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Digital transformation and bank loan pricing: New insights from an emerging market

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DIGITAL TRANSFORMATION AND BANK LOAN PRICING: NEW INSIGHTS FROM AN EMERGING MARKET

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ABSTRACT

This study investigates the impact of digital transformation on bank loan costs in Vietnam. Using an unbalanced panel dataset of 28 commercial banks from 2007 to 2023 and employing fixed-effects, GMM, and two-way cluster estimations, the results reveal that higher levels of digital transformation significantly reduce loan costs. Digital transformation enhances information transparency, streamlines credit operations, and strengthens risk management, allowing banks to offer more competitive lending rates. The heterogeneity analyses further show that the cost-reducing effect of digital transformation is stronger among large and state-owned commercial banks, which possess superior financial resources, technological infrastructure, and government support for digital initiatives. By contrast, smaller and joint-stock banks exhibit more modest benefits, reflecting resource and capability constraints. The findings underscore that digital transformation acts as a critical efficiency lever in emerging markets lowering borrowing costs, improving financial inclusion, and fostering sustainable banking competitiveness. Policy implications emphasize the need for continued regulatory support, digital infrastructure investment, and inclusive digital capacity building to ensure that the benefits of banking digitalization are evenly distributed across institutions and customer segments.

1. Introduction

The global trend of digital transformation has been profoundly reshaping economic systems worldwide. The integration of advanced technologies such as artificial intelligence (AI), big data, cloud computing, and blockchain has fundamentally altered how industries operate, with particularly strong implications for the financial services sector (Vives, 2019). These innovations expand data processing capacity, improve the monitoring and assessment of risks, and enhance the competitiveness of financial institutions (Anagnostopoulos, 2020). In banking, digital technologies are transforming the entire lending value chain from loan origination and credit scoring to approval, disbursement, and post-loan monitoring offering opportunities to lower costs, increase efficiency, and strengthen financial inclusion.

In bank-based economies such as Vietnam, where equity and bond markets remain underdeveloped, the banking system plays a pivotal role in financial intermediation. The majority of corporate and household financing needs are met through bank credit, making the efficiency of the banking sector critical for capital allocation, investment decisions, and sustainable economic growth (Beck et al., 2004). Lending costs, defined as the interest rates and associated fees charged to borrowers, are not only central to firms' financing decisions but also reflect the competitive conditions and efficiency of financial intermediation within the economy (Beck et al., 2004). Lower lending costs support investment and consumption, while higher costs may constrain credit access, particularly for small and medium-sized enterprises (SMEs), which are key drivers of growth in emerging markets.

From a theoretical standpoint, digital transformation is expected to reduce loan costs through several mechanisms. First, by leveraging diverse datasets and advanced analytics, digital tools help mitigate information asymmetry between banks and borrowers, thereby lowering adverse selection and moral hazard problems (Stiglitz & Weiss, 1981). Second, digitalization enhances risk assessment through the use of big data, AI-driven credit scoring, and real-time monitoring, enabling banks to adopt more accurate and risk-adjusted lending rates (Claessens et al., 2018). Third, operational digitalization streamlines loan processing, reduces paperwork, and automates credit approval workflows, resulting in lower transaction and administrative costs that can be passed on to borrowers (Gomber et al., 2017).

Empirical evidence supports these theoretical mechanisms. Studies have shown that banks adopting digital technologies tend to improve credit allocation efficiency and offer more competitive loan pricing, particularly in emerging markets where conventional credit information systems are limited (Beck et al., 2018). For instance, Tian et al. (2022) demonstrate that digital adoption improves transparency and reduces borrowing costs by alleviating information asymmetry. At the same time, fintech innovations such as digital lending platforms and alternative credit scoring models have expanded credit access to underserved borrowers, improving financial inclusion while reducing the average cost of funds (Philippon, 2016; Frost et al., 2019).

