

CEO Age and Firm Digital Transformation in China: The Moderating Role of Firm Size

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Abstract: This study examines the relationship between CEO age and firm digital transformation using Chinese listed firms from 2011 to 2022. Drawing on upper echelons, as well as career concern and career horizon perspectives, we identify a robust inverse U-shaped relationship: digital transformation intensity increases with CEO age up to an inflection point at approximately 51.05 years and declines thereafter. Younger CEOs tend to adopt a more cautious approach toward long-term and uncertain digital investments due to career concerns, whereas mid-career CEOs are more actively engaged in digital transformation as a result of accumulated experience, authority and balanced risk incentives. In contrast, as career horizons shorten, older CEOs become increasingly risk-averse. We further find that firm size positively moderates this relationship by enhancing managerial discretion through greater resource availability and implementation capacity. These findings highlight the joint role of executive career stage and organisational context in shaping digital transformation strategies. This study contributes to the literature by demonstrating that CEO age effects are nonlinear, career-stage dependent, and context-sensitive, and provides practical insights for aligning executive characteristics with organisational conditions to support digital transformation.

Keywords: CEO age, firm digital transformation, firm size, managerial discretion, nonlinear

JEL classification: G32, G34, O33

1. Introduction

China, as one of the world's largest emerging economies, is undergoing a profound transition toward a digital economy. Digital transformation has the potential to improve firm productivity, reduce operation costs and enhance innovation capacity (Chen et al., 2023; Du & Wang, 2024; Wu et al., 2024). Despite these potential benefits, the

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outcomes of digital transformation remain highly uneven. Survey evidence indicates that only 17% of Chinese firms report satisfactory results from their digital initiatives (Accenture, 2022). Many firms continue to face persistent challenges, including limited transformation capabilities, financing constraints and uncertainty regarding returns (Dai et al., 2023; Yu & Yan, 2022). Consequently, digital transformation has become both a necessary and strategically complex endeavour for Chinese firms.

Digital transformation is not merely the adoption of new technologies; it involves long-term investment, cross-functional coordination and organisational restructuring. Leadership characteristics, particularly those of CEOs, play a central role in shaping firms' digital strategies (Buck et al., 2023; Côte-Real et al., 2019). CEOs are the primary decision-makers responsible for setting strategic priorities and allocating resources toward digital initiatives (Volberda et al., 2021). In China, insufficient involvement of top executives has been identified as a critical obstacle to successful digital transformation (Shang et al., 2023). However, CEOs differ substantially in their willingness and ability to initiate and sustain digital transformation, suggesting that both CEO characteristics and organisational context are essential for understanding heterogeneous firm outcomes (Luo et al., 2023; Zhou et al., 2023).

Among observable CEO characteristics, age has received sustained attention in the upper echelons literature as it reflects systematic differences in cognitive frames, risk tolerance and strategic time horizons (Hoskisson et al., 2017). In the context of digital transformation, CEO age may be particularly relevant as digital initiatives are typically risky, involve long payback periods, and require learning and adaptation. However, prior studies in China report mixed evidence regarding the effect of CEO age. Some studies suggest that younger CEOs are more likely to promote digital transformation due to longer career horizons and higher tolerance for uncertainty (Zou et al., 2024). In contrast, others argue that younger or newly appointed CEOs may engage in symbolic digital initiatives while avoiding substantive investment due to career concerns (Zhang, W. et al., 2023). Additional evidence shows that middle-aged CEOs may be most effective in promoting digital transformation, with weak effects observed among very young or older executives (Wang & He, 2024).

These mixed findings indicate that the relationship between CEO age and firm digital transformation is likely nonlinear and driven by multiple underlying mechanisms. Specifically, younger CEOs may exhibit strong incentives to pursue innovative strategies due to career concerns but may lack the experience and organisational influence required to implement complex digital initiatives. In contrast, older CEOs possess greater experience and knowledge but may become more risk-averse due to shorter career horizons. Middle-aged CEOs may strike an optimal balance between risk-taking incentives and managerial experience, leading to more effective digital transformation. This reasoning implies an inverse U-shaped relationship between CEO age and firm digital transformation.

Importantly, the effect of CEO age may depend on organisational context. Firm size is a critical yet underexplored factor that shapes managerial discretion and the implementation of strategic initiatives. Firm size embodies a trade-off between resources and constraints. On the one hand, larger firms typically possess greater financial resources, specialised human capital, and more developed infrastructures, which facilitate large-scale digital investments. On the other hand, they are characterised by

higher bureaucratic complexity and stronger organisational inertia, which may constrain executives' ability to implement strategic change. In contrast, smaller firms tend to have more flexible structures, allowing CEOs to exert greater influence, but they often face resource limitations that hinder sustained digital transformation.

Drawing on upper echelons theory (Hambrick & Mason, 1984) and insights from career concern and career horizon theories (Fama, 1980; Holmstrom 1999), this study proposes that CEO age exhibits an inverse U-shaped relationship with firm digital transformation. Furthermore, we argue that firm size positively moderates this nonlinear relationship. As a proxy for managerial discretion, firm size reflects firms' resource endowments and implementation capacity, which shape the extent to which CEOs can translate personal attributes into strategic digital actions. Larger firms typically possess greater financial slack, specialised human capital, and more developed digital infrastructures, enabling experienced CEOs to undertake complex and long-term digital transformation initiatives more effectively. In contrast, resource constraints in smaller firms may limit the scale and sustainability of digital investment, thereby attenuating the influence of CEO age. By examining firm size as a boundary condition, this study highlights that the impact of CEO age on digital transformation depends critically on organisational scale and resource availability.

Using a panel dataset of 1,236 Chinese listed firms over the period 2011–2022, this study empirically examines the nonlinear association between CEO age and firm digital transformation and investigates the moderating role of firm size. By explicitly incorporating firm size as a contextual factor, this study contributes to the literature by demonstrating that the influence of CEO age on digital transformation is contingent on organisational structure. The findings offer insights into how leadership characteristics and organisational constraints jointly shape digital transformation strategies in emerging economies.

This study makes several contributions to the literature. First, it advances digital transformation literature by showing that the effect of CEO age is nonlinear and driven by the interplay between risk preferences, cognitive flexibility and managerial experience. Second, it extends upper echelons theory by demonstrating how managerial characteristics interact with organisational context, proxied by firm size, to shape strategic outcomes. Third, focusing on Chinese listed firms, this study provides evidence from an emerging economy where digital transformation is policy-driven yet uneven, thereby enriching the contextual understanding of executive decision-making and firm strategy.

The rest of the paper is structured as follows. Section 2 reviews the relevant literature. Section 3 presents the methodology and Section 4 provides the results. Section 5 discusses the results and Section 6 concludes the paper.

2. Literature Review

2.1 Firm Digital Transformation

Digital transformation has wide-ranging impacts on firm performance, generating both opportunities and challenges (Feliciano-Cestero et al., 2023; Oduro et al., 2023; Zoppelletto et al., 2023). On the one hand, the adoption of digital technologies can

enhance firms' financial performance (Zhai et al., 2022), risk-taking capacity (Tian et al., 2022), data-driven decision makings (Tian et al., 2022), innovation quality (Chin et al., 2021), and dynamic capital structure adjustment (Niu et al., 2023). These benefits highlight the strategic importance of digital transformation as a source of competitive advantage.

