Digital Transformation and Bank Profitability: Evidence from Chinese Commercial Banks

Xinyi Hu

Sanda University, Shanghai, 201209, China
y250251101@st.sandau.edu.cn

Abstract. Amidst the background of FinTech penetration and intensified industry competition, digital transformation has become a key path to reshape the operational management of commercial banks. Based on panel data from commercial banks, we employ two-way fixed effects regression models and Double Machine Learning (DML) models to investigate the micro-level mechanisms through which digital transformation affects banking operations. The study reveals that: First, digital transformation significantly enhances the profitability of commercial banks, and this finding remains robust after various robustness checks and controlling for potential endogeneity issues; Second, this positive effect is primarily achieved through two parallel micro-level paths: promoting "revenue enhancement" and strengthening "risk mitigation"; Third, the promotional effect of digital transformation on the profitability of central state-owned banks is more significant. Our conclusions provide important theoretical basis and practical insights for commercial banks to formulate optimal digital transformation strategies and for regulatory authorities to improve relevant policies.

Keywords: Digital Transformation; Bank Profitability; Revenue Enhancement; Risk Mitigation; State-owned Commercial Banks

1 Introduction

Digital transformation has emerged as a defining force reshaping the business models and operational logic of commercial banks. On the one hand, the rise of fintech companies and third-party payment platforms has broken down traditional banking boundaries, compelling banks to adopt digital tools to improve service efficiency, while user behaviour is shifting decisively toward digital channels such as mobile banking and robo-advisory. On the other hand, interest rate liberalization and sustained investment in digital infrastructure have compressed net interest margins and imposed substantial cost burdens. In this dual environment, digital transformation is no longer optional but a strategic imperative for banks seeking to restore profitability.

Whether digital transformation genuinely enhances bank profitability, and through what micro-level mechanisms it does so, remains an open empirical question. This study addresses this question using panel data from 35 listed Chinese commercial banks over 2010–2022, uncovering two parallel pathways—the 'revenue enhancement effect'

© The Author(s) 2026
B. P. Siba et al. (eds.), *Proceedings of the 2026 5th International Conference on Public Service, Economic Management and Sustainable Development (PESD 2026)*, Advances in Economics, Business and Management Research 411,
https://doi.org/10.2991/978-94-6239-825-2_48

and the 'risk mitigation effect'—through which digital transformation improves bank profitability.

The remainder of this paper is organized as follows. Section 2 reviews the literature and identifies the research gap. Section 3 develops the theoretical analysis. Section 4 describes the data and methodology. Section 5 presents the empirical results, and Section 6 concludes with policy recommendations.

2 Literature Review and Research Gap

Existing literature examines digital transformation from multiple perspectives, treating it not merely as a technological upgrade but as a systematic restructuring of organizational strategy and operational models (Vial, 2021). At the macro level, digital transformation significantly enhances firms' total factor productivity and innovation capacity (Goldfarb & Tucker, 2019), whilst its relationship with corporate risk-taking often follows a U-shaped pattern—initially heightening uncertainty but ultimately reducing overall risk through enhanced process optimization (Tian et al., 2022; Plekhanov et al., 2023).

At the banking sector level, digital transformation profoundly reshapes competitive landscapes, risk governance, and business structures. Regarding credit allocation, digital technologies mitigate information asymmetry and transaction costs, thereby broadening financing availability for SMEs and optimizing capital allocation to the real economy (Gomber et al., 2017; Thakor, 2020; Berg et al., 2020). In terms of risk governance, while business diversification can reduce individual bank risk (Khattak et al., 2023), digital lending platforms also prompt a reallocation of bank capital from high-risk to low-risk sectors (Wu et al., 2025), curbing excessive risk-taking behavior (Yu et al., 2026). Concerning performance, frontier technologies significantly enhance banks' return on assets (Fuster et al., 2019), though a phased threshold effect exists where initial sunk costs suppress profitability before long-term gains materialize (Carbó-Valverde et al., 2024). Furthermore, due to stronger technological investment capabilities, large banks often exacerbate a "Matthew effect" and a winner-takes-all pattern in the industry (Vives, 2019).