Despite these promising findings, the empirical evidence regarding the effect of digital transformation on loan costs in Vietnam remains scarce. Existing studies on the Vietnamese banking sector have mainly focused on the effects of digitalization on operational efficiency (Nguyen et al., 2023; Do et al., 2022), risk-taking (Hoque et al., 2024), and decision-making processes (Nguyen & Tran, 2023). This research gap is especially important given the uneven pace of digital adoption among Vietnamese commercial banks. While some banks have invested heavily in digital platforms and data analytics, others remain in the early stages of transformation, constrained by legacy information technology infrastructure, limited skilled personnel, and evolving regulatory frameworks. This heterogeneity raises important questions about how digital adoption translates into differences in loan pricing across banks. Moreover, Vietnam's reliance on bank credit amplifies the macroeconomic significance of this relationship. If digital transformation systematically reduces lending costs, it could not only improve bank competitiveness and borrower affordability at the micro level but also enhance financial inclusion and support long-term economic growth at the macro level. Conversely, if digital adoption primarily benefits large or technologically advanced banks, it may widen the cost gap between banks, reinforcing market concentration and limiting credit access for smaller borrowers.

To address these issues, this study investigates the impact of digital transformation on loan costs in Vietnamese commercial banks using an unbalanced panel dataset from 2007 to 2023. By employing a text-based measure of digital adoption capturing the frequency of digital-related keywords in banks' annual reports, this study introduces a novel approach that reflects the actual extent of digitalization efforts (following Cui et al., 2025). The empirical strategy accounts for potential endogeneity and heterogeneity by applying dynamic panel techniques, two-way clustering, and subsample analyses based on bank size and ownership structure.

This paper makes four main contributions to the literature. First, it extends the empirical understanding of how digital transformation influences loan pricing in an emerging market context where bank credit dominates financial intermediation. Second, it proposes a novel, text-based measure of digitalization that captures banks' actual strategic orientation, addressing limitations of prior proxies such as survey data or binary indicators. Third, it explores heterogeneity across bank characteristics specifically size and ownership offering insights into whether digital transformation disproportionately benefits certain types of banks. Finally, the study provides policy-relevant implications by showing how digital adoption can serve as a mechanism to reduce borrowing costs, strengthen financial inclusion, and enhance credit market efficiency in Vietnam and similar emerging economies.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the research methodology and data. Section 4 presents and discusses the empirical results. Section 5 concludes with key implications and directions for future research.

2. Literature review

2.1. Digital transformation in banking

Digital transformation refers to the comprehensive integration of digital technologies into all areas of an organization, fundamentally changing how it operates, delivers value, and interacts with customers (Vives, 2019). In the banking sector, digital transformation extends beyond mere digitization of data and processes to encompass the full reconfiguration of business models and operations through technologies such as artificial intelligence (AI), big data analytics, cloud computing, blockchain, and robotic process automation (Gomber et al., 2017; Anagnostopoulos, 2020). According to Chen et al. (2019), digital transformation in banking involves three core dimensions: internal process digitalization, digital service delivery, and data-driven decision-making. These transformations enhance operational efficiency, lower costs, strengthen risk management, and improve customer experience.

The measurement of digital transformation has evolved across the literature. Earlier studies often used direct indicators such as information technology expenditure ratios, the number of online transactions, or the proportion of customers using digital banking services (Del Gaudio et al., 2021). More recently, researchers have adopted text-based indices to capture the strategic emphasis on digitalization by counting the frequency of digital-related keywords in banks' annual reports (Cui et al., 2025; Nguyen et al., 2023). This approach offers greater comparability and transparency, especially in emerging markets where detailed financial data on digital investment are limited. It also captures the bank's strategic intent and commitment to digital transformation, rather than focusing solely on financial input measures. Overall, digital transformation has become a key driver of banking competitiveness, efficiency, and financial inclusion by facilitating better information processing, automation, and cost reduction across financial intermediation activities.

2.2. The impact of digital transformation on bank loan costs

The relationship between digital transformation and bank loan costs has received increasing scholarly attention. Theoretically, digital transformation can reduce loan costs through three primary mechanisms. First, it mitigates information asymmetry between lenders and borrowers by improving data collection, credit scoring accuracy, and monitoring processes, thereby reducing adverse selection and moral hazard (Claessens et al., 2018; Stiglitz & Weiss, 1981). Second, it enhances operational efficiency by automating loan origination, assessment, approval, and monitoring processes, which reduces administrative expenses and transaction costs (Chen et al., 2019; Gomber et al., 2017). Third, it fosters greater competition and financial inclusion through digital lending platforms and fintech partnerships, which pressure traditional banks to offer more competitive interest rates (Frost et al., 2019; Philippon, 2016).