On the other hand, digital transformation is characterised by substantial upfront costs, long implementation cycles and elevated uncertainty, which may expose firms to significant operational and financial risks (Buck et al., 2023; Oduro et al., 2023). The "digital paradox" suggests that while digital investments may generate long-term value, firms often face short-term performance pressures and uncertain returns during the transformation process (Zhai et al., 2022). In addition, data security and privacy concerns impose compliance costs and increase demand for specialised human capital, potentially dampening the realised benefits of digital transformation (Rodrigues et al., 2022; Xu et al., 2019).

Given these characteristics, digital transformation requires firm leaders to tolerate uncertainty, commit to long-term investment, and coordinate complex organisational changes (Tagscherer & Carbon, 2023). As such, CEOs' personal attributes, particularly those related to risk preferences, cognitive flexibility and strategic orientation, become salient in shaping firms' digital transformation strategies.

2.2 CEO Age and Firm Digital Transformation

Drawing on upper echelons theory and insights from career concerns and career horizon perspectives (Cabrerros et al., 2024; Cheng et al., 2024; Yeoh & Hooy, 2022), this study argues that the relationship between CEO age and firm digital transformation is nonlinear. CEO age reflects differences in accumulated experience, risk preferences, reputation concerns, and strategic time horizons, all of which influence strategic decision-making under uncertainty.

Early-career CEOs are typically subject to strong career concerns and market evaluation pressure (Holmstrom, 1999). To signal competence and legitimacy to boards and capital markets, younger CEOs may emphasise engagement with prominent managerial trends such as digital transformation. However, given the high uncertainty and delayed payoffs of digital investment, they may initially favour symbolic or incremental actions rather than substantive transformation (Zhang, W. et al., 2023).

As CEOs accumulate tenure and experience, they gradually gain organisational authority, develop firm- and industry-specific knowledge, and strengthen internal and external networks (Cho & Kim, 2017; Jeong et al., 2021). These factors may increase their confidence and ability to initiate complex strategic changes. Digital transformation, which requires sustained commitment, coordination and tolerance for ambiguity, may therefore become more feasible and attractive during mid-career stages (Kane et al., 2015). In addition, successful digital transformation can enhance CEOs' professional reputation, particularly for those with meaningful remaining career horizons (Zou et al., 2024).

However, beyond a certain point, the career horizon problem becomes increasingly salient. As CEOs approach the later stages of their careers, shorter time horizons and

heightened risk aversion may reduce incentives to undertake long-term, uncertain investments (Cabreros et al., 2024; Kim & Kim, 2023; Mukherjee & Sen, 2022). Given that digital transformation typically involves substantial upfront costs and delayed returns (Liu et al., 2023), older CEOs may become less inclined to initiate or intensify digital transformation efforts.

In sum, CEOs' incentives and capabilities to pursue digital transformation evolves systematically over the career lifecycle. Younger CEOs face strong career concerns and may prioritise signalling behaviour, potentially limiting substantive digital investment. As experience, authority and networks accumulate, mid-career CEOs become better positioned to initiate and sustain complex digital transformation. However, as career horizons shorten, older CEOs may become increasingly risk-averse and less willing to undertake long-term and uncertain investments. Taken together, these dynamics suggest that the relationship between CEO age and firm digital transformation follows an inverse U-shaped pattern (Figure 1), driven by the interaction between career incentives, managerial experience and risk preferences. Accordingly, this study proposes the following hypothesis:

H1: CEO age has an inverse U-shaped relationship with firm digital transformation.

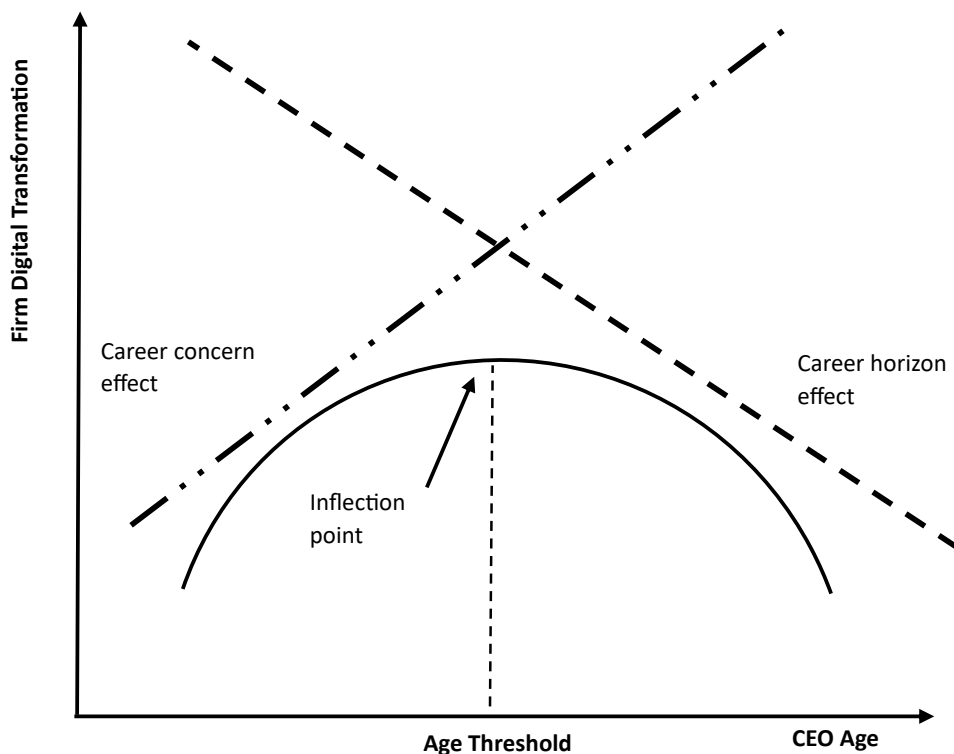


Figure 1. Illustration of inverse U-shaped relation between CEO age and firm digital transformation

2.3 Managerial Discretion and the Moderating Role of Firm Size

The extent to which CEO characteristics shape strategic outcomes depends critically on managerial discretion, defined as the latitude of action available to executives in implementing strategic decisions (Hambrick & Finkelstein, 1987). Upper echelons theory suggests that executive attributes, including age, are more likely to be reflected in firm outcomes when organisational and environmental conditions allow CEOs sufficient discretion to act on their preferences and judgments (Hambrick 2007).

Firm size represents a key organisational condition shaping managerial discretion. While prior research often associates larger firm size with organisational inertia and bureaucratic rigidity (Hannan & Freeman, 1984), an alternative perspective emphasises that larger firms also possess superior resource endowments, structural capacity and external legitimacy, which may expand the feasible set of strategic actions available to CEOs (Wangrow et al., 2015; Weinzimmer et al., 2023). In the context of digital transformation, these enabling features of firm size may be particularly important.

Digital transformation requires substantial investment, complementary assets and coordination across organisational units (Kane et al., 2015; Vial, 2019). Larger firms are more likely to have the internal resources, technological infrastructure and absorptive capacity necessary to support such complex initiatives. Moreover, larger firms' scale and market position can reduce the perceived risk of experimentation and enhance tolerance for temporary performance volatility during the transformation process. These conditions may allow CEOs, especially those with sufficient experience and authority, to pursue digital transformation more decisively.

From a managerial discretion perspective, firm size primarily enhances the ability of CEOs to translate their characteristics into strategic outcomes by relaxing resource constraints and increasing implementation capacity. While larger firms may face greater bureaucratic complexity, their superior financial resources, technological infrastructure and organisational capabilities are particularly critical for digital transformation, which requires sustained investment and cross-functional coordination. As a result, firm size strengthens the extent to which CEO age-related differences, including experience, risk tolerance and strategic orientation, are reflected in digital transformation outcomes.

