



INTERNATIONAL JOURNAL OF BANKING AND FINANCE

<https://e-journal.uum.edu.my/index.php/ijbf>

How to cite this article:

Weng, L., Lin, Z., & Hooy, C. -W. (2026). CEO age and firm digital transformation in China: The moderating role of digital financial inclusion. *International Journal of Banking and Finance*, 21(2), 1-19. <https://doi.org/10.32890/ijbf2026.21.2.1>

CEO AGE AND FIRM DIGITAL TRANSFORMATION IN CHINA: THE MODERATING ROLE OF DIGITAL FINANCIAL INCLUSION

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Received: 31/12/2025

Revised: 10/2/2026

Accepted: 16/2/2026

Published: 31/7/2026

ABSTRACT

This study examines how CEO age influences firm digital transformation and how regional digital financial inclusion moderates this relationship, using a large panel of Chinese listed firms. Drawing on upper echelons theory and resource dependence theory, the study conceptualizes digital transformation as a resource-intensive, high-uncertainty strategic investment that depends critically on executive capabilities and the surrounding financial environment. Employing firm-level panel regressions with industry and year-fixed effects, the analysis documents that CEO age is positively associated with firm digital transformation, suggesting that older CEOs are better able to mobilize resources, exercise authority, and sustain long-term digital initiatives. Further analyses show that digital financial inclusion negatively moderates this relationship: as regional digital financial infrastructure improves, the positive effect of CEO age on digital transformation becomes weaker. This finding indicates that digital financial inclusion serves as an institutional substitute for executive-specific experience and reputation by easing financing constraints through standardized, data-driven financial services. A series of robustness tests, including propensity score matching and placebo tests, confirms the validity of the baseline results and mitigates concerns about self-selection and spurious correlations. This study contributes to the literature by reconciling mixed evidence on the relationship between CEO age and digital transformation, highlighting the role of financial institutions in shaping managerial effects, and offering new insights into how executive characteristics and digital finance jointly influence firms' strategic transformation in emerging economies.

Keywords: Firm digital transformation, CEO age, digital financial inclusion, upper echelons theory, resource dependence theory.

INTRODUCTION

China, as one of the world's largest emerging economies, is undergoing a profound transition toward a digital economy. Digital transformation has been widely recognized as a key driver of firm productivity, operational efficiency, and innovation capability (Chen et al., 2023; Du & Wang, 2024; Wu et al., 2024). However, recent evidence shows that while Chinese firms are increasingly adopting advanced digital technologies, the realization of business value from digital transformation remains limited. According to the Accenture China Digital Transformation Index 2025, only about 9% of Chinese firms that have adopted digital tools and technologies, including generative artificial intelligence (AI), are achieving significant profitability gains, despite nearly half of firms applying these technologies in core processes (e.g., R&D, manufacturing, and supply chains) (Accenture, 2025). Meanwhile, although China's overall digital transformation adoption rate has risen steadily to 46%, much of the value created by digitalization remains unrealized across firms (Accenture, 2025). These patterns highlight persistent challenges Chinese firms face in translating digital investments into firm performance, particularly in scaling up and extracting value from digital initiatives (Dai et al., 2023; Yu & Yan, 2022).

For many Chinese firms, digital transformation remains both necessary and difficult. Beyond technological adoption, digital transformation is a capital-intensive, uncertain strategic investment characterized by high upfront costs, long payback periods, and extensive organizational change. Successful digital transformation, therefore, requires not only technological capability but also sustained strategic leadership and effective resource mobilization by top management (Buck et al., 2023; Côte-Real et al., 2019). This challenge is especially salient in China, where digital transformation often involves coordinating complex internal processes, restructuring of traditional business practices, and engaging external stakeholders such as financial institutions and technology providers. As a result, firm leaders, especially chief executive officers (CEOs), play a pivotal role in initiating, financing, and sustaining digital transformation efforts (Shang et al., 2023; Volberda et al., 2021).

An expanding literature explores the role of CEOs in shaping firms' digital transformation initiatives. Existing studies focus on a wide range of executive attributes, including social status (Wang et al., 2023), educational background (Kong et al., 2023; Zhong, 2023), individual risk attitudes (Niu & Zuo, 2022), personality characteristics (Saesen et al., 2024; Zhang et al., 2023b; Zhu et al., 2023), accumulated professional experience (Zhang et al., 2023b), and managerial power (Zhang et al., 2024). Together, these studies highlight the importance of executive-level determinants in influencing firms' digitalization strategies and performance outcomes. Despite this growing literature, it remains unclear whether CEO age affects firms' digital transformation primarily because of differences in technological orientation or because age proxies executives' ability to mobilize financial resources and overcome financing constraints associated with large, intangible investments. Nevertheless, comparatively little attention has been paid to CEOs' demographic traits, particularly age, from a financial and institutional standpoint, leaving an incomplete understanding of how CEO age shapes firms' digital transformation decisions when external financing constraints are salient.