Previous studies support these theoretical predictions. For instance, Cui et al. (2025) found that banks with higher digital transformation scores tend to offer loans at lower costs in China, especially among large institutions with greater technological capacity. Similarly, Tian et al. (2022) showed that digitalization enhances transparency, reduces credit risk, and narrows loan spreads. Beck et al. (2018) further demonstrated that fintech development facilitates cheaper credit provision in developing economies by leveraging alternative data to assess borrower risk.

Despite these findings, research on this topic in Vietnam remains limited. Existing studies have primarily focused on how digital transformation affects bank profitability (Nguyen et al., 2023; Nguyen et al., 2025) or risk-taking behavior (Hoque et al., 2024), leaving the direct impact on loan pricing largely unexplored. Given Vietnam's bank-based financial system,

where credit plays a central role in corporate and household financing, understanding how digital transformation influences loan costs has significant implications for both financial inclusion and economic efficiency. Therefore, this study aims to fill this research gap by empirically testing the hypothesis that digital transformation has a negative effect on bank loan costs, meaning that higher levels of digital adoption are associated with lower lending costs.

Hypothesis 1: Digital transformation has a negative effect on bank loan costs.

3. Data and methodology

3.1. Model specification

Our purpose is to investigate the the impact of digital transformation on bank loan costs in Vietnam. Following Nguyen et al. (2024), Pham et al. (2025), Nguyen (2026), this paper proposes the following equation:

$$LC_{i,t} = \beta_0 + \beta_1 DT_t + \sum_{i=1}^{k} \beta_{2i} Controls_i + \delta_i + \varepsilon_{i,t}$$

Following Ashraf and Shen (2019), and Nguyen and Nguyen (2025), this study employs the ratio of interest income to gross loans as a proxy for bank loan cost. The main independent variable is the digital transformation (DT), which captures the extent of digital transformation by Vietnamese commercial banks. The control variables included in the model are bank capitalization, current account savings account ratio (CASA), income diversification (IDIV), funding diversification (FDIV), and macroeconomic factors such as GDP growth rate and the COVID-19 dummy. In addition, following Nguyen et al. (2024), this paper incorporates bank fixed effects (δi) to control for unobserved, time-invariant characteristics at the bank level, such as risk appetite, organizational culture, and strategic orientation. However, time fixed effects are excluded from the model specification because the macroeconomic variables such as GDP and COVID remains constant across banks within each year. Therefore, including time fixed effects would absorb the entire variation of these variables (Gulen & Ion, 2015). Table 1 presents the details of the variable measurements.

Table 1. Variables description

Variables	Abbreviation	Variable measurements
Dependent variable		
Bank loan cost	LC	Interest income to gross loans ratio
Independent variables		
Digital transformation	DT	Digital transformation level, measured as the natural logarithm of the total number of digital transformation–related keywords disclosed in a bank's annual report (Nguyen et al., 2023; Cui et al., 2025).
Current account savings account	CASA	$\text{CASA} = \frac{\text{Total demand deposits}}{\text{Total deposits}}$
Capitalization	CAPITAL	$\text{CAPITAL} = \frac{\text{Total equity}}{\text{Total assets}}$
Income diversification	IDIV	$\text{IDIV} = 1 - \left(\frac{\text{NII}}{\text{NOP}}\right)^2 - \left(\frac{\text{NON}}{\text{NOP}}\right)^2$ Where: NII: Net interest income. NON: Non-interest income.

