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Abstract: The advent of the Information Technology Revolution has created an imperative for corporate leadership to effectively facilitate digital transformation initiatives, however, the extant literature remains limited in empirically examining the precise mechanisms through which CEOs' technological competencies influence organisational innovation outcomes. To address this gap, we investigate whether and how Chief Executive Officers (CEOs) with IT backgrounds (CITs) influence firms' digital innovation. Using manually collected data from Chinese A-share listed companies (2007–2020), we find that CITs allocate significantly more attention to digital initiatives, resulting in measurable innovation gains. This effect is most pronounced in high-tech firms, low-financing-constraint firms, and competitive industries. Comparative analysis further reveals CITs' unique impact surpasses that of Chief Information Officers (CIOs). Our study advances the attention-based view (ABV) by demonstrating how leader-specific competencies translate into strategic focus, while offering practical insights for executive selection in digital transformation process.

Keywords: CEO; Chief Executive Officer; CIO; Chief Information Officers; IT background; attention configuration; digital innovation; ABV; attention-based view.

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1 Introduction

In the digital era, competitiveness will be determined by the strategic investments in digital infrastructure and the cultivation of environments conducive to innovation. Amidst the current information technology revolution, China engage in international competition by advancing digital technologies such as 5G, big data, and cloud computing. Since 2015, the Chinese government first formally proposed the initiative to advance the construction of a 'Digital China'. Over the past decade, efforts to enhance enterprises' digital capabilities have not ceased. In 2024, the *Third Plenary Session of the 20th Central Committee of the Communist Party of China* presented a detailed plan for advancing reforms, offering clear direction for enterprises to adopt digital strategies and attain high-quality development. Nevertheless, China's digital economy development faces challenges related to the imbalance between input and output. In 2021, the contribution of digital technology to China's economic growth is 39.8%, which is significantly lower than the 65% observed in the USA (Zhao et al., 2024). This situation can be likened to running with two legs, whereas China is still processing with a one-leg-jump. How to cultivate digital innovation remains an emergency challenge for developing country like China.

Prior studies indicate that external factors, such as government environmental policies (Shi and Huang, 2025), tax pressures (Liu et al., 2024), and intellectual property protections (Wen and Deng, 2023) significantly contribute to the advancement of digitalisation. Nevertheless, a firm's internal ability is remain crucial. In particular, the willingness of senior executives to confront both the risks of failure and the imperative for ongoing investment is of paramount importance. For instance, CEOs with a background in technology are instrumental in elevating IT development to the level of corporate strategy (Zhu et al.,2024). Moreover, executives with overseas education and

work experience tend to enhance efforts toward digital transformation (Hu et al., 2023). Despite the extensive body of literature examining the impact of CEOs' professional backgrounds on their imprinting or intuition, there is a notable gap concerning how these backgrounds influence their attention allocation. This study, grounded in the attention-based view (ABV), explores the mechanisms through which CEOs with information technology (IT) backgrounds shape corporate digital innovation.

Our study employs a regression model to examine the relationship between CEOs with an IT background and digital innovation, utilising a dataset of non-financial A-share listed firms from 2007 to 2020. Additionally, we apply text analysis methods to assess digital attention. Our analysis demonstrates that CEOs with IT expertise are pivotal in driving digital innovation. To ensure the robustness of these findings, we implement a series of tests, including the use of alternative variable definitions and the exclusion of specific industries from the sample. Furthermore, we utilise instrumental variable method to mitigate potential endogeneity issues. Significantly, the focus these CEOs place on advanced digital technologies is crucial for driving corporate digital innovation. Moreover, the positive effect is more pronounced in high-tech companies, firms with low financing constraints, and highly competitive industries. Finally, CEOs with IT backgrounds (CITs) play a more significant role than Chief Information Officers (CIOs) in driving digital innovation.

This study offers several important contributions to the literature. First, it enhances our understanding of the determinants of digital innovation, particularly in firms from developing economies, where the ability to leverage digital technologies for transformation strategies remains underexplored. While previous studies have explored the impact of CEOs' professional backgrounds on digitalisation (Zhu et al., 2024), they primarily focus on general concepts of corporate digital transformation, offering limited theoretical depth and empirical insights into the specific mechanisms at play. In contrast, this study fills this gap by focusing on the role of CEOs' IT backgrounds, providing a novel theoretical perspective on the specific drivers of digital innovation.