Drawing on upper echelons theory, CEO age captures systematic differences in accumulated managerial experience, authority, and strategic judgment that shape firms' major investment decisions (Hambrick & Mason, 1984; Hoskisson et al., 2017). Importantly, digital transformation is not solely a cognitive or technological challenge; it is also a resource-dependent strategic investment. From the perspective of resource dependence theory (Pfeffer & Salancik, 1978), firms' strategic choices are constrained by their ability to access critical external resources, particularly financial capital. In emerging economies where financial markets are imperfect and financing frictions persist, executives' reputational capital,

experience, and external networks play a crucial role in alleviating financing frictions and gaining access to bank credit for risky and intangible investments. Older CEOs, owing to longer career trajectories, are more likely to possess stronger relationships with financial institutions, greater credibility with external stakeholders, and enhanced authority within the firm, enabling them to mobilize the financial resources necessary to support large-scale digital transformation. Accordingly, CEO age is expected to be positively associated with firms' engagement in digital transformation.

Crucially, the extent to which CEO age translates into digital transformation outcomes depends on the surrounding financial environment. Over the past decade, China has experienced rapid expansion in digital financial inclusion, driven by fintech development, digital payments, and data-driven credit assessment. Digital financial inclusion enhances financial intermediation by improving credit access for firms, strengthening screening and monitoring using alternative data, and increasing cash flow transparency through digital payment infrastructure. These developments reduce information asymmetry, lower transaction costs, and weaken reliance on traditional relationship-based lending (Hu et al., 2023; Zhang et al., 2023a). From an institutional substitution perspective, improvements in formal financial infrastructure reduce firms' reliance on executive-specific experience and personal networks to obtain financial resources.

Consequently, while older CEOs may have advantages in mobilizing resources for digital transformation in regions with limited financial development, these advantages are expected to diminish as digital financial inclusion improves. In regions with more developed digital financial infrastructure, access to financing becomes more standardized and less dependent on CEOs' reputational capital or personal relationships with financial institutions. As a result, firms' digital transformation decisions become less sensitive to CEO age, leading to a weaker association between CEO age and digital transformation outcomes in regions with higher levels of digital financial inclusion.

Using a panel dataset of 1,236 Chinese listed firms from 2011 to 2022, this study empirically examines the relationship between CEO age and firm digital transformation. It investigates the moderating role of digital financial inclusion. The results show that CEO age is positively associated with firm digital transformation. In contrast, digital financial inclusion negatively moderates this relationship, such that the positive effect of CEO age is weaker in regions with higher levels of digital financial inclusion. These findings highlight a substitution effect between executive-specific human capital and external financial infrastructure in shaping firms' digital transformation strategies.

This study makes several contributions. First, it advances research on digital finance by demonstrating that digital financial inclusion not only directly affects firm outcomes but also reshapes the influence of CEO characteristics on strategic investment decisions. Second, it enriches the literature on CEO demographics and digital transformation by integrating upper echelons theory with resource dependence theory, providing a stronger theoretical explanation for the positive role of CEO age. Third, by focusing on China, an emerging economy with pronounced regional disparities in digital financial development, this study offers insights relevant to other economies undergoing fintech-driven financial transformation.

LITERATURE REVIEW

Firm Digital Transformation

Digital transformation refers to the strategic integration of digital technologies into business processes, organizational structures, and value-creation mechanisms (Vial, 2019; Volberda et al., 2021). Prior research documents that digital transformation can enhance firm productivity, operational efficiency, innovation capability, and long-term competitiveness (Chin et al., 2021; Du & Wang, 2024; Zhai et al., 2022). By leveraging data analytics, artificial intelligence, and digital platforms, firms can improve decision-making quality, optimize resource allocation, and adapt more effectively to market changes.

Importantly, recent studies emphasize that digital transformation is not merely a process of technology adoption but a capital-intensive and high-risk strategic investment. Digital transformation typically involves substantial upfront expenditures, long implementation cycles, and substantial uncertainty regarding future payoffs (Buck et al., 2023; Oduro et al., 2023). The “digital paradox” suggests that firms often incur high short-run costs, while the performance benefits of digital investments materialize only in the long term (Zhai et al., 2022). In addition, digital transformation introduces new risks, including data security, talent shortages, and organizational resistance, which may further discourage firms from undertaking such strategic initiatives (Rodrigues et al., 2022; Xu et al., 2019).

Given these characteristics, successful digital transformation depends not only on technological capability but also on firms’ ability to mobilize financial resources, manage uncertainty, and sustain long-term organizational change. Accordingly, scholars increasingly recognize the central role of top executives, particularly CEOs, in shaping firms’ digital transformation strategies (Kane et al., 2015; Volberda et al., 2021). This perspective motivates a closer examination of how CEO characteristics influence firms’ willingness and capacity to undertake digital transformation as a strategic investment.

CEO Age and Firm Digital Transformation

Upper echelons theory posits that organizational outcomes reflect the values, experiences, and cognitive bases of top executives (Hambrick, 2007; Hambrick & Mason, 1984). Among observable executive characteristics, CEO age is widely used as a proxy for accumulated experience, authority, and strategic judgment (Hoskisson et al., 2017). While some studies argue that younger CEOs may be more inclined toward innovation due to higher risk tolerance or greater familiarity with digital technologies, this view often treats digital transformation primarily as a technological choice rather than a financially constrained strategic investment. Additionally, despite growing literature on CEO traits (Chin et al., 2020; Ibrahim et al., 2020; Kong et al., 2023; Niu & Zuo, 2022; Saesen et al., 2024; Wang et al., 2023; Zhang & Bu, 2024; Zhong, 2023), it remains unclear whether CEO age affects firms’ digital transformation because of executives’ technological preferences or because age captures differential ability to secure external finance and mitigate financing frictions inherent in large, intangible strategic investments.