In summary, whilst existing research extensively covers the technological, organizational, and risk impacts of digital transformation on banks, the underlying logic regarding the specific micro-level mechanisms through which digital investment translates into improved overall profitability remains a "black box". There is a crucial need to clarify the exact chain of effects linking digital adoption to profitability gains.

To address this gap, this study aims to uncover how digital transformation systematically enhances bank profitability via two key micro-level pathways: the 'revenue enhancement effect' and the 'risk mitigation effect'. The marginal contributions of our study are threefold: First, we deepen the understanding of bank operations by analyzing not only what is influenced but delving into the how through micro-level mechanisms. Second, by constructing a theoretical analytical framework, we clearly elucidate the connotations and operational logic of 'revenue enhancement' and 'risk mitigation' as two parallel core mechanisms, providing a refined theoretical explanation for value

creation in the digital age. Third, we examine the heterogeneous manifestations of digital transformation on different types of commercial banks, offering specific multi-stakeholder policy recommendations.

3 Theoretical Analysis and Research Hypotheses

Table 1. Theoretical pathways of digital transformation.

Theoretical Perspective	Mechanism of Action	Operational Changes	Resulting Effect
Information Asymmetry Theory	Reducing information asymmetry	Enhances risk pricing accuracy; Expands coverage of long-tail customers; Reduces regulatory compliance costs.	Risk Mitigation (Lowered risk losses)
Transaction Cost Theory	Lowering transaction costs	Reduces information search & monitoring costs; Enables automated lending processes.	Revenue Enhancement (Improved efficiency) & Risk Mitigation
Technological Innovation Theory	Driving product & process innovation	Facilitates personalized product development; Creates new revenue streams (e.g., fees).	Revenue Enhancement (Increased income)

Digital transformation fundamentally reshapes bank business models, operational processes, and products. For commercial banks, it directly impacts profitability—typically measured by Return on Equity (ROE) or Return on Assets (ROA). To understand how digital technologies enhance bank profitability, we draw upon three core economic theories. Table 1 summarizes the theoretical pathways linking digital transformation to the dual effects of revenue enhancement and risk mitigation.

From the perspective of information asymmetry theory, digital empowerment allows banks to transform their information disadvantage into a competitive advantage. By utilizing big data, banks can accurately assess creditworthiness, minimize adverse selection, and lower regulatory compliance costs, thereby directly mitigating credit risk. Transaction cost theory posits that traditional lending relies on costly pre-loan investigations and post-loan inspections. Fintech enables automated monitoring and precise credit assessment, significantly reducing information acquisition costs and expanding revenue streams. Furthermore, technological innovation theory focuses on how technology drives business development. Banks utilize innovation to develop personalized financial products (e.g., robo-advisory, mobile payments), diversifying revenue sources and creating new fee income.

To elucidate these mechanisms formally, we define a commercial bank's profit function as:

$$\pi(D) = R(D) - C(D) - L(D) \tag{1}$$

Where D represents digital transformation; $R(D)$ is revenue; $C(D)$ is technology investment cost; and $L(D)$ is risk losses.

First, assuming digital transformation enhances total factor productivity within the revenue function and thus raises revenue, the positive derivative $\partial R/\partial D > 0$ indicates

that digitalization increases revenue. We define this as the **'revenue-boosting effect'**. Second, bank risk losses can be expressed as $L(D) = p(D)E + \sigma(D)$, where $p(D)$ is the probability of loan default and E is the total loan portfolio. Existing research indicates that digitalization effectively reduces default probability and risk losses ($\partial L/\partial D < 0$). We define this as the **'risk-mitigation effect'**. Finally, digital transformation requires substantial technology investment. Defining the cost function as $C(D) = F_0 + cD + \omega D^2$ (where F_0 is fixed infrastructure investment, cD is variable costs, and ωD^2 reflects marginally increasing organizational resistance costs), the derivative $\partial C/\partial D > 0$ highlights the **'technology-cost effect'**, where increased investment temporarily suppresses profitability (Hanelt et al., 2021; Wang et al., 2023).