Second, this study enriches the literature on the economic impacts of senior executives' IT backgrounds. While previous research has shown that a CEO's IT background can affect corporate performance in areas such as reputation (Lim, 2013), information disclosure (Haislip and Richardson, 2018), and internal control quality (Li and Dang, 2022), this study advances the field by examining the specific mechanisms and boundaries through which a CEO's IT expertise drives digital technological innovation.

Third, this study enriches the literature by applying the ABV to examine how CEOs' professional backgrounds shape corporate behaviour, expanding the traditional CEO characteristics framework. Specifically, we use text analysis methodology to quantify a CEO's attention towards digital transformation, offering a novel and more precise approach to measuring CEOs' digital attention. Furthermore, utilising instrumental variable, this study explores the mechanisms through which a CEO's IT background fosters corporate digital strategy, offering deeper insights into the relationship between leadership attributes and digital innovation.

2   Literature review

2.1   Literature related to CEO characteristics

Numerous studies have examined how senior executives' demographic characteristics affect corporate decisions, with CEO age, for example, influencing a firm's risk tolerance, innovation propensity, and strategic orientation (Jenter and Lewellen, 2015). Additionally, female CEOs are more inclined toward risk-averse decision-making strategies (Huang and Kisgen, 2013). Early-life experiences also shape a CEO's intuition and decision-making. CEOs who endured famine during their formative years often exhibit risk aversion and a heightened sense of social responsibility (Han and Xu, 2022), while those with military backgrounds tend to embrace risk and favour restructuring strategies (Solano et al., 2024). These studies emphasise that CEOs' personal traits significantly influence a firm's risk-taking behaviour and strategic responses to uncertainty.

Recently, academic attention has expanded to explore how professional backgrounds and experiences shape CEO decision-making. For example, those with a background in green initiatives are more likely to increase green investments and enhance the firm's social responsibility (Huang and Wei, 2023). CEOs with foreign experience promote sustainable development within their firms (Wang et al., 2022), and those with financial backgrounds may exhibit conservatism and risk aversion, which can hinder corporate innovation (Gao et al., 2023). Additionally, executives with overseas education and work experience generally exhibit higher risk preferences, which can accelerate digital transformation initiatives (Hu et al., 2023). While these studies explain how CEOs' backgrounds and experiences influence their choice of strategies and decisions, they fail to consider the role of CEOs' backgrounds in shaping their attention allocation.

2.2   The determinants of corporate digital innovation

Digital technologies provide firms with opportunities to sustain their competitive advantage in a dynamic and uncertain economic landscape. Consequently, relevant theoretical research has become a prominent area in recent years. Yoo et al. (2010) conceptualised digital innovation as the integration of digital and physical components to create new products, while Nambisan et al. (2017) defined it as the use of digital technologies to enhance products, processes, and business models. Hu and Ma (2023) further defined digital innovation as a process driven by digital thinking, where firms leverage digital knowledge and physical components to refine or create new products.

A growing body of research identifies external environmental factors and internal organisational dynamics as key drivers of digital innovation. Hu and Ma (2023) show that market integration boosts both the quantity and quality of digital innovation, while Chen et al. (2023) highlight the role of digital finance in accelerating innovation and promoting regional economic growth. Luo et al. (2023) highlight that a favourable business environment helps to increase digital transformation. In terms of internal factors, various elements contribute to the accumulation of technological capital that promotes corporate digital transformation, including senior executive teams (Li et al., 2013), entrepreneurs with extensive social networks (Song and Chen, 2021), and differences in age and gender (Zhang and Chen, 2021). Additionally, CEOs with an IT background play a significant role in driving digital innovation (Wu et al., 2022).

Overall, the existing literature indicates that digital innovation represents a technological evolution on a global scale. Both external and internal factors that promote digital innovation are of considerable concern. Research is shifting its attention from external to internal factors, investigating the impact of senior executives – typical representatives of internal factors – on digital development (Cai et al., 2024; Zhu et al., 2024). However, the mechanism through which CEOs' IT backgrounds influence digital innovation strategies via attention allocation remains underexplored. Drawing on the ABV, this study establishes a theoretical framework and employs text analysis to measure CEOs' digital attention, offering insights into their impact on digital innovation.