From a resource dependence theory perspective (Pfeffer & Salancik, 1978), firms’ strategic investments are constrained by their access to critical external resources, especially financial capital. Digital transformation requires sustained financing, coordination with external stakeholders, and credibility in capital markets to support long-term and intangible investments. In institutional environments characterized by information asymmetry and financing frictions, such as China, executives’ reputational capital and external networks play a crucial role in securing bank credit and other external funding.

Older CEOs, through longer career trajectories, tend to accumulate richer managerial experience, stronger relationships with financial institutions, and greater legitimacy in the eyes of investors, creditors, and regulators (Wang et al., 2016). These advantages enhance their ability to alleviate financing constraints, mobilize external resources, and withstand short-term performance pressures associated with digital transformation investments. Moreover, senior CEOs often enjoy higher internal authority, enabling them to overcome organizational resistance and align internal stakeholders around long-term strategic initiatives.

In contrast, younger CEOs, despite potentially greater technological familiarity, may face constraints stemming from limited experience, weaker external networks, and lower credibility in capital markets. These limitations can hinder their ability to initiate and sustain large-scale digital transformation when external financing and long-term commitment are required. Accordingly, digital transformation is viewed as a resource-intensive strategic investment rather than a purely technological adoption; CEO age is expected to be positively associated with firm digital transformation.

Hypothesis 1: CEO age is positively associated with firm digital transformation.

The Moderating Role of Digital Financial Inclusion

While CEO age may influence digital transformation decisions, the magnitude of this effect depends on the broader financial environment in which firms operate. Digital financial inclusion, defined as the expansion and deepening of financial services through digital technologies, has fundamentally reshaped financial intermediation in China (Hu et al., 2023; Liu et al., 2024). By reducing information asymmetry, lowering transaction costs, and improving credit allocation efficiency, digital financial inclusion enhances firms' access to external finance and alleviates financing constraints (Du & Geng, 2024; Guo et al., 2020).

From an institutional substitution perspective, improvements in formal financial infrastructure reduce firms' reliance on informal mechanisms, such as personal relationships and executive reputation, to obtain financial resources (Allen et al., 2005; Khanna & Palepu, 2000). Unlike a generic contextual moderator, digital financial inclusion alters the mapping between CEO characteristics and firm outcomes by changing the underlying financial intermediation process through which executives influence strategic investment decisions. In regions with low levels of digital financial inclusion, firms often rely more on CEOs' experience, credibility, and social capital to secure financing for risky, long-term projects. In such contexts, the advantages associated with older CEOs become particularly salient, strengthening the relationship between CEO age and digital transformation.

However, as digital financial inclusion develops, access to finance becomes more standardized and data-driven, and less dependent on executive-specific characteristics. Fintech-enabled credit assessment, digital payments, and platform-based financial services allow firms with different leadership profiles to obtain financing more efficiently. Consequently, the marginal importance of CEO age in facilitating digital transformation diminishes in regions with higher levels of digital financial inclusion.

Thus, while digital financial inclusion directly supports firms' innovation and transformation activities, it simultaneously weakens the role of CEO age by substituting for executive-specific resource mobilization advantages.

Hypothesis 2: Digital financial inclusion negatively moderates the relationship between CEO age and firm digital transformation, such that the positive effect of CEO age is weaker in regions with higher levels of digital financial inclusion.

METHODOLOGY

Research Sample

This study employs panel data on Chinese listed firms from the China Stock Market & Accounting Research (CSMAR) database over the period 2011–2022. Firms listed on the B-share market and those designated as Special Treatment (ST or *ST) are excluded. Financial firms are also removed due to their distinct regulatory environment and business models, which differ substantially from those of non-financial firms in digital transformation activities. After excluding observations with missing values, the final sample consists of an unbalanced panel of non-financial listed firms.

Empirical Model

To test the baseline relationship between CEO age and firm digital transformation (Hypothesis 1), this study estimates the following fixed-effects panel regression model:

$$LogFDT_{i,t} = c + \alpha_1 LogCEOage_{i,t} + \alpha_2 \sum Controls_{i,t} + Industry_j + Year_t + \varepsilon_{i,t} \quad (1)$$

where i , t , and j denote firm, year, and industry, respectively. Firm digital transformation ($LogFDT$) is the dependent variable, while CEO age ($LogCEOage$) is the main independent variable. Industry and year fixed effects are included to control for time-invariant industry characteristics and macroeconomic shocks.

To test the moderating effect of digital financial inclusion (Hypothesis 2), the baseline model is extended by introducing the interaction term between CEO age and digital financial inclusion:

$$LogFDT_{i,t} = c + \gamma_1 LogCEOage_{i,t} + \gamma_2 LogDFI_{i,t} + \gamma_3 LogCEOage_{i,t} \times LogDFI_{i,t} + \gamma_4 \sum Controls_{i,t} + Industry_j + Year_t + \varepsilon_{i,t} \quad (2)$$

A negative coefficient on the interaction term would indicate that digital financial inclusion weakens the positive association between CEO age and firm digital transformation, consistent with the institutional substitution mechanism.