Variables	Abbreviation	Variable measurements
		NOP: Operating income.
Funding diversification	FDIV	$\text{FDIV} = 1 - \left[\left(\frac{EQU}{FUND}\right)^2 + \left(\frac{GOV}{FUND}\right)^2 + \left(\frac{IBD}{FUND}\right)^2 + \left(\frac{CD}{FUND}\right)^2 + \left(\frac{DER}{FUND}\right)^2 + \left(\frac{FF}{FUND}\right)^2 + \left(\frac{VP}{FUND}\right)^2 + \left(\frac{OTHER}{FUND}\right)^2\right]$ Where: FUND: Total funding of bank EQU: Shareholders' equity GOV: Amounts due to the Government and the State Banks IBD: Deposits and borrowings from other credit institutions CD : Deposit from customers DER: Derivative financial instruments and other financial liabilities FF: Funds for finance, entrusted investments and entrusted loans VP: Valuable papers issued Other: Other liabilities following Pham & Nguyen (2023)
GDP growth rate	GDP	GDP growth rate
COVID-19	COVID	Dummy variable - takes the value "1" in years 2020-2023; "0" for the remaining years

Source: Authors' own work

3.2. Data

This paper utilizes an unbalanced panel dataset consisting of 28 Vietnamese banks from 2007 to 2023. This dataset is collected from the WiData database. This paper winsorizes all variables at the 1st and 99th percentile level to remove the potential outlier effects in the analyses. Table 2 shows the descriptive statistics show that the loan cost variable (LC) has a relatively stable mean, reflecting a certain degree of similarity in credit cost structures across banks. However, the digital transformation variable (DT) exhibits a high standard deviation, indicating substantial heterogeneity among Vietnamese commercial banks: while some institutions have made significant investments in digitalization, others remain at an early stage. This variation provides a favorable setting for analyzing the impact of digital transformation on loan costs. The control variables, including CASA, CAPITAL, IDIV, and FDIV, capture differences in funding strategies and risk management across banks, whereas GDP growth and the COVID dummy are included to account for macroeconomic conditions and specific external shocks.

Table 2. Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
LC	451	0.144	0.071	0.073	0.720
DT	383	3.277	1.074	0.693	5.694
CASA	353	0.154	0.097	0.010	0.505
CAPITAL	451	0.100	0.053	0.041	0.462
IDIV	357	0.286	0.132	0.010	0.646
FDIV	451	0.525	0.114	0.195	0.773
GDP	451	0.060	0.015	0.026	0.081
COVID	451	0.246	0.431	0	1

Source: Authors' calculation

The correlation coefficient is a statistical measure that assesses the strength of the linear relationship between two variables. The results in Table 3 show that the correlation coefficients of the variables are all lower than 80%, so these independent variables are suitable for regression (Hair et al., 2006).

Table 3. Correlation matrix

Variable	DT	CASA	Capital	IDIV	FDIV	GDP	COVID
DT	1.000						
CASA	0.368	1.000					
CAPITAL	-0.138	0.092	1.000				
IDIV	0.415	0.539	0.073	1.000			
FDIV	0.049	0.064	0.255	0.181	1.000		
GDP	-0.105	-0.094	-0.047	-0.083	0.027	1.000	
COVID	0.359	0.098	-0.055	0.193	-0.004	-0.548	1.000

Source: Authors' calculation

4. Main findings

4.1. Empirical results

Table 4 presents the main empirical findings of this study. Model (1) reports the baseline regression, examining the direct effect of digital transformation (DT) on bank loan costs without additional controls. Model (2) incorporates control variables such as CASA ratio, capitalization, funding diversification (FDIV), GDP growth, and the COVID-19 dummy variable. Model (3) applies the two-step Generalized Method of Moments (GMM) estimator to address potential endogeneity issues between digital transformation and loan costs. Model (4) employs a two-way cluster regression by bank and time to ensure the robustness of the standard errors against both autocorrelation and heteroscedasticity.