3 Hypothesis development

Since digital innovation requires comprehensive integration of digital technologies across all stages of the process (Nambisan et al., 2017), executives, particularly CEOs, must demonstrate creativity, determination, and expertise in managing strategy design, process execution, and resource allocation. The efficacy of CEOs in fulfilling these responsibilities is significantly influenced by their patterns of attention allocation, as extensive research has demonstrated that strategic decisions are fundamentally shaped by the distribution of leaders' focus (Simon, 1959; Ocasio, 1997). These patterns of attention are rooted in the cognitive frameworks of executives, which are largely shaped by their career trajectories and educational backgrounds (Hambrick and Mason, 1984; Frank et al., 1993; Manner, 2010). As a result, senior leaders systematically prioritise strategic domains based on their experiential filters, cognitive preferences, and organisational imperatives. Empirical evidence indicates that such selective attention is observable in tangible outcomes: for instance, dominant CEOs tend to place a disproportionate emphasis on environmental innovation (Zhang et al., 2022), while entrepreneurially-inclined leaders are more likely to focus on CSR initiatives (Zhang et al., 2021).

The distinctive challenges of digital innovation further amplify the importance of CEO attributes. Current studies establish that academic pedigree and international exposure significantly accelerate digital transformation (Luo et al., 2024; Hu et al., 2023), though technological expertise now emerges as the decisive differentiator in the digital age. When a CEO's attention is directed towards emerging technologies and related industries, the organisation is likely to integrate into new technological markets more rapidly (Eggers and Kaplan, 2009), as the focused attention of executives facilitates targeted resource mobilisation and enhances the achievement of organisational objectives (Fu et al., 2020).

CEOs with backgrounds in information technology exhibit distinct advantages in fostering corporate digital innovation through various interconnected mechanisms. Primarily, their educational and professional experiences in IT cultivate cognitive frameworks that are particularly attuned to technological development. This technical foundation equips them with a comprehensive understanding of digital technologies and the ability to formulate long-term strategic visions for innovation. Consequently, such CEOs are better positioned to identify and capitalise on emerging digital opportunities compared to their counterparts from financial or non-technical backgrounds. While non-technical CEOs may adopt conservative investment strategies due to concerns about career advancement, executives with IT experience demonstrate greater proficiency in

recognising the potential of technological advancements. As a result, they are more effective in guiding their firms toward embracing digital transformation initiatives.

Furthermore, CEOs with backgrounds in information technology exhibit a distinctive technological learning capacity that significantly enhances digital innovation outcomes. Their specialised training facilitates a profound comprehension of global technology trends, practical skills such as debugging, and a more precise evaluation of the resources required for innovation. These competencies enable IT-proficient CEOs to more effectively identify promising technological opportunities and make superior decisions regarding research and development investments. The integration of technical expertise with strategic resource allocation fosters a continuous improvement cycle in digital innovation. By staying abreast of technological advancements and aligning research priorities with organisational objectives, these executives systematically enhance both the speed and success rate of their firms' innovation initiatives. Consequently, organisations led by technically proficient CEOs exhibit measurable advantages in the implementation of digital transformation strategies.

> *Hypothesis 1: CEOs with an IT background have a positive influence on corporate digital innovation.*

> *Hypothesis 2: CEOs with an IT background promote corporate digital innovation through their attention configuration.*

4   Research design and results analysis

4.1   Sample selection

Our research sample consists of all A-share non-financial companies listed on the Shanghai and Shenzhen Stock Exchanges, covering the period from 2007 to 2020. We excluded ST or *ST companies, financial firms, and those with missing data. All continuous variables were winsorised at the 1% and 99% levels. The final sample includes 16,129 firm-year observations, with digital innovation patent data sourced from the State Intellectual Property Office (SIPO), financial and governance controls from the China Stock Market and Accounting Research Database (CSMAR), and CEO IT background data collected manually.

4.2   Variable definition

4.2.1   Dependent variable

Following Hu and Ma (2023) and Huang et al. (2023), digital innovation (DI) is measured by the number of digital innovation patent applications. Specifically, we take the natural logarithm of the total number of digital patents plus one to represent the firm's level of digital innovation each year.