Variables

Dependent Variable

Firm Digital Transformation ($LogFDT$). Firm digital transformation is measured using the China Listed Firms' Digital Transformation Index provided by CSMAR. This index integrates multiple dimensions of digital transformation, including strategic leadership, technology empowerment, organizational empowerment, environmental support, digital application, and digital outcomes. Key components, including technology empowerment, organizational empowerment, and digital application, are

constructed using text-mining techniques applied to firms' annual reports. Compared with simple keyword-frequency approaches used in prior studies, this third-party index provides a more standardized and comprehensive measure of digital transformation, enhancing objectivity and comparability across firms and over time. The index is transformed using the natural logarithm to reduce skewness.

Independent Variable

CEO Age (*LogCEOage*). CEO age is measured as the natural logarithm of the CEO's chronological age, calculated as the difference between the observation year and the CEO's birth year. Treating CEO age as a continuous variable is consistent with prior research on executive characteristics (Yeoh & Hooy, 2022).

Moderating Variable

Digital Financial Inclusion (*LogDFI*). Digital financial inclusion is measured using the Peking University Digital Financial Inclusion Index, jointly developed by the Digital Finance Research Center of Peking University and Ant Group Research Institute. This index captures regional variation in digital finance development across Chinese cities and has been widely adopted in the literature (Li et al., 2023; Liu et al., 2024). The index value corresponding to the city in which a firm's headquarters is registered is used, and the natural logarithm is applied to ensure normality.

Control Variables

Following prior studies on firm digital transformation, this study includes a set of CEO-level, governance-level, and firm-level control variables. CEO-level controls include CEO duality (*CEOdual*), a dummy variable equal to one if the CEO also serves as board chair, and zero otherwise; CEO gender (*CEOgender*), equal to one for male CEOs and zero otherwise; and CEO ownership (*CEOownership*), measured as the proportion of shares held by the CEO. Corporate governance controls include board size (*LogBDsize*), measured as the natural logarithm of the number of directors, and board independence (*BDindep*), measured as the proportion of independent directors on the board. Firm-level controls include firm age (*LogFirmage*), measured as the natural logarithm of years since establishment; firm size (*LogFirmsize*), measured as the natural logarithm of total assets; firm leverage (*Firmleverage*), defined as total liabilities divided by total assets; and Tobin's Q (*Tobinq*), measured as market value scaled by total assets. Industry and year dummy variables are included in all regressions.

RESULTS

Descriptive Statistics

Table 1 reports the descriptive statistics for the full sample. Firm digital transformation (*FDT*) shows substantial variation, with a mean of 37.54 and values ranging from 21.38 to 79.81. The median (35.03) is slightly below the mean, indicating that more than half of the firms exhibit below-average levels of digital transformation.

The average CEO age is 49.78 years, with a standard deviation of 6.73 and a range from 24 to 81 years. The proximity of the mean and median (50) suggests an approximately symmetric distribution. Digital financial inclusion also exhibits substantial regional variation, with *DFI* values ranging from 25.8 to 361.1, providing sufficient dispersion to examine its moderating role.

Table 1

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min.	Median	Max.
Dependent Variable						
FDT	14,400	37.54	11.10	21.38	35.03	79.81
LogFDT	14,400	3.584	0.282	3.062	3.556	4.380
Independent Variable						
CEOage	14,400	49.78	6.729	24	50	81
LogCEOage	14,400	3.898	0.140	3.178	3.912	4.394
Control Variables						
CEOdual	14,400	0.257	0.437	0	0	1
CEOgender	14,400	0.928	0.259	0	1	1
CEOownership	14,400	0.0540	0.120	0	0.00100	0.843
LogBDsize	14,400	2.142	0.194	1.386	2.197	2.890
BDindep	14,400	0.373	0.0540	0.167	0.333	0.800
LogFirmage	14,400	2.865	0.386	0.693	2.944	3.829
Firmleveragew	14,400	0.449	0.211	0.0540	0.445	0.938
Tobinqw	14,400	1.761	1.676	0	1.285	9.790
LogFirmsizew	14,400	22.48	1.349	19.69	22.33	26.49
Moderating Variable						
DFI	14,400	224.2	80.14	25.80	234	361.1
LogDFI	14,400	5.327	0.451	3.250	5.455	5.889

Pairwise Correlation Analysis

Table 2 reports the pairwise correlations among the main variables. Firm digital transformation (*LogFDT*) is positively correlated with CEO age (*LogCEOage*). Digital financial inclusion (*LogDFI*) shows a relatively stronger positive correlation with firm digital transformation, suggesting that firms located in regions with more developed digital financial infrastructure tend to exhibit higher levels of digital transformation.

Most control variables display correlations with firm digital transformation that are consistent with prior literature. Importantly, none of the pairwise correlation coefficients exceed conventional thresholds, alleviating concerns about multicollinearity. This is further supported by variance inflation factor (VIF) tests, with a maximum VIF of 1.77 and an average VIF of 1.39, indicating no serious multicollinearity concerns.¹

¹ The variance inflation factor (VIF) results are available from the authors upon request.