Table 4. Empirical results

Variables	(1) Baseline	(2) Additional variables	(3) GMM	(4) Two-way cluster
DT	-0.024***	-0.012*	-0.004**	-0.012**
	(0.004)	(0.006)	(0.002)	(0.005)
CASA		-0.242**	-0.246***	-0.242***
		(0.097)	(0.054)	(0.057)
CAPITAL		0.531***	0.666***	0.531***
		(0.113)	(0.128)	(0.111)
IDIV		-0.115**	-0.111***	-0.115***
		(0.049)	(0.009)	(0.038)
FDIV		0.193***	0.249***	0.193***
		(0.035)	(0.018)	(0.031)
GDP		-0.537***	-0.407***	-0.537***
		(0.095)	(0.042)	(0.122)
COVID		-0.020**	-0.022***	-0.020***
		(0.008)	(0.003)	(0.006)
L.LC			0.116***	
			(0.032)	
Constant	0.220***	0.138***	0.045***	0.138***
	(0.014)	(0.034)	(0.013)	(0.021)

Note: All financial variables are winsorized at 1% level on top and bottom of the distribution. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Standard errors are clustered at the bank level. Numbers in parentheses are standard errors.

Source: Authors' calculation

The results presented in Table 4 indicate that digital transformation (DT) has a negative and statistically significant effect on the cost of loans across all model specifications, consistent with the hypothesis that digital transformation enhances banking efficiency, reduces operational expenses, and mitigates information asymmetry between lenders and borrowers (Claessens et al., 2018; Tian et al., 2022), thereby providing loans at cheaper prices. First, digital transformation improves information efficiency by enabling banks to exploit alternative and real-time data sources, such as digital payment histories, supply-chain transactions, and behavioral analytics, thereby enhancing credit screening and reducing the informational rents traditionally embedded in lending margins. Enhanced borrower transparency lowers the perceived probability of default and allows banks to price credit more competitively. Second, digitalization fosters operational efficiency through process automation, straight-through loan processing, and electronic document management, which substantially reduce administrative and monitoring costs. These efficiency gains translate into narrower interest spreads as banks pass part of the cost savings on to clients. Third, digital ecosystems facilitate dynamic risk management: machine-learning-based early-warning systems and real-time portfolio monitoring help contain non-performing loans, thereby lowering provisioning requirements and the overall cost of capital. Finally, by intensifying market competition through digital channels and fintech partnerships, digital transformation exerts competitive pressure that disciplines pricing behavior, further reducing lending rates (Frost et al., 2019; Philippon, 2016). Collectively, these mechanisms demonstrate that technological advancement not only enhances internal bank efficiency but also restructures the broader pricing dynamics of credit markets toward greater transparency and cost effectiveness.

Beyond digital transformation, the control variables provide additional evidence on the bank-specific and macroeconomic factors shaping loan pricing decisions. First, the negative coefficient on the CASA ratio suggests that banks with a larger proportion of low-cost demand deposits are able to reduce their funding costs and, consequently, offer credit at more competitive rates. By contrast, capitalization is positively associated with loan costs, implying that better-capitalized banks tend to price loans more conservatively to maintain capital adequacy and compensate for the higher opportunity cost of equity financing. Income diversification (IDIV) also exhibits a negative and significant effect, indicating that banks with broader non-interest income sources are less dependent on lending revenues and therefore face weaker incentives to charge higher lending rates. Conversely, funding diversification (FDIV) is positively related to loan costs, suggesting that greater reliance on wholesale and other non-traditional funding sources increases the marginal cost of funds, which is subsequently transmitted to borrowers through higher lending rates. At the macroeconomic level, stronger GDP growth significantly reduces loan costs, consistent with the view that favorable economic conditions improve borrower creditworthiness, lower expected default risk, and compress credit risk premia. Finally, the negative coefficient on the COVID-19 dummy reflects the extraordinary monetary and regulatory interventions implemented during the pandemic. In particular, the State Bank of Vietnam adopted an accommodative monetary stance and encouraged commercial banks to lower lending rates through debt restructuring, interest-rate concessions, and targeted credit support, thereby mitigating financing constraints for firms and households.

4.3. The effect of bank size

The previous literature has emphasized the heterogeneity of digital transformation benefits across banks of different sizes. Vives (2019) argued that larger financial institutions are better positioned to exploit digital technologies due to their economies of scale and stronger infrastructure. Cornelli et al. (2020) further noted that large banks often gain more from adopting advanced technologies because they can spread fixed costs over a wider customer base, achieving efficiency gains unavailable to smaller institutions. Consistent with this view, Del Gaudio et al. (2021) and George (2025) found that bank size is positively associated with digital adoption, since larger banks have both the resources and incentives to invest in

innovation. In contrast, Beck et al. (2016) highlighted that small banks face structural constraints such as limited financial resources, lower technological capacity, and weaker human capital, which hinder their ability to capitalize on digital opportunities.