4.2.2   Independent variable

Following Haislip and Richardson (2018) and Yuan et al. (2021), CEOs with an IT background (CIT) is measured by a dummy variable, which equals 1 if the CEO has IT-related education or work experience, and 0 otherwise.

4.2.3 Mediating variable

Following Wang et al. (2023) and Xu et al. (2023), we measure CEO digital attention by quantifying the frequency of digital-related terms in annual reports, which reflect CEOs' operational priorities and strategic plans.

We calculate the frequency of digital-related words in the annual report through a series of steps. First, we select the digital dictionary provided by Wu et al. (2021), which comprises five terms: artificial intelligence, big data, blockchain, cloud computing, and digital technology application. Second, we use the Jieba library in Python to split the digital-related words in the annual report and extract the relevant terms. Third, we calculate the frequency of the extracted digital-related words in the annual report. The digital-related words included in the digital dictionary are shown in Table 1. To avoid measurement errors from extreme word frequencies, we use the natural logarithm of the number of digital words plus one in the regression analysis.

Table 1   Digital keywords dictionary

Category	*Keywords*
Artificial intelligence technology	Artificial intelligence, business intelligence, image understanding, investment decision, aid system, intelligent data analysis, intelligent robotics, machine learning, deep learning, semantic search, biometrics, face recognition, voice recognition, identity verification, autonomous driving
Big data technology	Big data, data mining, text mining, data visualisation, heterogeneous data, credit, augmented reality, mixed reality, virtual reality
Blockchain technology	Blockchain, digital currency, distributed computing, differential privacy technology, smart financial contracts
Cloud computing technology	Cloud computing, stream computing, graph computing, memory computing, multiparty secure computing, brain-like computing, green computing, cognitive computing, converged architecture, billion concurrency, EB-level storage, internet of things, information physical system
Digital technology application	Mobile internet, industrial internet, mobile connectivity, internet healthcare, e-commerce, mobile payment, third-party payment, NFC payment, smart energy, B2B, C2C, C2B, O2O, netlink, smart wear, smart agriculture, smart transportation, smart healthcare, smart customer service, smart home, smart investment, smart cultural tourism, smart environmental protection, smart grid, smart marketing, digital marketing, unmanned retail, internet finance, digital finance, fintech, financial technology, quantitative finance, open banking

4.2.4 Control variables

We control for various corporate performance, structure, and governance characteristics, as outlined by Weber and Yang (2020) and Zhang and Ma (2020). These include asset size (*Size*), financial leverage (*Lev*), return on total assets (*Roa*), firm age (*Age*), growth rate (*Growth*), operating cash flow (*Cfo*), CEO-chairman duality (*Dual*), board size (*Board*), executive compensation (*Pay*), firm growth (*Tobinq*), shareholding ratio of the largest shareholder (*Top1*), proportion of independent directors on the board (*Independent*), equity concentration (*TOP10*), state ownership (*SOE*), as well as year

(*Year*) and industry (*IND*) fixed effects. The definitions of these variables are provided in Table 2.

Table 2   Variable definitions

Variable symbol	Variable definition
DI	Digital innovation, the natural logarithm of digital patent applications plus one
CIT	Dummy variable, equalling 1 if the CEO has an IT background in the current year and 0 otherwise
Attention	CEO's digital attention, the nature logarithm of digital related word frequency in the annual report plus one. (The calculations are shown above)
Size	The natural logarithm of total assets
Lev	The percentage of total liabilities divided by total assets
Roa	The percentage of net income divided by total assets
Age	The natural logarithm of enterprise age plus 1
Growth	Operating income growth rate
Cfo	The percentage of net cash flow from operating activities divided by total assets
Dual	Dummy variable, equalling 1 when the CEO is also the chairman in the board
Board	Total number of directors of the company
Tobinq	Market value divided by replacement cost of the enterprise
Pay	The natural logarithm of the pay for the top three senior executives
Top1	Shareholding ratio of the largest shareholder
Independent	The percentage of independent directors divided by the total number of directors
TOP10	Distribution of ownership, shareholding ratio between the largest shareholder and the total second to tenth largest shareholders
SOE	Dummy variable, equalling 1 if the real controller is SOEs and 0 otherwise
IND	Industry dummy variable
Year	Year dummy variable