Table 2

Pairwise Correlation Analysis

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LogFDT	1											
LogCEOage	0.040***	1										
CEOdual	0.131***	0.136***	1									
CEOgender	-0.00800	0.051***	0.0110	1								
CEOownership	0.125***	-0.00800	0.451***	0.00400	1							
LogBDsize	-0.069***	0.055***	-0.167***	0.095***	-0.146***	1						
BDindep	0.050***	0.016*	0.107***	-0.055***	0.072***	-0.515***	1					
LogFirmage	0.029***	0.149***	-0.100***	-0.028***	-0.273***	0.038***	-0.024***	1				
Firmleverage	-0.073***	0.077***	-0.114***	0.016*	-0.261***	0.124***	0.00300	0.241***	1			
Tobinq	0.086***	-0.059***	0.107***	-0.023***	0.165***	-0.150***	0.053***	-0.139***	-0.401***	1		
LogFirmsize	0.068***	0.172***	-0.148***	0.036***	-0.260***	0.220***	0.037***	0.245***	0.465***	-0.462***	1	
LogDFI	0.323***	0.170***	0.00700	-0.035***	-0.092***	-0.092***	0.053***	0.480***	0.080***	-0.032***	0.292***	1

Notes. The parentheses report p-values of ***, **, and *, which indicate 1%, 5%, and 10% levels of significance, respectively.

Base Regression Results

Table 3 reports the baseline regression results examining the relationship between CEO age and firm digital transformation. Model (1) presents a simple OLS specification without controls, showing a positive and significant association between CEO age and firm digital transformation. After adding control variables and industry and year-fixed effects in Model (2), the coefficient on CEO age becomes negative but statistically insignificant.

Models (3) and (4) report the random-effects (RE) and fixed-effects (FE) estimations, respectively. The Hausman test strongly rejects the random-effects specification ($\text{Prob} > \chi^2 = 0.000$), indicating that the fixed-effects model is more appropriate. Consistent with Hypothesis 1, the fixed-effects results in Model (4) show that CEO age is positively and significantly associated with firm digital transformation ($\alpha = 0.0211$, $p < 0.05$), suggesting that within-firm increases in CEO age are associated with higher levels of digital transformation.

Model (5) further introduces digital financial inclusion and its interaction with CEO age. The interaction term between CEO age and digital financial inclusion is negative and statistically significant ($\beta = -0.0294$, $p < 0.10$), providing support for Hypothesis 2. This result indicates that the positive effect of CEO age on firm digital transformation is weaker in regions with more developed digital financial infrastructure. In such environments, external digital resources and institutional support may partially substitute for CEOs' experience-based capabilities in driving digital transformation.

Overall, the results support both hypotheses and highlight the conditional role of the regional digital environment in shaping how CEO age influences firm digital transformation in China.

Table 3

Base Regression Results

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
	OLS	OLS	RE	FE	FE
Variables	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>
LogCEOage	0.0812*** (0.0168)	-0.0043 (0.0118)	0.0140 (0.0100)	0.0211** (0.0100)	0.0205** (0.0100)
LogDFI					-0.1261*** (0.0197)
LogCEOage * LogDFI					-0.0294* (0.0169)
CEOdual		0.0247*** (0.0041)	0.0072** (0.0035)	0.0032 (0.0035)	0.0022 (0.0035)
CEOgender		0.0005 (0.0062)	-0.0012 (0.0056)	0.0011 (0.0057)	0.0013 (0.0057)
CEOownership		0.1045*** (0.0156)	0.0444*** (0.0164)	0.0195 (0.0171)	0.0249 (0.0171)
LogBDsize		0.0002 (0.0103)	-0.0016 (0.0105)	0.0055 (0.0108)	0.0035 (0.0107)
BDindep		0.0498 (0.0349)	-0.0585* (0.0313)	-0.0683** (0.0316)	-0.0727** (0.0316)
LogFirmage		-0.0479*** (0.0053)	-0.0451*** (0.0096)	-0.0221* (0.0122)	-0.0283** (0.0123)
Firmleveragew		-0.0394*** (0.0093)	-0.0227** (0.0090)	-0.0091 (0.0092)	-0.0111 (0.0092)
Tobinqw		0.0041*** (0.0012)	0.0036*** (0.0009)	0.0032*** (0.0009)	0.0032*** (0.0009)
Logfirmsizew		0.0365*** (0.0016)	0.0341*** (0.0021)	0.0386*** (0.0024)	0.0385*** (0.0023)
Constant	3.2681*** (0.0656)	2.6280*** (0.0633)	2.6646*** (0.0781)	2.5070*** (0.0899)	2.4840*** (0.0848)
Industry	No	Yes	Yes	Yes	Yes
Year	No	Yes	Yes	Yes	Yes
N	14400	14400	14400	14400	14400
R ²	0.0016	0.5686		0.4181	0.4200
R ² adjusted	0.0015	0.5657		0.3608	0.3628
Hausman Test			Prob>chi2 =	0.0000	

Notes. The dependent variable is firm digital transformation (*LogFDT*); Independent variable is CEO age (*LogCEOage*). The control variables are CEO duality (*CEOdual*), CEO gender (*CEOgender*), CEO ownership (*CEOownership*), board size (*LogBDsize*), board independence (*BDindep*), firm age (*LogFirmage*), firm leverage (*Firmleverage*), firm performance (*Tobinqw*), firm size (*LogFirmsize*). Moderating variable is digital financial inclusion (*LogDFI*). The parentheses report p-values of ***, **, and *, which indicate 1%, 5%, and 10% levels of significance, respectively. The regression is conducted using ordinary least squares (OLS), random effect (RE), and fixed effect (FE) models.