Accordingly, while firm size may introduce coordination challenges, this study emphasises its enabling role in expanding managerial discretion by providing resources, legitimacy and implementation capacity. As a result, firm size is expected to strengthen, rather than weaken, the relationship between CEO age and firm digital transformation.

H2: Firm size positively moderates the inverse U-shape relationship between CEO age and firm digital transformation, such that the effect of CEO age on digital transformation is stronger in larger firms.

3. Method

3.1 Research Sample

This study uses panel data on Chinese A-share listed firms from 2011 to 2022, obtained from the China Stock Market and Accounting Research (CSMAR) database. Firms listed on the B-share market and those designated as special treatment (*ST or ST) are

excluded due to different disclosure requirements and abnormal financial conditions. Firm-year observations with missing key variables are removed. To reduce the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. The final sample consists of approximately 1,236 firms, forming a balanced panel over the sample period.

3.2 Panel Regression

To examine the nonlinear relationship between CEO age and firm digital transformation, this study follows prior research on curvilinear effects (Haans et al., 2016) by including both CEO age (LogCEOage) and its squared term (LogCEOage^2). The baseline panel regression model is specified as:

$$\text{LogFDT}_{i,t} = \alpha_0 + \alpha_1 \text{LogCEOage}_{i,t} + \alpha_2 \text{LogCEOage}_{i,t}^2 + \alpha_3 \text{Controls}_{i,t} + \text{Industry}_j + \text{Year}_t + \varepsilon_{i,t} \quad (1)$$

where i , t and j denote each firm, year and country, respectively. LogFDT represents the degree of firm digital transformation, LogCEOage is the natural logarithm of CEO age, and Controls is a vector of control variables. Industry and year fixed effects are included to control for unobserved heterogeneity.

Consistent with Haans et al. (2016), the turning point of the inverse U-shaped relationship is calculated as:

$$\frac{\partial \text{LogFDT}}{\partial \text{LogCEOage}} = 0 \Rightarrow \text{LogCEOage}^* = -\frac{\alpha_1}{2\alpha_2} \quad (2)$$

To examine the moderating role of firm size (H2), the baseline model is extended by incorporating firm's size and its interaction terms with CEO age and CEO age squared:

$$\text{LogFDT}_{i,t} = \beta_0 + \beta_1 \text{LogCEOage}_{i,t} + \beta_2 \text{LogCEOage}_{i,t}^2 + \beta_3 \text{LogFirmSize}_{i,t} + \beta_4 (\text{LogCEOage}_{i,t} \times \text{LogFirmSize}_{i,t}) + \beta_5 (\text{LogCEOage}_{i,t}^2 \times \text{LogFirmSize}_{i,t}) + \beta_6 \sum \text{Controls}_{i,t} + \text{Industry}_j + \text{Year}_t + \varepsilon_{i,t} \quad (3)$$

A statistically significant coefficient on the interaction terms indicates that firm size moderates the nonlinear relationship between CEO age and firm digital transformation.

3.3 Variables

Dependent variable. Firm digital transformation (LogFDT) is measured using the Digital Transformation Index from the *China Listed Firm's Digital Transformation Research Database* provided by CSMAR. The index captures multiple dimensions of digital transformation, including strategic leadership, technology empowerment, organisational empowerment, environmental support, digital achievement and digital application.¹

¹ Digital Transformation Index = 0.3472 * Strategic Leadership Score + 0.162 * Technology Driven Score + 0.0969 * Organisational Empowerment Score + 0.0342 * Environmental Support Score + 0.2713 * Digital Achievement Score + 0.0884 * Digital Application Score, each subdivision index is the standardised value.

Several components are constructed using text-mining techniques applied to firms' annual reports. Compared with keyword-frequency measures, this composite index provides a more standardised and comparable measure across firms and over time. The index is log-transformed.

Independent Variables. The independent variable in the model is CEO age (LogCEOage) and its squared term (LogCEOage^2). This study treats CEO age as a continuous variable and measured by the natural logarithm of the difference of the CEO's birth year and the year of the sample observation.

Control Variables. Following prior studies (Zhang, Y. et al., 2023; Zhang et al., 2024; Zou et al., 2024), this study controls for CEO-level, governance-level and firm-level characteristics. CEO-level controls include CEO duality (CEOdual), CEO gender (CEOgender) and CEO ownership (CEOownership). Firm-governance controls include board size (LogBDsize), board independence (BDindep), and ownership concentration (Largestshares), and the cumulative shareholding of the top ten ownership (Toptenshare). Firm-level controls include firm age (LogFirmage), leverage (Firmleverage), profitability (FirmROA), and firm performance (Tobinqs). Industry and year dummies are included in all regressions.

Moderating Variable. Firm size (LogFirmsize) is used as a proxy of firm-level managerial discretion and is measured as the natural logarithm of annual sales, following prior research (Raguseo et al., 2020).

4. Results

4.1 Descriptive Statistics

Descriptive statistics for the full sample are reported in Table 1. Firm digital transformation exhibits substantial cross-sectional variation, with a mean of 37.61 and values ranging from 21.38 to 79.81. The median value of 35.20 is below the mean, suggesting that more than half of the firms operate at a level of digital transformation lower than the sample average. CEO age averages 49.81 years with a standard deviation of 6.70. The close alignment between the mean and median (50) indicates an approximately symmetric distribution, with CEO ages ranging from 24 to 81 years. Overall, the variation in key variables provides a suitable empirical setting to examine both non-linear effects and moderating mechanisms.

4.2 Pairwise Correlation Analysis

Table 2 reports pairwise correlations among the main variables. Most correlation coefficients fall well below conventional thresholds for multicollinearity, suggesting that multicollinearity is unlikely to bias the regression estimates. Firm digital transformation is positively correlated with CEO age, with a correlation coefficient of 0.039, significant at the 1% level. This weak bivariate association suggests that simple linear relationships may be insufficient, thereby motivating the use of nonlinear specifications and multivariate analysis.

4.3 Base Regression Results

Table 3 shows the estimation results for Equation (1). Model (1) demonstrates the ordinary least square (OLS) regression with only independent variables, does not provide clear evidence of nonlinearity. After adding control variables in Model (2), the coefficient on *LogCEOage* becomes positive and statistically significant, while the coefficient on *LogCEOage*² is negative and significant, indicating an inverse U-shape relationship between CEO age and firm digital transformation.

Table 1. Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min.	Median	Max.
Dependent variables						
FDT	14,832	37.61	11.07	21.38	35.20	79.81
LogFDT	14,832	3.587	0.282	3.062	3.561	4.380
Independent variables						
CEOage	14,832	49.81	6.697	24	50	81
CEOage ²	14,832	2526	666.3	576	2500	6561
LogCEOage	14,832	3.899	0.139	3.178	3.912	4.394
LogCEOage ²	14,832	15.22	1.074	10.10	15.30	19.31
Control variables						
<i>CEO level</i>						
CEOdual	14,832	0.255	0.436	0	0	1
CEOgender	14,832	0.928	0.259	0	1	1
CEOownership	14,832	0.053	0.120	0	0	0.843
<i>Firm Governance</i>						
LogBDsize	14,832	2.147	0.199	1.386	2.197	3.045
BDindep	14,832	0.373	0.054	0.167	0.333	0.800
Largestshares	14,832	32.68	14.98	0.290	30.02	99
Toptenshares	14,832	55.95	15.85	1.320	55.94	100
<i>Firm Level</i>						
LogFirmage	14,832	2.869	0.385	0.693	2.944	3.829
Firmleverage	14,832	0.455	0.214	0.054	0.451	0.942
ROA	14,832	0.048	0.067	-0.259	0.047	0.237
Tobinq	14,832	1.741	1.682	0	1.265	9.790
Moderating Variables						
Firmsize	14,832	2.556*10 ¹⁰	8.322*10 ¹⁰	3.553*10 ⁸	5.155*10 ⁹	6.648*10 ¹¹
LogFirmsize	14,832	22.55	1.442	19.69	22.36	27.22