Taking these three effects into account, the overall impact of digital transformation on profitability is derived as:

$$\frac{\partial \pi}{\partial D} = (Revenue\ boosting) + (Risk\ mitigation) - (Technology\ cost) \quad (2)$$

Because the technology-cost effect primarily absorbs initial capital, long-term profit growth is driven through two core channels: the revenue-boosting effect and the risk-mitigation effect. These theoretical mechanisms form the core hypotheses for our subsequent empirical analysis.

4 Data & Methodology

4.1 Specifications

To identify the impact of digital transformation on the profitability of commercial banks, we employ a two-way fixed-effects panel data model, as shown in Equation (3). This model effectively controls for unobservable individual bank characteristics and macroeconomic time trends.

$$Profit_{it} = \beta_0 + \beta_1 Digital_{it} + \beta_2 Controls_{it} + \gamma_i + \lambda_t + \varepsilon_{it} \quad (3)$$

Where $Profit_{it}$ represents bank profitability, $Digital_{it}$ denotes the level of digital transformation, $Controls_{it}$ represents control variables, γ_i and λ_t denote individual and time fixed effects respectively, and ε_{it} is the error term.

4.2 Variables and Data Sources

The core explanatory variable, Digital, is measured using the "Peking University Commercial Bank Digital Transformation Index" (Cao et al., 2022). This index comprehensively covers strategic, operational, and managerial digitalization. We apply a logarithmic transformation to mitigate heteroscedasticity. The dependent variable is bank profitability, measured by Return on Equity (ROE), defined as the ratio of net profit to average shareholders' equity. Control variables include the Reserve Ratio (RR), Equity Multiplier (Multiplier), M2 Growth Rate (M2), Loan-to-Deposit Ratio (LD), and

Capital Adequacy Ratio (CAR) to control for macro-monetary policies and bank-specific financial characteristics.

Table 2. Descriptive statistics for variables.

Variable	Observation	Mean	std	Min	Max
ROE	446	14.9570	4.7870	4.4630	29.3790
Digital	446	4.2510	0.7910	0.3450	5.2200
RR	446	16.3620	3.4020	11.0000	21.0000
Multiplier	446	14.9450	2.8110	6.0500	29.3060
M2	446	11.7200	3.0420	8.1000	19.7200
LD	446	71.9760	14.753	27.9300	116.2350
CAR	444	13.3130	1.7560	9.1400	24.8600

Notes: In this study, the dependent variable is *ROE*, the unit is %; the main independent variable is Digital, which is the logarithm of the Peking University Digital Transformation Composite Index; the control variables are *RR*, *Multiplier*, *M2*, *LD* and *CAR*.

Data is primarily sourced from the Peking University Commercial Bank Digital Transformation Index, Wind, and CSMAR databases. The final panel dataset covers 35 listed commercial banks from 2010 to 2022, comprising 446 valid observations. Table 2 presents the descriptive statistics. The mean ROE is 14.957%, and the mean Digital is 4.251, showing sufficient variation. Prior to regression, a Variance Inflation Factor (VIF) test was conducted, yielding a mean VIF of 2.23 (well below the threshold of 10), which confirms the absence of severe multicollinearity.

5 Empirical Results

5.1 Benchmark Regression and Robustness

Table 3 presents the benchmark regression results. In Model (1), with only the core variable included, Digital shows a negative correlation that likely reflects omitted variable bias. However, upon progressively incorporating control variables, individual fixed effects, and time fixed effects in Model (2), digital transformation demonstrates a significant positive impact on bank profitability. Specifically, the coefficient for Digital is 0.5519 (significant at the 5% level), indicating that a one-unit increase in the logarithmic digital transformation index increases ROE by an average of 0.55 percentage points. To ensure reliability, we conducted robustness tests by winsorizing variables and replacing the dependent variable with net interest income. As shown in Models (3) and (4), the coefficients remain significantly positive, confirming that the core findings are not driven by extreme values or specific proxy variables.

5.2 Endogeneity and Machine Learning Validation

To address potential endogeneity, we employ the ratio of China's third-party internet payment scale to total bank assets as an instrumental variable (IV). The 2SLS second-stage results in Model (5) show that the Digital coefficient is 4.8867 (significant at the

1% level), with a first-stage F-statistic of 28.37 rejecting the weak instrument hypothesis. Furthermore, to account for complex non-linear relationships and high-dimensional confounding factors, we apply the Double Machine Learning (DML) model using a Random Forest algorithm. As shown in Model (6), the DML coefficient remains significantly positive (0.6046); additional robustness checks across different numbers of cross-fitting folds and machine learning algorithms yield consistent results (available upon request). These results confirm that digital transformation has a robust causal positive effect on bank profitability.