Robustness Tests

To further ensure the reliability of our baseline findings, the researchers conduct robustness tests to address potential endogeneity and spurious correlation concerns. Specifically, CEO age may be endogenously related to firm digital transformation due to non-random CEO–firm matching. In contrast, the moderating effect of digital financial inclusion may reflect unobserved firm-level characteristics.

To mitigate these concerns, the researcher implement propensity score matching (PSM) to alleviate selection bias arising from observable characteristics and conduct placebo tests to rule out the possibility that our results are driven by random chance or mechanical correlations.

Propensity Score Matching Analysis

The study employs propensity score matching to address potential selection bias related to observable firm and CEO characteristics. The sample is divided into a treatment group comprising firms led by younger CEOs and a control group comprising firms led by older CEOs, based on the median CEO age. Using a one-to-one nearest-neighbor matching procedure without replacement, firms are matched based on a comprehensive set of CEO-level, corporate governance, and firm-level control variables. Table 4 reports the balance test results. Prior to matching, several covariates exhibit substantial standardized mean differences between the treated and control groups. After matching, the absolute standardized biases are substantially reduced for all variables, with most falling below 2%, and none of the post-matching differences remain statistically significant. These results indicate that the matched sample achieves satisfactory covariate balance and is suitable for subsequent analysis.

Table 5 presents the regression results based on the matched sample. Consistent with the baseline regressions, CEO age remains positively and significantly associated with firm digital transformation. Moreover, the interaction term between CEO age and digital financial inclusion is negative and statistically significant, indicating that the positive effect of CEO age on digital transformation is attenuated in regions with higher levels of digital financial inclusion. The magnitudes and statistical significance of the coefficients are comparable to those obtained from the full-sample estimations, providing strong support for Hypotheses 1 and 2 and suggesting that the baseline findings are not driven by observable selection bias.

Table 4

Balance Test of PSM

Variable	Unmatched	Mean		%bias	%reduct bias	t-test	
	Matched	Treated	Control			t	$P > t $
CEOdual	U	0.298	0.211	20.10		11.99	0
	M	0.263	0.260	0.700	96.80	0.370	0.710
CEOgender	U	0.937	0.917	7.500		4.500	0
	M	0.939	0.934	1.700	77.20	1.060	0.290
CEOownership	U	0.0516	0.0564	-4		-2.390	0.017
	M	0.0518	0.0520	-0.100	96.90	-0.0700	0.943
LogBDsize	U	2.149	2.134	7.600		4.520	0
	M	2.146	2.143	1.800	76.60	1.040	0.299
BDindep	U	0.375	0.372	5.400		3.220	0.001
	M	0.373	0.374	-1.800	66.90	-1.040	0.298
Logfirmage	U	2.916	2.807	28.40		17.10	0
	M	2.907	2.913	-1.600	94.20	-1.080	0.282
Firmleverage	U	0.462	0.433	13.60		8.140	0
	M	0.455	0.456	-0.500	96.20	-0.300	0.765
Tobinq	U	1.679	1.853	-10.40		-6.210	0
	M	1.720	1.771	-3	70.70	-1.750	0.079
LogFirmsize	U	22.67	22.25	31.70		18.91	0
	M	22.54	22.53	0.600	98.00	0.380	0.704

Table 5

Regression Results of PSM

	Model (6)	Model (7)
	PSM	PSM
Variables	<i>LogFDT</i>	<i>LogFDT</i>
<i>LogCEOage</i>	0.0483*** (0.0147)	0.0502*** (0.0147)
<i>LogDFI</i>		-0.0941*** (0.0298)
<i>LogCEOage * LogDFI</i>		-0.0723*** -0.0941***
Constant	2.4397*** (0.1639)	2.8578*** (0.2092)
Controls	YES	YES
Industry	YES	Yes
Year	YES	Yes
N	7189	7189
R ²	0.4166	0.4182
R ² adjusted	0.2901	0.2918

Placebo Test

To further assess whether the documented relationship between CEO age and firm digital transformation is driven by random chance or spurious correlations, this study conducts a placebo test by randomly reassigning CEO age across firms while maintaining the empirical specification unchanged. The procedure is repeated 1,000 times to generate empirical distributions of both coefficient estimates and corresponding t-values.

Figure 1 presents the placebo test results for baseline regression. Panel 1(a) shows that the distribution of placebo t-values is centered around zero and largely falls within conventional significance thresholds, indicating that randomly assigned CEO age does not yield statistically significant effects. Panel 1(b) reports the distribution of placebo coefficients, which are tightly concentrated around zero, suggesting negligible economic effects under random assignment. In contrast, the actual estimated coefficient and t-value from the baseline regression lie in the extreme right tail of their respective distributions.

Figure 2 reports the placebo test results for the moderating analysis. Panels 2(a) and 2(b) show that the placebo interaction coefficients between CEO age and digital financial inclusion are centered around zero, and the associated t-values largely fall within conventional significance thresholds. By contrast, the actual interaction estimate from the baseline regression lies in the extreme tail of the placebo distributions. These findings indicate that the observed negative moderating effect of digital financial inclusion is unlikely to be due to chance, providing additional support for Hypothesis 2.