Table 2. Pairwise correlation analysis

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1. LogFDT	1														
2. LogCEOage	0.039***	1													
3. LogCEOage ²	0.039***	1.000***	1												
4. CEOdual	0.130***	0.136***	0.139***	1											
5. CEOgender	-0.003	0.052***	0.051***	0.013	1										
6. CEOownership	0.128***	-0.009	-0.009	0.452***	0.005	1									
7. LogBDsize	-0.056***	0.057***	0.056***	-0.167***	0.098***	-0.149***	1								
8. BDindep	0.048***	0.020**	0.021**	0.107***	-0.054***	0.068***	-0.500***	1							
9. Largestshares	-0.150***	0.028***	0.028***	-0.060***	-0.011	-0.020**	0.012	0.012	1						
10. Toptenshares	-0.099***	-0.002	-0.001	-0.026***	-0.038***	0.123***	0.062***	0.006	0.673***	1					
11. LogFirmage	0.030***	0.152***	0.154***	-0.100***	-0.029***	-0.273***	0.049***	-0.023***	-0.137***	-0.222***	1				
12. Firmleveragew	-0.062***	0.082***	0.082***	-0.121***	0.018**	-0.268***	0.163***	0.001	0.042***	-0.036***	0.247***	1			
13. ROAW	-0.072***	0.029***	0.029***	-0.012	0.017**	0.039***	0.054***	-0.033**	0.147***	0.208***	-0.096***	-0.237***	1		
14. Tobinqw	0.085***	-0.062***	-0.063***	0.114***	-0.021**	0.177***	-0.167***	0.053***	-0.048***	-0.013	-0.145***	-0.412***	0.166***	1	
15. LogFirmsizew	0.079***	0.176***	0.176***	-0.152***	0.038***	-0.259***	0.269***	0.034***	0.164***	0.207***	0.248***	0.501***	0.067***	-0.466***	1

Note: Parentheses report p-values of ***, **, * and *, which indicate 1%, 5% and 10% levels of significance, respectively.

Table 3. Base regression results

	Model (1) OLS	Model (2) OLS	Model (3) RE	Model (4) FE	Model (5) FE
Variables	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>
LogCEOage	1.0073* (0.5685)	2.1622*** (0.3888)	1.1334*** (0.3015)	1.0964*** (0.3006)	1.2390*** (0.3126)
LogCEOage ²	-0.1203 (0.7369)	-0.2785*** (0.0505)	-0.1447*** (0.0392)	-0.1394*** (0.0391)	-0.1582*** (0.0406)
Logfirmsize					0.0394*** (0.0024)
LogCEOage * Logfirmsize					0.4974** (0.2270)
LogCEOage ² * Logfirmsize					(0.0293) -0.0647**
CEOdual		0.0230*** (0.0042)	0.0076** (0.0035)	0.0045 (0.0035)	0.0048 (0.0034)
CEOgender		0.0069 (0.0061)	0.0043 (0.0055)	0.0059 (0.0056)	0.0041 (0.0055)
CEOownership		0.0817*** (0.0158)	0.0396** (0.0165)	0.0202 (0.0172)	0.0248 (0.0171)
LogBDsize		0.0518*** (0.0100)	0.0264*** (0.0102)	0.0292*** (0.0106)	0.0079 (0.0106)
BDindep		0.1843*** (0.0343)	-0.0203 (0.0310)	-0.0449 (0.0315)	-0.0688** (0.0312)
Largestshares		-0.0004*** (0.0001)	-0.0011*** (0.0002)	-0.0011*** (0.0002)	-0.0009*** (0.0002)
Toptenshares		0.0002 (0.0001)	0.0002 (0.0001)	0.0004*** (0.0001)	-0.0001 (0.0001)
LogFirmage		-0.0580*** (0.0054)	-0.0482*** (0.0098)	-0.0178 (0.0126)	-0.0368*** (0.0125)
Firmleverage		0.0275*** (0.0092)	0.0147 (0.0090)	0.0267*** (0.0093)	-0.0153 (0.0095)
ROA		0.1378*** (0.0253)	0.0218 (0.0182)	0.0163 (0.0181)	-0.0338* (0.0181)
Tobinq		-0.0049*** (0.0011)	-0.0002 (0.0009)	-0.0006 (0.0009)	0.0039*** (0.0009)
Constant	1.4900 (1.0958)	-0.9636 (0.7501)	1.1652** (0.5832)	1.1910** (0.5831)	0.2035 (0.6102)
Industry	No	Yes	Yes	Yes	Yes
Year	No	Yes	Yes	Yes	Yes
N	14832	14832	14832	14832	14832
R ²	0.0017	0.5573		0.4076	0.4195
R ² adjusted	0.0016	0.5541		0.3491	0.3620
Hausman Test			Prob>chi2 = 0.0000		

Notes: Table 3 presents the results for Models 1–5. The dependent variable is firm digital transformation (*LogFDT*); independent variables are CEO age (*LogCEOage*) and CEO age squared term (*LogCEOage*²). The control variables are CEO duality (*CEOdual*), CEO gender (*CEOgender*), CEO ownership (*CEOownership*), board size (*LogBDsize*), board independence (*BDindep*), largest ownership (*Largestshares*), top ten ownerships (*Toptenshare*), firm age (*LogFirmage*), firm leverage (*Firmleverage*), profitability (*ROA*), firm performance (*Tobinq*); moderating variables are firm size (*LogFirmsize*). Parentheses report p-values of ***, ** and *, which indicate 1%, 5% and 10% levels of significance, respectively. The regression is conducted using ordinary least square (OLS), random effect (RE) and fixed effect (FE) models.

Models (3) and (4) estimate Equation (1) using random-effects and fixed-effects specifications, respectively. The results remain stable across estimators. In the fixed-effects model (Model 4), which is preferred based on the Hausman test ($\text{Prob} > \chi^2 = 0.0000$), the coefficient on LogCEOage is 1.0964 ($p < 0.01$), while the coefficient on LogCEOage^2 is -0.1394 ($p < 0.01$). These findings indicate that the inverse U-shaped relationship between CEO age and firm digital transformation is robust after controlling for unobserved firm-specific heterogeneity. Overall, the baseline regression results support Hypothesis H1.

These findings are consistent with the theoretical expectation that mid-career CEOs optimally balance risk-taking incentives and managerial experience, enabling them to more effectively initiate and sustain digital transformation. In contrast, younger CEOs may face career concerns that limit substantive investment, while older CEOs may become more risk-averse due to shorter career horizons.

4.4 Moderating Effect of Firm Size

Model (5) introduces firm size (LogFirmsize) and its interaction terms with CEO age and CEO age squared to test H2. The coefficient on firm size itself is positive and statistically significant ($\beta = 0.0394$, $p < 0.01$), suggesting that larger firms, on average, exhibit higher levels of digital transformation.