Table 3. Benchmark, Robustness, and Endogeneity Results.

Variable	*(1) ROE*	*(2) ROE*	*(3) ROE Winsorized*	*(4) Net Interest Income*	*(5) ROE (2SLS)*	*(6) ROE (DML)*
Digital	-3.4034***	0.5519**	0.5337*	0.1367***	4.8867***	0.6046**
Controls	N	Y	Y	Y	Y	Y
Bank FE	N	Y	Y	Y	Y	Y
Time FE	N	Y	Y	Y	Y	Y
N	446	444	444	444	444	444
Adj. R²	0.315	0.826	0.831	0.990	0.639	-

Notes: Robust standard errors available upon request. *p < 0.1, **p < 0.05, ***p < 0.01. Column (5) uses 2SLS; Column (6) uses DML (k-folds=5).

5.3 Heterogeneity Analysis

We examine whether the impact varies across bank types. The sample is divided into central state-owned banks and non-central state-owned banks. The results reveal a strong "Matthew effect": for central state-owned banks, the Digital coefficient is 1.3079 (significant at 5%), whereas for non-central state-owned banks, the impact is insignificant (coefficient: 0.3376); the subsample sizes are N = 98 and N = 346, respectively. This indicates that larger, better-resourced state-owned banks are better positioned to capitalize on the benefits of digital transformation through top-down strategic coordination and deeper data application, whereas smaller banks face constraints in achieving profound transformation outcomes.

5.4 Mechanism Testing

We empirically test the two parallel micro-level mechanisms: revenue enhancement and risk mitigation.

Revenue-Boosting Effect: Table 4 (Columns 1-3) shows that digital transformation significantly increases banks' operating revenue (0.1238), interest income (0.1534), and fee and commission income (0.1228), all at the 1% significance level. This confirms that digitalization broadens revenue streams through improved efficiency, optimized credit processes, and new digital service models.

Risk-Mitigation Effect: Table 4 (Columns 4-5) demonstrates that digital transformation significantly reduces the non-performing loan ratio (-0.4759) and increases net

capital (0.1504). This proves that digitalization effectively curbs risk formation through enhanced risk identification while simultaneously bolstering the bank's long-term risk-absorption capacity.

Table 4. Mechanism Testing Results.

Variable	*(1)* *Revenue*	*(2)* *Interest Income*	*(3)* *Fee Income*	*(4)* *NPL Ratio*	*(5)* *Net Capital*
Digital	0.1238***	0.1534***	0.1228***	-0.4759***	0.1504***
Controls	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y
N	444	444	444	444	435
Adj. R²	0.992	0.991	0.980	0.283	0.993

Notes: Robust standard errors available upon request. All variables are calculated as the logarithm of (1 + amount) except NPL Ratio. *p < 0.1, **p < 0.05, ***p < 0.01.

6 Conclusions and Recommendations

This study uncovers the core mechanisms through which digital transformation reshapes banking operations. Based on a panel dataset of 35 listed commercial banks from 2010 to 2022, our two-way fixed-effects model indicates that digital transformation significantly and causally enhances bank profitability, with a one-unit increase in the logarithmic digital transformation index raising Return on Equity by an average of 0.5519 percentage points. This finding remains robust after rigorous robustness checks and endogeneity treatments using instrumental variables (2SLS) and Double Machine Learning (DML). Furthermore, mechanism tests reveal two parallel micro-level pathways driving this profitability: a "revenue-enhancement effect," characterized by significant growth in operating revenue, interest income, and fee income; and a "risk-mitigation effect," evidenced by a reduced non-performing loan ratio and increased net capital. Finally, heterogeneity analysis reveals a pronounced "Matthew effect": the positive impact is significant for central state-owned banks but not for non-central state-owned banks, indicating that larger, better-resourced banks are better positioned to leverage data for deep digital value creation.