Building on this background, Columns (5) and (6) in Table 5 present the subsample results by bank size. The classification of banks into large and small groups is based on their total assets, consistent with prior empirical studies (Berger & Bouwman, 2013; Cornett et al., 2011). Specifically, banks with total assets above the sample mean at observe year are classified as large banks, whereas those below the mean are categorized as small banks. This approach reflects the differences in resource capacity, technological capability, and operational scale that may influence the effectiveness of digital transformation initiatives.

Table 5. The effects of digital transformation on loan costs by bank size

Variables	**(5)** **Large banks**	**(6)** **Small banks**
DT	-0.018***	0.005
	(0.005)	(0.005)
CASA	-0.237***	-0.215
	(0.069)	(0.177)
Capital	0.025	0.739***
	(0.184)	(0.222)
IDIV	-0.128***	-0.000
	(0.035)	(0.053)
FDIV	0.166***	0.198***
	(0.030)	(0.052)
GDP	-0.199**	-0.517**
	(0.088)	(0.256)
COVID	0.003	-0.004
	(0.006)	(0.013)
Constant	0.201***	0.011
	(0.023)	(0.047)

Note: All financial variables are winsorized at 1% level on top and bottom of the distribution. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Standard errors are clustered at the bank level. Numbers in parentheses are standard errors.

Source: Authors' calculation

The findings reveal that the negative impact of digital transformation (DT) on loan costs is statistically significant for large banks but insignificant for small banks. This asymmetry suggests that the benefits of digital transformation are more effectively realized by larger institutions, consistent with prior evidence that digital investments are scale-sensitive (Vives, 2019; Cornelli et al., 2020). Large banks typically possess stronger financial resources, more advanced technological infrastructure, and greater managerial expertise to integrate and optimize digital technologies in their operations. As a result, they can enhance efficiency, reduce transaction costs, and improve credit risk assessment, leading to lower lending costs. In contrast, small banks often face financial and organizational barriers in implementing large-scale digital initiatives (Vial, 2019). Limited capital budgets, a lack of specialized personnel, and conservative management structures may constrain their ability to adopt advanced technologies effectively. Consequently, digital transformation may reinforce the competitive advantage of large banks, potentially widening the performance and efficiency gap between large and small institutions in emerging markets. This divergence underscores the need for policymakers to support smaller banks through digital infrastructure investments and capacity-building programs to ensure that the benefits of digitalization are distributed more evenly across the banking sector.

4.4. The effect of ownership

Prior research has highlighted that the impact of digital transformation on banking outcomes may vary across ownership types due to differences in governance structures and strategic orientations. Claessens et al. (2018) argued that state-owned banks, while benefiting from government backing and dominant market shares, often face bureaucratic rigidities that can slow the adoption of innovative technologies. Gomber et al. (2017) further noted that private banks in emerging markets often view digitalization as a strategic necessity to differentiate themselves, while Chen et al. (2019) emphasized that ownership structure influences the speed and effectiveness of technology adoption.

Table 6. The effects of digital transformation on loan costs by ownership

Variables	(7) State-owned banks	(8) Join-stock banks
DT	-0.020***	-0.012**
	(0.006)	(0.005)
CASA	-0.048	-0.273***
	(0.096)	(0.061)
Capital	0.060	0.533***
	(0.210)	(0.114)
IDIV	-0.230***	-0.105***
	(0.054)	(0.039)
FDIV	0.110**	0.200***
	(0.051)	(0.034)
GDP	-0.276**	-0.579***
	(0.125)	(0.135)
COVID	0.012	-0.025***
	(0.010)	(0.006)
Constant	0.217***	0.138***
	(0.052)	(0.022)

Note: All financial variables are winsorized at 1% level on top and bottom of the distribution. ***, **, * indicate significance at the 1%, 5%, and 10% level respectively. Standard errors are clustered at the bank level. Numbers in parentheses are standard errors.