More importantly, the interaction between CEO age and firm size is positive and statistically significant ($\beta_4 = 0.4974$, $p < 0.05$), while the interaction between the squared term of CEO age and firm size is negative and statistically significant ($\beta_5 = -0.0647$, $p < 0.05$). Following Haans et al. (2016), a negative coefficient on the quadratic interaction term indicates that the curvature of the inverse U-shaped relationship becomes flatter as the moderating variable increases. Consistent with this interpretation, the calculated value of $(\beta_1\beta_5 - \beta_2\beta_3)$ is negative (-0.001), indicating a leftward shift of the inflection point as firm size increases. This implies that in larger firms, the peak influence of CEO age on digital transformation occurs earlier, and the overall sensitivity of digital transformation to CEO age is reduced.

Figure 2 further illustrates this moderating effect by plotting the predicted relationship between CEO age and firm digital transformation at low, medium and high levels of firm size. The inverse U-shaped curve becomes noticeably flatter at higher levels of firm size, indicating that organisational scale and bureaucratic complexity constrain the extent to which CEO age translates into digital transformation initiatives. Taken together, these findings provide empirical support for H2, showing that firm size positively moderates the nonlinear relationship between CEO age and firm digital transformation.

4.5 Robustness Tests for the Inverse U-shaped Relation

U-test. To formally validate the inverse U-shaped relationship, a U-test is conducted. The results in Table 4 reject the null hypothesis of monotonicity at the 1% level. Moreover, the estimated inflection point ($\text{CEOage} = 51.05$; $\text{LogCEOage} = 3.9328$) lies within the observed range of CEO age (CEOage : 24 – 81; LogCEOage : 3.1781 – 4.3944), and the slope changes sign across the interval, providing additional support for H1.

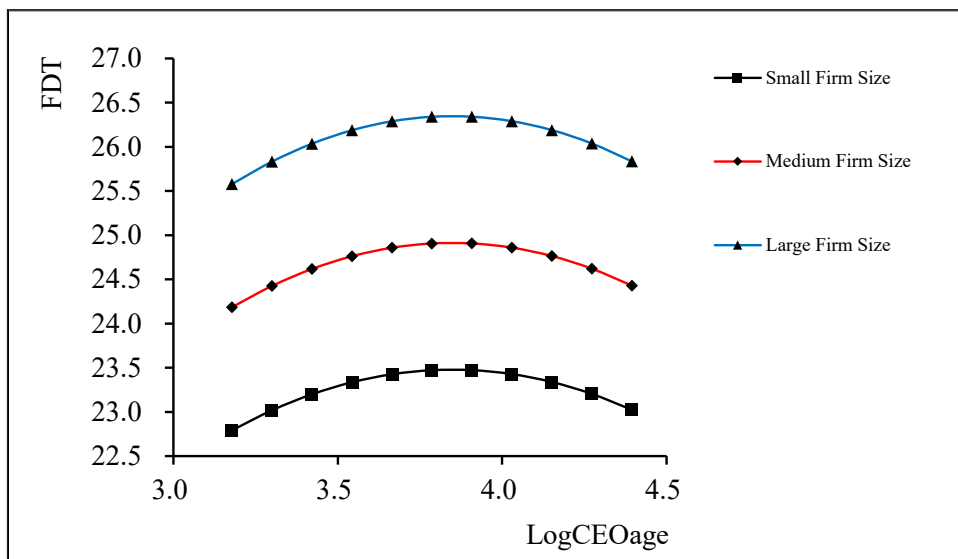


Figure 2. Interaction plot for firm size on the relationship between CEO age and firm digital transformation

Table 4. U-test results

	Model (4) FE	
	Lower bound	Upper bound
Interval	3.1781	4.3944
Slope	0.2104	-0.1287
t-value	3.9761	-2.9049
$P > t $	0.0004	0.0018
Test for inverse	t-value = 2.90	
U-shape	$P > t = 0.0018$	
Inflection points	$LogCEOage = 3.9328$ $CEOage = 51.05$	

Note: H1: Inverse U shape; H0: Monotone or U shape. Lower bound value of $LogCEOage_{min} = 3.1781$, $CEOage_{min} = 24$; Upper bound value of $LogCEOage_{max} = 4.3944$, $CEOage_{max} = 81$.

Higher-order nonlinearity. To examine whether the relationship between CEO age and firm digital transformation follows a higher-order nonlinear pattern, a cubic term of CEO age ($LogCEOage^3$) is added into Equation (1). As shown in Table 5 (Model 7), the coefficients of $LogCEOage$, $LogCEOage^2$ and $LogCEOage^3$ are all statistically insignificant, indicating no evidence of an S-shaped relationship between CEO age and firm digital transformation. Additionally, compared to the baseline fixed-effects specification in

Table 5. Regression results for the S-shape and subgroup analysis

Variables	Model (7)	Model (8)	Model (9)
	FE	FE <i>LogCEOage < 3.9328</i>	FE <i>LogCEOage ≥ 3.9328</i>
	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>
LogCEOage	3.2292 (5.8148)	0.0306* (0.0159)	-0.0607* (0.0342)
LogCEOage ²	-0.6987 (1.5233)		
LogCEOage ³	0.0488 (0.1329)		
Constant	-1.5154 (7.3920)	3.3040** (0.1029)	3.5773*** (0.1588)
Control variables	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	14832	8814	6018
R ²	0.4076	0.4000	0.3795
R ² adjusted	0.3490	0.2998	0.2380
SUR test		Prob>chi2 = 0.0055	

Note: Parentheses report p-values of ***, ** and *, which indicate 1%, 5% and 10% levels of significance, respectively.

Model (4), the R² of the regression model does not increase with the inclusion of the variable (*LogCEOage*³), which further ensures the robustness of the main results.

Subsample Analysis. The sample is split based on the estimated inflection point (Table 5). For firms led by younger CEOs (*LogCEOage* < 3.9328), CEO age is positively associated with digital transformation, whereas for firms led by older CEOs (*LogCEOage* ≥ 3.9328), the relationship becomes negative. A coefficient difference test confirms that the two effects differ significantly, further confirming the inverse U-shaped pattern.

4.6 Treatment on Endogeneity

Although the baseline two-way fixed-effects regressions and robustness tests consistently support the proposed inverse U-shaped relationship between CEO age and firm digital transformation, potential endogeneity concerns cannot be fully eliminated. Reverse causality, omitted variable bias and non-random CEO assignment may affect the estimates. While firm and year fixed effects help control for time-invariant firm heterogeneity and common macro shocks, they do not fully address these concerns. Therefore, we adopt additional approaches, including propensity score matching (PSM) and lagged independent-variable regressions, to strengthen causal interpretation, while acknowledging the remaining limitations.

4.6.1 Propensity Score Matching

CEO-driven digital transformation decisions are unlikely to be randomly assigned and may depend on firm characteristics that also influence transformation outcomes. Firms led by younger versus older CEOs may therefore differ systematically, generating self-selection bias. Following Zou et al. (2024), this study applies PSM to construct a more comparable treatment and control group. Firms are divided into a treatment group (younger CEOs) and a control group (older CEOs) based on the median CEO age. All control variables included in Equation (1) are used as covariates to estimate the propensity score. One-to-one nearest-neighbour matching without replacement is adopted, with a caliper width of 0.0001.

Table 6 reports the balance test results. Before matching, most covariates exhibit statistically significant differences between the two groups, indicating substantial selection bias. After matching, the absolute standardised bias for all covariates falls below 10%, and the mean differences are statistically insignificant, suggesting that the matched sample achieves satisfactory covariate balance.