Figure 1

Placebo Test: Base Regression – LogCEOAge.

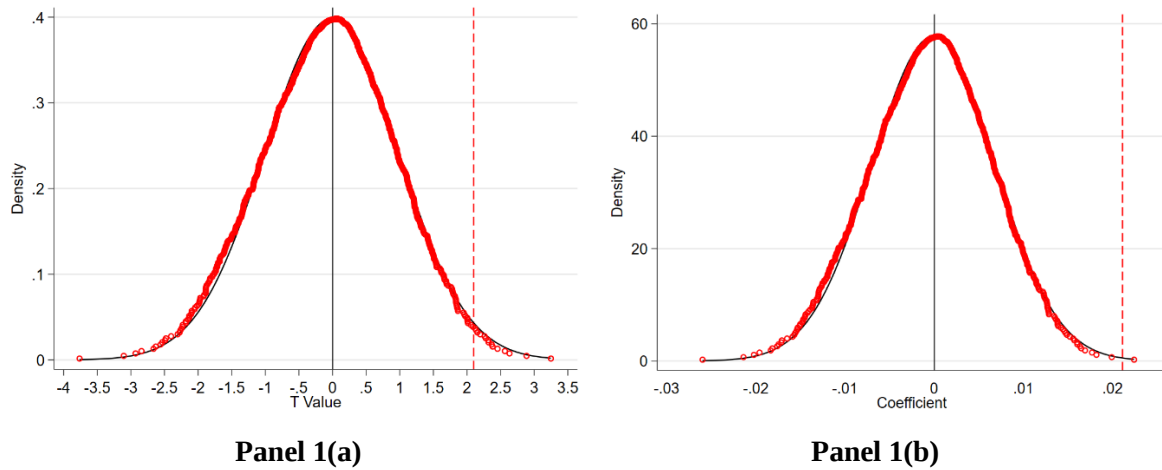
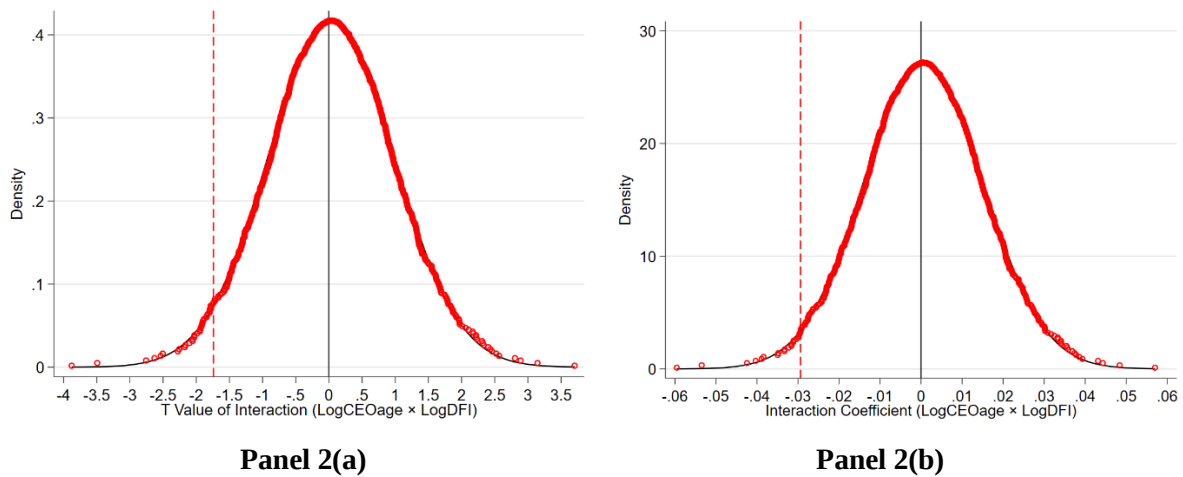


Figure 2

Placebo Test: Moderating Analysis - LogCEOAge × LogDFI



DISCUSSION

This study investigates how CEO age influences firm digital transformation and how regional digital financial inclusion moderates this relationship. Using a large panel of Chinese listed firms, the researchers document two main findings. First, CEO age is positively associated with firm digital transformation. Second, digital financial inclusion negatively moderates this relationship, such that the positive effect of CEO age is weaker in regions with higher levels of digital financial inclusion. These findings remain robust after addressing endogeneity concerns through propensity score matching and placebo tests.

CEO Age and Firm Digital Transformation

The finding that CEO age is positively related to firm digital transformation contrasts with a dominant strand of prior literature that emphasizes the inhibiting role of older CEOs due to risk aversion and career horizon effects (Zhang et al., 2023b; Zou et al., 2024). However, this result is consistent with prior research emphasizing that digital transformation is a long-term, high-risk strategic investment rather than a purely technological upgrade (Buck et al., 2023; Vial, 2019; Volberda et al., 2021). The substantial upfront costs, long implementation cycles, and uncertain payoffs associated with digital transformation require strong leadership commitment and organizational coordination (Oduro et al., 2023; Zhai et al., 2022).

