (2024). Can digital transformation mitigate banks' credit risk? An empirical test based on an overlapping DID model. *Modern Finance (Journal of Tianjin University of Finance and Economics), 44*(03), 3–18. https://doi.org/10.19559/j.cnki.12-1387.2024.03.00