Two-way fixed-effect regressions are then re-estimated using the matched sample. As shown in Table 7, Model (11) shows that the coefficient on *LogCEOage* remains

Table 6. Balance test of PSM

Variable	Unmatched	Mean		%bias	%reduct bias	t-test	
	Matched	Treated	Control			t	P> t
CEOdual	U	0.2944	0.2089	19.8		11.97	0.000
	M	0.2589	0.2562	0.6	96.9	0.36	0.716
CEOgender	U	0.9369	0.9173	7.5		4.6	0.000
	M	0.9359	0.9324	1.3	82.1	0.84	0.399
CEOownership	U	0.0505	0.0557	-4.3		-2.61	0.009
	M	0.0509	0.0489	1.6	61.8	0.99	0.322
LogBDsize	U	2.1548	2.1389	8.0		4.83	0.000
	M	2.1518	2.1515	0.2	98.0	0.1	0.923
BDindep	U	0.3745	0.3712	6.2		3.76	0.000
	M	0.3730	0.3738	-1.5	76.5	-0.87	0.385
Largestshares	U	33.1800	32.1130	7.1		4.33	0.000
	M	33.1140	32.6460	3.1	56.1	1.88	0.061
Toptenshares	U	56.0280	55.8630	1.0		0.63	0.527
	M	55.7190	55.3920	2.1	-98.1	1.24	0.216
Logfirmage	U	2.9214	2.8091	29.3		17.91	0.000
	M	2.9147	2.9200	-1.4	95.2	-0.96	0.339
Firmleverage	U	0.4694	0.4377	14.8		9.02	0.000
	M	0.4645	0.4655	-0.4	97.0	-0.27	0.789
ROAw	U	0.0489	0.0469	3.0		1.84	0.066
	M	0.0480	0.0477	0.5	85.0	0.28	0.781
Tobinqw	U	1.6534	1.8423	-11.2		-6.83	0.000
	M	1.6722	1.6833	-0.7	94.1	-0.4	0.688

positive and significant ($\beta = 0.9785, p < 0.05$), while the coefficient on LogCEOage^2 remains negative and significant ($\beta = -0.1254, p < 0.05$), confirming the inverse U-shape relationship. Model (12) further indicates that the moderating effects of firm size remain statistically significant, reinforcing the robustness of the main findings after controlling for observable heterogeneity.

4.6.2 Lagged Independent Variables

To further address concerns related to reverse causality, the baseline model is re-estimated using one-period lagged CEO age variables. As reported in Model (13) of Table 7, the coefficient on Lag_LogCEOage is positive and significant at the 1% level ($\beta = 1.1532$), while the coefficient on Lag_LogCEOage^2 is negative and significant at the 1% level ($\beta = -0.1504$). These results indicate that the inverse U-shaped relationship persists when CEO age is lagged, suggesting that digital transformation outcomes are not driving CEO age-related effects.

Table 7. Regression results of PSM and lagged independent variables

	Model (11) PSM	Model (12) PSM	Model (13) FE
Variables	<i>LogFDT</i>	<i>LogFDT</i>	<i>LogFDT</i>
LogCEOage	0.9785** (0.4306)	1.2704*** (0.4462)	
LogCEOage ²	-0.1254** (0.0561)	-0.1629*** (0.0580)	
Logfirm sizew		0.0410*** (0.0036)	
LogCEOage * Logfirm sizew		0.8013*** (0.3391)	
LogCEOage ² * Logfirm sizew		-0.1029*** (0.0439)	
Lag_LogCEOage			1.1532*** (0.3066)
Lag_LogCEOage ²			-0.1504*** (0.0399)
Constant	1.4406* (0.8367)	0.0897 (0.8716)	1.1877** (0.5965)
Control variables	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	7550	7550	13596
R ²	0.4166	0.4289	0.4289
R ² adjusted	0.2921	0.3067	0.3067

Note: Parentheses report p-values of ***, ** and *, which indicate 1%, 5% and 10% levels of significance, respectively.

5. Discussion

5.1 *The Inverse U-shaped Relationship Between CEO Age and Digital Transformation*

The results indicate that CEO age has a nonlinear effect on firm digital transformation, driven by the interaction between career concerns and career horizon considerations. After controlling for CEO characteristics, firm attributes, governance structure, ownership and performance, firms led by middle-aged CEOs exhibit higher levels of digital transformation, while those led by very young or older CEOs show lower engagement. This finding helps reconcile mixed evidence in prior studies, which largely assume a linear relationship between CEO age and strategic outcomes.

Younger CEOs are generally more willing to engage in risk-taking and innovation. However, stronger career concerns and evaluation pressures may lead them to prioritise short-term performance and reputation-building, thereby limiting their willingness to commit large-scale, uncertain digital transformation initiatives (Cheng et al., 2024; Gibbons & Murphy, 1992). As CEOs accumulate experience and organisational authority, they become better positioned to initiate complex strategic changes. During this stage, career concerns and accumulated capabilities jointly encourage greater engagement in long-term, high-impact investments such as digital transformation (Holmstrom, 1999; Yeoh & Hooy, 2022).

When CEO age exceeds the inflection point of 51.05 years, career horizon considerations dominate. As CEOs approach the later stages of their careers, career horizon considerations become increasingly salient. With shorter remaining tenure and reduced incentives tied to future labour market opportunities, older CEOs tend to become more risk-averse and less willing to undertake long-term, uncertain investments such as digital transformation (Cabrerós et al., 2024; Yeoh & Hooy, 2022). Figure 3 illustrates that firm digital transformation rises with CEO age until 51.05 years, after which it declines, confirming the inverse U-shaped pattern. This pattern highlights that digital transformation is not solely a function of managerial risk preference, but also of the alignment between incentives, experience and time horizon across different career stages.

To quantify the effect across ages, marginal effects of CEO age on firm digital transformation were calculated based on Model (4) in Table 3. As shown in Figure 4 and Table 8, the marginal effect is positive and significant up to age 48, becomes positive but not significant between 49 and 51, turns negative but not significant from 52 to 58, and becomes negative and significant from age 59 onward. This pattern indicates that the influence of CEO age increases firm digital transformation initially, diminishes near the inflection point, and declines in later years.

Overall, these findings provide strong support for H1 and demonstrate that CEO age influences digital transformation in a career-stage dependent manner rather than through a monotonic effect.

5.2 *Moderating Effects of Firm Size*

H2 posits that firm size positively moderates the inverse U-shaped relationship between CEO age and firm digital transformation, such that the effect of CEO age is stronger in larger firms. The empirical results provide strong support for this hypothesis. In the

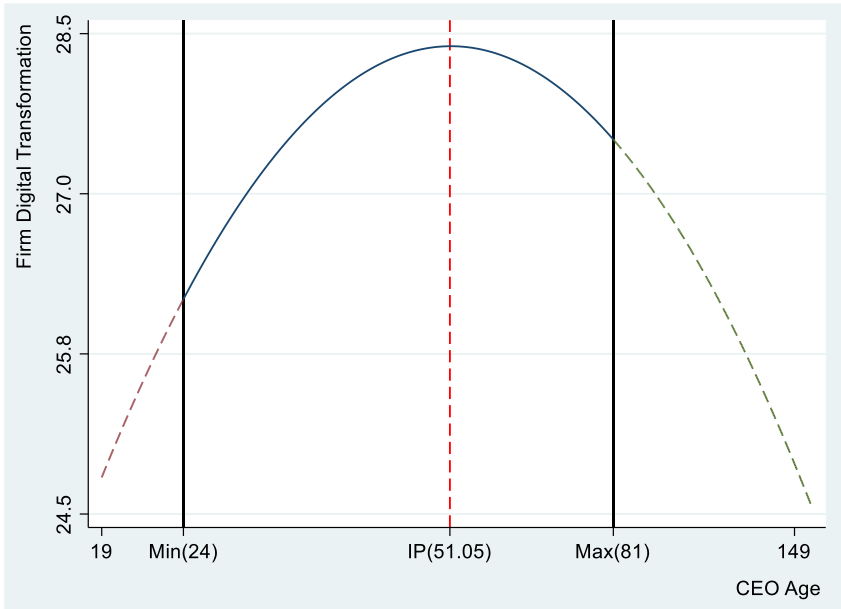


Figure 3. Impact of CEO age on firm digital transformation
 Note: The inflection point (IP) is at age 51.05 where firm digital transformation peaks.