From the perspective of upper echelons theory, observable executive characteristics, such as CEO age, reflect differences in experience, cognitive frameworks, and strategic judgment, which, in turn, shape firm outcomes (Hambrick, 2007; Hambrick & Mason, 1984). Older CEOs are more likely to possess accumulated managerial experience, internal authority, and credibility with external stakeholders, enabling them to overcome organizational inertia and mobilize resources for high-risk, long-term digital transformation (Kane et al., 2015). This highlights that CEO age represents a managerial effect rather than a superficial demographic characteristic.

In addition, drawing on resource dependence theory (Pfeffer & Salancik, 1978), digital transformation requires sustained access to financial resources and coordination with external stakeholders. In emerging markets such as China, where information asymmetry and financing constraints remain pronounced, executives' reputational capital and external networks play a critical role in securing financing for long-term, risky investments (Hoskisson et al., 2017; Wang et al., 2016). Older CEOs, through longer career trajectories, tend to enjoy greater legitimacy among investors, creditors, and regulators, facilitating resource mobilization for digital initiatives. This provides a concrete financial intermediation channel linking CEO traits to digital transformation outcomes.

Importantly, our results suggest that technological familiarity alone is insufficient to drive digital transformation. While younger CEOs may be more digitally savvy, their limited experience, weaker reputational capital, and lower bargaining power in capital markets may constrain their ability to initiate and sustain large-scale transformation projects. This finding helps reconcile mixed evidence in prior studies and underscores the need to distinguish between innovation enthusiasm and the capacity to execute complex strategic change.

The Moderating Role of Digital Financial Inclusion

This study further shows that digital financial inclusion weakens the positive relationship between CEO age and firm digital transformation. Digital financial inclusion improves firms' access to external finance by reducing information asymmetry, lowering transaction costs, and enhancing credit allocation efficiency through digital technologies (B. Guo et al., 2023; Hu et al., 2023; Liu et al., 2024). Unlike a generic contextual control, digital financial inclusion is identification-relevant: it systematically alters the financial intermediation process through which CEO characteristics translate into strategic investment outcomes.

As a result, firms become less reliant on informal financing channels and executive-specific characteristics to obtain capital. From an institutional substitution perspective, improvements in formal financial infrastructure reduce the importance of personal relationships, managerial reputation, and

executive experience in resource acquisition (Du & Geng, 2024). Specifically, in regions with lower levels of digital financial inclusion, firms depend more heavily on CEOs' social capital and credibility to secure financing for risky, long-term projects, thereby strengthening the role of CEO age. In contrast, as digital financial inclusion develops, fintech-enabled credit assessment and platform-based financial services enable firms to access capital in a more standardized, data-driven manner, thereby mitigating the marginal impact of CEO age on digital transformation.

This finding complements prior studies showing that digital financial inclusion directly promotes innovation and corporate transformation (Du & Wang, 2024; Guo et al., 2023), while also revealing an indirect effect: it reshapes the mechanisms through which executive characteristics influence strategic decisions. Thus, digital financial inclusion serves both as a direct facilitator of digital transformation and as a moderator that clarifies when and how CEO managerial traits matter.

Theoretical Contributions

This study makes several theoretical contributions. First, it extends the digital transformation literature by identifying CEO age as an important leadership determinant, thereby enriching the micro-foundations of firm digital strategy. Second, by integrating upper echelons theory with resource dependence theory, the study provides a more nuanced explanation of why CEO age can positively influence digital transformation in emerging markets. Third, the moderating role of digital financial inclusion advances institutional substitution theory by demonstrating how financial infrastructure reshapes the relevance of executive characteristics.

Practical Implications

The findings offer practical implications for firms, policymakers, and investors. For firms, experience and authority may be more important than technological enthusiasm when selecting leaders to oversee digital transformation. For policymakers, the development of digital financial inclusion not only directly supports innovation but also reduces firms' dependence on individual executives, contributing to more inclusive and resilient transformation processes. For investors, understanding how leadership characteristics interact with regional financial conditions can improve the evaluation of firms' digital transformation prospects.

Limitations and Future Research

This study has several limitations. First, CEO age is an observable proxy and may not fully capture unobservable traits such as cognitive flexibility or leadership style. Future research could incorporate psychological or behavioral measures to deepen understanding. Second, while this study focuses on China, the findings may differ in developed economies with more mature financial systems. Cross-country comparisons would be a valuable avenue for future research. Finally, future studies could explore whether similar substitution effects arise for other executive characteristics, such as tenure or educational background.

CONCLUSION

This study investigates the relationship between CEO age and firm digital transformation and examines the moderating role of digital financial inclusion in the Chinese context. The findings show that CEO age is positively associated with firm digital transformation, indicating that older CEOs are more likely to initiate and sustain digital transformation as a long-term strategic investment. Moreover, digital financial inclusion weakens this relationship by reducing firms' reliance on executive-specific experience, reputation, and social capital to access external finance. Together, these results highlight that digital transformation is shaped not only by managerial characteristics but also by the surrounding financial infrastructure. By integrating upper echelons theory with a resource dependence perspective, this study advances understanding of how executive attributes interact with institutional conditions to influence firms' strategic transformation decisions. The findings offer important implications for firms selecting leadership for digital transformation initiatives and for policymakers seeking to promote digital transformation through the development of inclusive digital financial systems.

ACKNOWLEDGMENT

This research received no specific grant from any funding agency in the public, commercial, or not-for profit sectors.

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