4.3   Model setting

We construct three regression models (1)–(3) based on the empirical models in the relevant literature (Zhu et al., 2024), to examine the effect of CEO IT background on corporate digital innovation and the mediating effect of CEO's digital attention. The models setting as follows:

$$DI_{i,t} = \beta_0 + \beta_1 CIT_{i,t} + \beta_2 Controls_{i,t} + \sum IND + \sum Year + \varepsilon_{i,t} \tag{1}$$

$$Attention_{i,t} = \beta_0 + \beta_1 CIT_{i,t} + \beta_2 Controls_{i,t} + \sum IND + \sum Year + \varepsilon_{i,t} \tag{2}$$

$$DI_{i,t} = \beta_0 + \beta_1 CIT_{i,t} + \beta_2 Attention_{i,t} + \beta_3 Controls_{i,t} + \sum IND + \sum Year + \varepsilon_{i,t} \tag{3}$$

Equation (1) is set to estimate the basic regression result of Hypothesis1. In equation (1), the explained variable $DI_{i,t}$ measures the level of corporate digital innovation. The explanatory variable $CIT_{i,t}$ measures the CEO's IT background. *Controls* represent control variables, *Year* indicates the year effect, *IND* the industry effect, and ε the random error term, with subscripts i and t referring to firm and year, respectively. Equations (1)–(3) are jointly used to estimate Hypothesis 2. Especially, the dependent variable *Attention* $_{i,t}$ donates the CEO's digital attention. If the coefficient β_1 in equations (1)–(3) are all significant positive and the coefficient β_2 in equations (2)–(3) is positive and significant, it suggests the mediating effect of CEO's digital attention is existing between the relationship of CEO IT background and corporate digital innovation.

4.4 *Descriptive statistical analysis*

Table 3 displays the descriptive statistics for the key variables. The dependent variable *DI* ranges from 0 to 5.61, reflecting substantial variation in digital innovation among corporates. The mean value 1.2 is higher than the median value 0.69, suggesting a relatively small number of enterprises have higher levels of digital innovation. The explanatory variable *CIT* has a mean of 0.100, which indicates that 10% of the companies in the total sample have CEOs with an IT background. This implies that CEOs with an IT background are scarce resources in corporates. The control variables are evenly distributed with no significant skewness, align with those in the existing literature, and fall within a reasonable range.

Table 3   Descriptive statistics

Variable	Observations	Mean	Standard deviation	Median	Minimum	Maximum
DI	16,129	1.200	1.420	0.690	0	5.610
CIT	16,129	0.100	0.300	0	0	1
Size	16,129	22.15	1.280	21.94	19.53	26.13
Lev	16,129	0.410	0.200	0.410	0.050	0.950
Roa	16,129	0.040	0.060	0.040	–0.280	0.200
Age	16,129	2.100	0.690	2.160	0.690	3.330
Growth	16,129	0.180	0.390	0.120	–0.590	3
Cfo	16,129	0.090	0.150	0.080	–0.710	0.730
Dual	16,129	0.280	0.450	0	0	1
Board	16,129	8.600	1.700	9	5	15
Pay	16,129	14.37	0.820	14.36	0	18.05
Tobinq	16,129	2.080	1.280	1.680	0.870	8.770
Top1	16,129	34.25	14.68	32.16	8.770	74.09
Independent	16,129	0.380	0.050	0.360	0.300	0.570
TOP10	16,129	0.960	0.820	0.740	0.040	3.950
SOE	16,129	0.350	0.480	0	0	1

4.5   Empirical results

Table 4 provides a detailed summary of the regression results. In column (1), the coefficient for CIT is significantly positive at the 1% level without control variables, Column (2) presents the results after incorporating industry and year fixed effects, showing that the positive relationship remains robust. Column (3) presents the results with all control variables from the baseline regression, including industry and year fixed effects. The coefficient for *CIT* remains positive and statistically significant at the 1% level (0.366), confirming a strong positive association between a CEO's IT background and corporate digital innovation, consistent with Hypothesis 1.