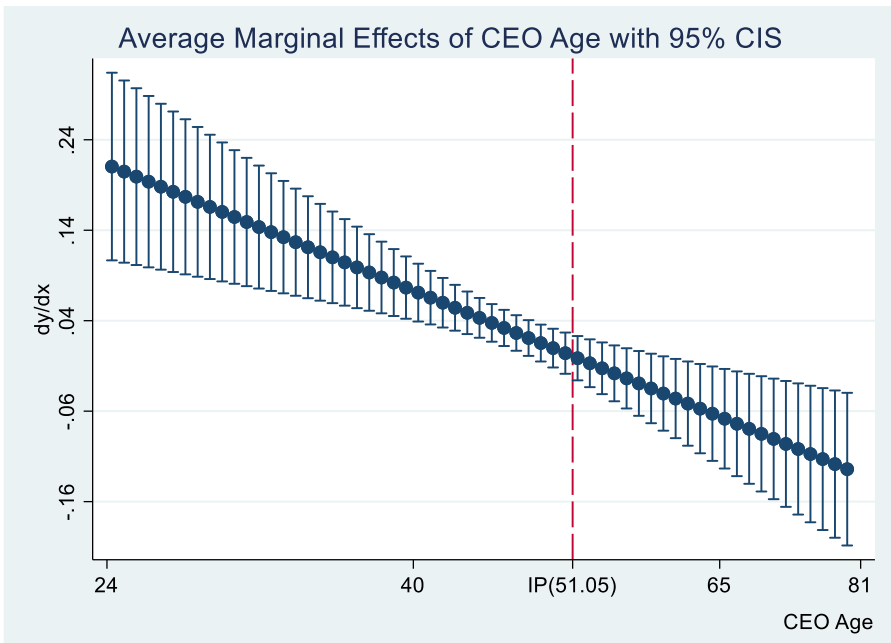


Figure 4. Plot of marginal effects of CEO age on firm digital transformation

Table 8. Marginal effects of CEO age on firm digital transformation

CEO age	dy/dx	SD	P>z	95% C.I.		CEO age	dy/dx	SD	P>z	95% C.I.	
				Lower limit	Upper limit					Lower limit	Upper limit
24	0.21	0.05	0.0000	0.11	0.31	53	-0.01	0.01	0.6020	-0.03	0.02
25	0.20	0.05	0.0000	0.10	0.30	54	-0.01	0.01	0.4330	-0.04	0.02
26	0.19	0.05	0.0000	0.10	0.28	55	-0.02	0.02	0.3100	-0.05	0.01
27	0.18	0.04	0.0000	0.09	0.26	56	-0.02	0.02	0.2230	-0.05	0.01
28	0.17	0.04	0.0000	0.09	0.25	57	-0.02	0.02	0.1620	-0.06	0.01
29	0.16	0.04	0.0000	0.08	0.24	58	-0.03	0.02	0.1200	-0.06	0.01
30	0.15	0.04	0.0000	0.08	0.22	59	-0.03	0.02	0.0900	-0.07	0.00
31	0.14	0.03	0.0000	0.07	0.21	60	-0.04	0.02	0.0690	-0.08	0.00
32	0.13	0.03	0.0000	0.07	0.19	61	-0.04	0.02	0.0530	-0.08	0.00
33	0.12	0.03	0.0000	0.07	0.18	62	-0.04	0.02	0.0420	-0.09	0.00
34	0.11	0.03	0.0000	0.06	0.17	63	-0.05	0.02	0.0340	-0.09	0.00
35	0.11	0.02	0.0000	0.06	0.15	64	-0.05	0.02	0.0280	-0.10	-0.01
36	0.10	0.02	0.0000	0.05	0.14	65	-0.06	0.03	0.0230	-0.11	-0.01
37	0.09	0.02	0.0000	0.05	0.13	66	-0.06	0.03	0.0190	-0.11	-0.01
38	0.08	0.02	0.0000	0.05	0.12	67	-0.07	0.03	0.0170	-0.12	-0.01
39	0.08	0.02	0.0000	0.04	0.11	68	-0.07	0.03	0.0140	-0.13	-0.01
40	0.07	0.02	0.0000	0.04	0.10	69	-0.07	0.03	0.0120	-0.13	-0.02
41	0.06	0.01	0.0000	0.03	0.09	70	-0.08	0.03	0.0110	-0.14	-0.02
42	0.06	0.01	0.0000	0.03	0.08	71	-0.08	0.03	0.0100	-0.14	-0.02
43	0.05	0.01	0.0000	0.02	0.07	72	-0.09	0.03	0.0090	-0.15	-0.02
44	0.04	0.01	0.0000	0.02	0.07	73	-0.09	0.03	0.0080	-0.16	-0.02
45	0.03	0.01	0.0010	0.01	0.06	74	-0.09	0.04	0.0070	-0.16	-0.03
46	0.03	0.01	0.0030	0.01	0.05	75	-0.10	0.04	0.0060	-0.17	-0.03
47	0.02	0.01	0.0270	0.00	0.04	76	-0.10	0.04	0.0060	-0.18	-0.03
48	0.02	0.01	0.0770	0.00	0.04	77	-0.11	0.04	0.0050	-0.18	-0.03
49	0.01	0.01	0.3740	-0.01	0.03	78	-0.11	0.04	0.0050	-0.19	-0.03
50	0.01	0.01	0.6300	-0.02	0.03	79	-0.12	0.04	0.0050	-0.20	-0.04
51	0.00	0.01	0.9120	-0.02	0.02	80	-0.12	0.04	0.0040	-0.21	-0.04
52	-0.00	0.01	0.8230	-0.03	0.02	81	-0.13	0.04	0.0040	-0.21	-0.04

moderating analysis, the coefficients of CEO age and its squared term remain positive and negative, respectively, confirming that the inverse U-shaped relationship persists after incorporating firm size. Moreover, the quadratic interaction term between CEO age and firm size is negative. Following Haans et al. (2016), this pattern indicates a positive moderating effect: increases in firm size attenuate the curvature of the inverse U-shape and extend the effective range over which CEO age influences digital transformation. This finding is consistent with the view that managerial discretion operates through both resource availability and implementation capacity.

Importantly, this flattening does not imply a weakening of CEO age effects. Rather, it indicates that CEO age-related differences are realised more consistently across age groups in larger firms, where resource availability and organisational capacity enable strategic intentions to be effectively implemented. Consequently, CEOs in larger firms, particularly middle-aged CEOs with optimal combinations of experience and remaining career horizons, are able to sustain higher overall levels of digital transformation.

From an upper echelons perspective, executive characteristics affect firm strategies through the discretion afforded by organisational context. Although large firms are often associated with bureaucratic inertia, they also offer a resource-rich environment in which CEOs' strategic intentions can be implemented more effectively. In this sense, firm size enhances rather than constrains the expression of CEO age effects on digital transformation.