Source: Authors' calculation

Columns (7) and (8) in Table 6 report the regression results by ownership structure. The classification of banks into state-owned and joint-stock categories follows the official ownership structure reported by the State Bank of Vietnam (SBV). Specifically, state-owned banks are defined as those in which the government holds a controlling share (typically above 50% of total equities), such as Vietcombank, VietinBank, and BIDV. This classification approach aligns with prior Vietnamese banking studies (Nguyen et al., 2023; Nguyen & Nguyen, 2025) and reflects fundamental differences in governance, strategic flexibility, and competitive orientation across ownership types.

Empirical results indicate that the coefficient of digital transformation (DT) is negative and statistically significant for both state-owned and joint-stock banks, indicating that digitalization contributes to lowering loan costs across ownership structures. Notably, the coefficient for state-owned commercial banks (–0.020) is almost double that of joint-stock banks (–0.012), suggesting that the cost-reducing effect of digital transformation is more pronounced among state-owned institutions. This result can be explained by the fact that state-owned banks have been the pioneers of digital transformation in Vietnam, driven by the government's national strategy for digital economy development and the State Bank of Vietnam's (SBV) policy agenda promoting digital banking modernization. With stronger financial capacity, broader customer bases, and prioritized access to government-supported

digital infrastructure, state-owned banks have been able to deploy comprehensive digital platforms that enhance operational efficiency and reduce intermediation costs more effectively. By contrast, joint-stock banks, while also advancing in digital adoption, tend to pursue incremental and resource-constrained strategies that yield smaller cost advantages. Overall, these findings underscore that state-owned commercial banks lead Vietnam's digital transformation efforts, translating policy-driven innovation into measurable reductions in lending costs and improved financial efficiency across the banking system.

5. Conclusion

This study provides comprehensive empirical evidence on how digital transformation affects the cost of loans in Vietnamese commercial banks. Using panel data from 28 banks over the period 2007–2023 and a combination of fixed-effects, GMM, and two-way cluster estimations, the results consistently confirm that greater digital transformation significantly reduces loan costs by improving information transparency, enhancing operational efficiency, and strengthening banks' risk management capabilities. In other words, banks with higher levels of digital transformation provide loans at lower cost.

The heterogeneity analyses further reveal that the cost-reducing impact of digital transformation is more significant among large and state-owned commercial banks. Accordingly, larger banks benefit from economies of scale, more advanced digital infrastructure, and stronger organizational capabilities, enabling them to translate digital investments into greater operational efficiencies and lower lending costs. Meanwhile, state-owned commercial banks have been at the forefront of digital transformation in Vietnam, driven by the government's national strategy for digital economy development and the State Bank of Vietnam's initiatives to modernize the banking sector. Their stronger financial resources, broader customer networks, and earlier adoption of digital technologies have enabled them to realize greater efficiency gains and larger reductions in lending costs. This finding underscores the effectiveness of Vietnam's policy-driven approach in positioning state-owned banks as key drivers of digital innovation and financial modernization.

From a policy perspective, the findings highlight that digital transformation is not merely a technological upgrade but a strategic lever for improving financial inclusion and lowering borrowing costs in emerging markets. Policymakers should continue to foster an enabling environment for digital banking by investing in national digital infrastructure, enhancing cybersecurity frameworks, and incentivizing innovation through regulatory sandboxes. Moreover, targeted support for smaller and joint-stock banks through capacity-building programs, data-sharing initiatives, and digital ecosystem partnerships would help ensure that the benefits of digitalization are distributed more evenly across the banking sector.

Overall, this study enriches the international literature on banking digitalization by providing novel evidence from a bank-dominated emerging economy. It demonstrates that digital transformation plays a critical role in enhancing cost efficiency, promoting fair competition, and advancing sustainable financial development. Future research could further explore the differential impacts of specific digital technologies such as AI-based credit scoring, blockchain-enabled lending platforms, and open banking systems on lending costs, credit accessibility, and financial stability.

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