Table 4   Regression results

Variable	*(1)* DI	*(2)* DI	*(3)* DI
CIT	0.9391***	0.4414***	0.3660***
	(10.093)	(5.107)	(4.837)
Size			0.3402***
			(10.802)
Lev			−0.0313
			(−0.239)
Roa			0.9600***
			(3.351)
Age			−0.2397***
			(−5.789)
Growth			−0.1154***
			(−4.340)
Cfo			−0.0816
			(−0.805)
Dual			0.0786*
			(1.871)
Board			0.0137
			(0.827)
Pay			0.1483***
			(4.751)
Tobinq			0.0409***
			(2.789)
Top1			−0.0061***
			(−2.647)
Independent			0.1910
			(0.468)
TOP10			−0.0895**
			(−2.551)
SOE			0.1396**
			(2.254)

Table 4 Regression results (continued)

Variable	(1) DI	(2) DI	(3) DI
_cons	1.1021***	−0.1905	−9.3429***
	(38.247)	(−1.164)	(−13.197)
IND	NO	YES	YES
Year	NO	YES	YES
N	16129	16129	16129
Adj R^2	0.0404	0.2627	0.3436

t-Statistics are presented in parentheses. *, **, *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

4.6 The mechanism test

Table 5 presents the mechanism test results, showing that CEOs' digital attention mediates the relationship between their IT backgrounds and corporate digital innovation. In Column (1) of Table 5, *t* the coefficients are significantly positive, with statistical significance at the 1% level, indicating that CEOs with an IT background are more likely to exhibit long-term strategic insight. In Column (2), the regression coefficient of CEOs' strategic insight (*Attention*) on digital innovation is 0.13, significant at the 1% level. Similarly, the coefficient of CEO IT background (*CIT*) on digital innovation is 0.329, also significant at the 1% level. Moreover, the Sobel test reports a Z-score of 8.491, confirming significance at the 1% level. The above results suggest that digital attention mediates the relationship between CEOs with an IT background and corporate digital innovation.

Table 5 The mechanism test results

Variable	(1) Attention	(2) DI
Attention		0.130***
		(13.710)
CIT	0.285***	0.329***
	(5.353)	(10.336)
Size	0.108***	0.326***
	(6.045)	(27.050)
Lev	−0.249**	0.001
	(−2.574)	(0.018)
Roa	0.078	0.950***
	(0.336)	(5.125)
Age	0.056*	−0.247***
	(1.953)	(−12.966)

Table 5   The mechanism test results (continued)

Variable	(1) Attention	(2) DI
Growth	0.046*	−0.121***
	(1.901)	(−4.938)
Cfo	−0.401***	−0.029
	(−4.948)	(−0.428)
Dual	0.085**	0.068***
	(2.519)	(3.118)
Board	−0.001	0.014**
	(−0.086)	(2.035)
Pay	0.063***	0.140***
	(2.960)	(10.590)
Tobinq	0.039***	0.036***
	(3.128)	(4.051)
Top1	0.001	−0.006***
	(0.636)	(−6.062)
Independent	−0.016	0.193
	(−0.055)	(0.982)
TOP10	−0.006	−0.089***
	(−0.195)	(−4.971)
SOE	−0.193***	0.165***
	(−4.519)	(6.395)
_cons	−3.496***	−8.888***
	(−8.947)	(−30.903)
Z	8.491	
$P > |Z|$	0.000	
Year	YES	YES
IND	YES	YES
N	16129	16129
Adj R^2	0.500	0.351

t-Statistics are presented in parentheses. *, **, *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

4.7   Robustness tests

4.7.1   Alternative measures of dependent variable

To ensure the robustness of our findings, we conduct a sensitivity test by substituting the dependent variable *DI*. Specifically, we standardise DI and incorporate it into Model (1) for regression analysis. The results, presented in Column (1) of Table 6, indicate that the

coefficient of *CIT* is 0.065, remaining significant at the 1% level, thus confirming the robustness of our main findings.