This moderating role of firm size can be further explained by the resource-based view. Digital transformation is capital-intensive, skill-dependent and characterised by high uncertainty (Buer et al., 2021; Raguseo et al., 2020). Larger firms typically possess greater slack resources, including financial capital, specialised human resources and established technological infrastructure, which collectively reduce the marginal risk and cost of digital initiatives. As a result, CEOs in larger firms, particularly middle-aged CEOs with optimal career incentives and accumulated experience, are better positioned to initiate and sustain digital transformation projects.

Financially, larger firms benefit from stronger internal funding capacity, which alleviates financing constraints and allows CEOs to commit resources to long-term digital investments without jeopardising short-term liquidity (Wu et al., 2024). In terms of human capital, large firms are more likely to maintain dedicated IT departments and digital expertise, enabling CEOs to mobilise organisational capabilities in support of transformation efforts (Eller et al., 2020). Moreover, economies of scale, diversified business portfolios and stronger market power further enhance large firms' ability to absorb potential failures associated with risky strategic decisions (Buer et al., 2021).

In contrast, smaller firms face tighter resource constraints and higher exposure to downside risks, which weakens the impact of CEO age on digital transformation decisions. Even when CEOs possess strong incentives or experience, limited organisational capacity may prevent these traits from translating into observable strategic outcomes.

Overall, the findings indicate that firm size amplifies the inverse U-shaped effect of CEO age on firm digital transformation. By providing resource support and risk-buffering mechanisms, larger firms enable CEO age-related characteristics to exert a stronger influence on digital transformation, thereby offering robust empirical support for H2.

5.3 Theoretical Contributions

This study makes three important contributions to the literature on top executives and firm digital transformation. Anchored in upper echelons theory, the findings demonstrate that CEOs' engagement in digital transformation increases with age up to an optimal point, after which it declines. This finding challenges the prevailing assumption of a linear relationship between CEO age and strategic decision-making, offering a novel explanation for the mixed empirical evidence in prior studies (Wang &

He, 2024; Zhang, W. et al., 2023; Zou et al., 2024). By integrating career concern theory and career horizon theory, the study provides a dynamic behavioural explanation for how CEOs' risk preferences and strategic priorities evolve across career stages. Younger CEOs are motivated by reputation building and career advancement, while older CEOs, facing shorter career horizons, become increasingly risk-averse and less inclined to initiate long-term digital transformation projects. This perspective shifts upper echelons research away from static executive characteristics toward career-stage dependent decision-making. In doing so, the study advances upper echelons theory by introducing a dynamic, career-stage based perspective on executive decision-making under uncertainty.

Second, the study contributes by identifying firm size as a critical organisational boundary condition shaping the CEO age–digital transformation relationship. Supporting H2, firm size positively moderates the inverse U-shaped relationship, such that the effect of CEO age on digital transformation is stronger in larger firms. This finding challenges the traditional view that large firms primarily constrain executives through bureaucratic inertia (Hannan & Freeman, 1984). Instead, organisational scale can expand managerial discretion by providing financial slack, technological infrastructure and structural legitimacy, thereby enabling CEOs across different age groups to pursue complex and resource-intensive digital initiatives. This insight clarifies the role of firm size not merely as a source of inertia but as a contextual enabler that conditions how executive characteristics translate into strategic outcomes.

Finally, the study shows that the inflection point of CEO age occurs earlier in China than in developed economies. The turning point identified in this study (51.05 years) precedes those reported in Europe (53.52 years) (Cabreros et al., 2024) and the United States (approximately 58 years) (Cheng et al., 2024), suggesting that career horizon effects are context-dependent rather than universal. In China's fast-moving digital economy, with intense competition, compressed innovation cycles and strong performance pressures, CEOs may experience accelerated career-stage transitions, leading to earlier peaks in digital-strategic engagement. By situating CEO age effects within a comparative institutional framework, this study extends upper echelons theory toward a more context-sensitive understanding of executive decision-making and highlights how executive age and organisational scale jointly shape firms' digital transformation strategies.

5.4 Practical Implications

This study offers several important managerial and governance implications. First, firms should recognise the important role of the CEO in driving digital transformation. The findings reveal a non-linear effect of CEO age, suggesting that both career concerns and career horizon should be considered when recruiting or promoting senior executives. Younger CEOs may benefit from mentorship programs or guidance from experienced board members to align their risk-taking tendencies with strategic digital objectives. For older CEOs, who may exhibit risk aversion due to shorter career horizons, enhanced oversight through active board engagement and performance-linked accountability mechanisms can help sustain innovation efforts.

Second, firm size significantly conditions the impact of CEO age on digital transformation. Larger firms, with greater financial, human and technical resources, can provide CEOs with the support and organisational slack necessary to undertake complex digital initiatives. Establishing dedicated digital transformation teams or cross-functional hubs can reduce reliance on individual executive effort and mitigate implementation risks. Conversely, small and medium-sized firms should focus on resource-efficient strategies, such as partnerships with technology providers, to facilitate digital transformation while minimising financial and operational strain.

Overall, these findings underscore the importance of aligning executive career-stage characteristics with organisational support structures. Firms that tailor governance, mentorship and resource allocation to the age and career stage of their CEOs are better positioned to implement effective and sustained digital transformation strategies. More broadly, the findings suggest that effective digital transformation depends not only on technological investment, but also on the alignment between executive characteristics and organisational context.

5.5 Limitation and Direction for Future Research

Despite its contributions, this study is subject to several limitations that open avenues for further research. First, this study uses data from listed firms across all industries, which may mask industry-specific variations in digital transformation adoption and executive decision-making. Future research could explore sectoral differences to uncover more nuanced patterns. Second, the role of other top management team members, such as chief financial officers or chief data officers, remains unexplored. Collecting primary data through surveys or interviews could shed light on their influence on digital transformation. Third, CEO compensation structures and incentive systems may shape risk-taking behaviour and engagement in digital initiatives. Future studies should examine both explicit contractual incentives and implicit career-related motives. Finally, although this study employs multiple robustness checks and endogeneity mitigation strategies, causal inference remains subject to limitations inherent in observational data. In particular, due to data constraints, we do not explicitly account for CEO turnover events, such as retirements or newly appointed CEOs, which may provide plausibly exogenous variation in leadership characteristics. Future research could exploit such transitions, as well as other exogenous shocks or natural experiments, to further strengthen causal identification.

6. Conclusion

This study examines the relationship between CEO age and firm digital transformation using Chinese listed firms from 2011 to 2022. Grounded in upper echelons theory, as well as career concern and career horizon perspectives, the findings reveal a robust inverse U-shaped relationship: firm digital transformation intensity increases with CEO age up to an inflection point at around 51.05 years and declines thereafter. Younger CEOs tend to exhibit caution toward long-term and uncertain digital investments due to career concerns, whereas mid-aged CEOs are more actively engaged in digital

transformation as a result of accumulated experience, authority and balanced risk incentives. In contrast, as career horizons shorten, older CEOs become increasingly risk-averse, leading to a decline in digital transformation engagement.

The study further shows that firm size positively moderates this relationship by enhancing managerial discretion through greater resources availability and implementation capacity, thereby enabling CEOs to more effectively translate strategic intent into digital transformation outcomes. Overall, these findings highlight the joint role of executive career stage and organisational context in shaping firms' digital transformation strategies. More broadly, the results suggest that successful digital transformation depends not only on technological investment, but also the alignment between executive characteristics and firm-level conditions.

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