Based on these findings, we propose three targeted recommendations. First, government regulatory authorities should establish a comprehensive digital financial governance framework covering the entire data lifecycle to break down data silos, whilst providing special transformation funds to alleviate technology investment costs for small and medium-sized banks. Second, commercial banks must balance technological investment with actual returns to avoid the strategic pitfall of "digitalization for digitalization's sake," with state-owned banks focusing on building digital ecosystems and smaller banks targeting localized vertical sectors. Third, fintech companies should collaborate with regulators and banks to develop modular, compliant technological solutions, ensuring data security while fostering an open and mutually beneficial fintech ecosystem.

Disclosure of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Berg, T., Burg, V., Gombović, A., & Puri, M. (2020). On the rise of fintechs: Credit scoring using digital footprints. The Review of Financial Studies, 33(7), 2845–2897. https://doi.org/10.1093/rfs/hhz112.
2. Cao, X., Han, B., Huang, Y., & Xie, X. (2022). Digital transformation and risk differentiation in the banking industry: Evidence from Chinese commercial banks. Asian Economic Papers, 21(3), 1–21. https://doi.org/10.1162/asep_a_00853.
3. Carbó-Valverde, S., Cuadros-Solas, P. J., Rodríguez-Fernández, F., & Sánchez-Béjar, J. J. (2024). Digital innovation and de-branching in the banking industry: Customer perception and satisfaction. Global Policy, 15(S1), 8–20. https://doi.org/10.1111/1758-5899.13313.
4. 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.
5. Goldfarb, A., & Tucker, C. (2019). Digital economics. Journal of Economic Literature, 57(1), 3–43. https://doi.org/10.1257/jel.20171439.
6. Gomber, P., Koch, J.-A., & Siering, M. (2017). Digital finance and FinTech: Current research and future research directions. Journal of Business Economics, 87(5), 537–580. https://doi.org/10.1007/s11573-017-0851-x.
7. Hanelt, A., Bohnsack, R., Marz, D., & Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. Journal of Management Studies, 58(5), 1159–1197. https://doi.org/10.1111/joms.12634.
8. Khattak, M. A., Ali, M., Azmi, W., & Rizvi, S. A. R. (2023). Digital transformation, diversification and stability: What do we know about banks? Economic Analysis and Policy, 78, 122–132. https://doi.org/10.1016/j.eap.2023.03.004.
9. Plekhanov, D., Franke, H., & Netland, T. H. (2023). Digital transformation: A review and research agenda. European Management Journal, 41(6), 821–844. https://doi.org/10.1016/j.emj.2022.09.007.
10. Thakor, A. V. (2020). Fintech and banking: What do we know? Journal of Financial Intermediation, 41, 100833. https://doi.org/10.1016/j.jfi.2019.100833
11. Tian, G., Li, B., & Cheng, Y. (2022). Does digital transformation matter for corporate risk-taking? Finance Research Letters, 49, 103107. https://doi.org/10.1016/j.frl.2022.103107
12. Vial, G. (2021). Understanding digital transformation: A review and a research agenda. In A. Hinterhuber, T. Vescovi, & F. Checchinato (Eds.), Managing digital transformation (pp. 13–66). Routledge. https://doi.org/10.4324/9781003008637-4.
13. Vives, X. (2019). Digital disruption in banking. Annual Review of Financial Economics, 11, 243–272. https://doi.org/10.1146/annurev-financial-100719-031129.
14. Wang, K., Zhang, Z., Xiong, J., Li, H., Liu, H., & Ma, H. (2023). Balancing strategic renewal, cost and efficiency: A case study in digital transformation. Journal of Business Strategy, 44(5), 266–276. https://doi.org/10.1108/JBS-05-2022-0087.
15. Wu, S., Tian, H., & Aden, E. (2025). Bank digitalization and capital reallocation. Journal of Business Ethics, 199(3), 583–601. https://doi.org/10.1007/s10551-024-05844-3.

16. Yu, S., Zheng, X., & Liu, M. J. (2026). Digital innovation as a bank risk mitigator: Empirical insights from Chinese commercial banks. Research Policy, 54(7), 105501. https://www.sciencedirect.com/science/article/pii/S0048733326000922.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