4.7.2 Alternative regression model

Additionally, to perform a sensitivity test, we replace the regression model with a logit model. We convert the dependent variable into a binary form, *DI_DUM*, and apply the logit model to reassess our main hypothesis. *DI_DUM* is assigned as 1 if the number of a firm's digital patents exceeds the year-industry median, and 0 otherwise. We report the result in Columns (2) of Table 6. The regression coefficient of CEO IT background (*CIT*) remains significantly positive at the 1% level, confirming that the empirical findings remain robust even after replacing the regression model.

4.7.3 Exclusion of special industries

Enterprises in electronic information science and technology industries naturally have a high level of digital technology and are more likely to have CEOs with an IT background than those in other industries. Therefore, to eliminate the interference of the particularities of such industries on the findings, we following Yuan et al. (2021) to remove the electronic information science and technology industry to avoid regression bias and report the results in Column (3) of Table 6. The regression results for CIT remain consistent with the main regression findings and are still significantly positive at the 1% level, suggesting that the results are not driven by industry-specific factors.

4.7.4 Exclusion of substitution explanation

Prior literatures investigate the quality of innovation and uncover that innovation can be classified as substantive innovation and strategic innovation. Substantive innovation refers to a firm's long-term investment in innovation activities, which enhances competitiveness in the market and provides a broader vision for the future. In contrast, strategic innovation refers to innovation activities aimed at satisfying organisational legitimacy requirements, which do not necessarily promote corporate growth or competitiveness. To rule out alternative explanations, we test the effect of a CEO's IT background on both substantive and strategic innovation based on patent classifications. The results in columns (4) and (5) of Table 6 show that the CIT coefficient remains positive and significant at the 1% level, indicating that firms led by CEOs with an IT background are more likely to pursue substantive innovation.

Table 6 Robustness test results

Variable	*(1)* *DI2*	*(2)* *DI_DUM*	*(3)* *DI*	*(4)* *SubDI*	*(5)* *StrDI*
CIT	0.065***	0.405***	0.365***	0.376***	0.219***
	(4.837)	(3.938)	(4.803)	(5.182)	(3.785)
Size	0.061***	0.341***	0.347***	0.326***	0.224***
	(10.802)	(6.536)	(10.809)	(11.389)	(9.122)

Table 6 Robustness test results (continued)

| Variable	(1) DI2	(2) DI_DUM	(3) DI	(4) SubDI	(5) StrDI
Lev	−0.006	0.409*	−0.036	−0.129	0.187*
	(−0.239)	(1.854)	(−0.269)	(−1.105)	(1.847)
Roa	0.171***	1.699***	0.954***	0.573**	0.932***
	(3.351)	(3.239)	(3.312)	(2.241)	(4.152)
Age	−0.043***	−0.352***	−0.244***	−0.193***	−0.169***
	(−5.789)	(−4.765)	(−5.809)	(−5.294)	(−5.187)
Growth	−0.021***	−0.185***	−0.119***	−0.086***	−0.079***
	(−4.340)	(−3.382)	(−4.453)	(−3.633)	(−3.950)
Cfo	−0.015	0.134	−0.083	−0.122	−0.027
	(−0.805)	(0.746)	(−0.815)	(−1.402)	(−0.338)
Dual	0.014*	0.111	0.080*	0.072*	0.045
	(1.871)	(1.558)	(1.903)	(1.897)	(1.378)
Board	0.002	0.011	0.014	0.009	0.016
	(0.827)	(0.430)	(0.838)	(0.584)	(1.280)
Pay	0.026***	0.257***	0.149***	0.139***	0.091***
	(4.751)	(2.864)	(4.730)	(4.935)	(4.106)
Tobinq	0.007***	0.004	0.042***	0.056***	0.005
	(2.789)	(0.148)	(2.860)	(4.090)	(0.454)
Top1	−0.001***	−0.012***	−0.006***	−0.004*	−0.005***
	(−2.647)	(−3.018)	(−2.702)	(−1.916)	(−2.690)
Independent	0.034	0.392	0.200	0.221	0.138
	(0.468)	(0.530)	(0.483)	(0.593)	(0.436)
TOP10	−0.016**	−0.152**	−0.090**	−0.044	−0.102***
	(−2.551)	(−2.399)	(−2.544)	(−1.358)	(−3.671)
SOE	0.025**	0.228**	0.142**	0.168***	0.028
	(2.254)	(2.143)	(2.270)	(2.992)	(0.587)
_cons	−1.667***	−5.619***	−9.485***	−9.103***	−6.028***
	(−13.197)	(−3.732)	(−13.187)	(−13.849)	(−10.736)
IND	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES
N	16129	13549	15956	16129	16129
Adj R^2	0.344	–	0.344	0.335	0.296
Pseudo R^2	–	0.1278	–	–	–

t-Statistics are presented in parentheses. *, **, *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

4.8 Endogeneity tests

4.8.1 Propensity score matching (PSM) test

Our finding documents a positive relationship between CEO in IT background and digital innovation, this finding may drive by the sample selection bias. The firms with IT-experienced CEOs may already possess higher levels of digital capability or operate in industries more conducive to digital innovation. This could lead to an overestimation of the actual impact of a CEO's IT background on innovation, as the sample may fail to account for other influential factors. To address the endogeneity problems caused by sample selection bias, this study implements propensity score matching (PSM) method to match each corporate CEO with IT background with a closest corporate CEO without IT background to further control the potential differences between the two groups. Specifically, we use a probit model to estimate the propensity score include *Roa Lev Size GDP Cflowta Indenpct*, then, we match each firm has IT background CEO to a firm has non-IT background CEO that has the closest propensity score. Finally, we use the firm-year observations as research sample to evaluate the impact of CEO IT background on digital innovation. The matching results are shown in Figure 1, and the regression results are shown in Table 7.

Figure 1 Matching result
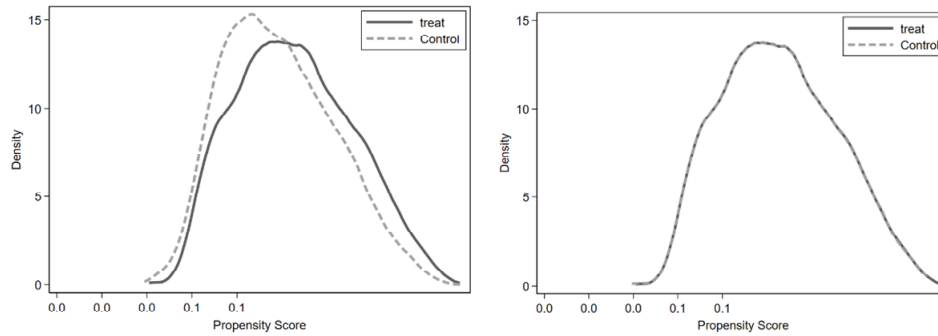
The figures show that after the matching process, the difference between the treatment and control groups narrows. In Column (1) of Table 6, the CIT coefficient is 0.389, significant at the 1% level. It demonstrates that, after control for the individual differences between the samples by using the PSM method, the result supports the notion that, CEO with IT background can significantly promote corporate digital innovation.

4.8.2 Instrumental variable method

Our findings may be subject to the potential confounding factor of reverse causality, wherein firms that prioritise digital innovation are more likely to appoint CEOs with IT backgrounds, rather than the CEO's IT background driving digital innovation. Furthermore, endogeneity may arise from omitted variable bias, as unobserved factors could influence the relationship between a CEO's IT background and digital innovation. To eliminate the reverse causality and omitted variable endogeneity problem, we utilise the instrumental variable to further examine the impact of CEO in IT background on

digital innovation. Building on the methodology of existing studies that employ the average of the same region or industry within the same year as an instrumental variable (Huang and Wei, 2023), we utilise the average of the same region and industry in the same year, excluding the firm itself. This variable is selected as an instrumental variable because the regional environment fosters the development of IT-oriented CEOs and is correlated with the presence of CEOs with IT backgrounds. Additionally, the industry demonstrates a trend of hiring IT CEOs. The mean values of the region and industry potentially influence a firm's CEO hiring decisions, while they do not directly impact the firm's digital innovation outcomes.

We apply the two-stage least squares (2SLS) regression approach, using the average of the same region and industry in the same year (*Newceotech*) as an instrumental variable, with the results presented in Table 7. The first-stage regression analysis, presented in Column (1), demonstrates a statistically significant positive association between CEO in IT background (*CIT*) and the selected instrument, with an estimated coefficient of 0.01 reaching significance at the 1% level ($p < 0.01$), thereby validating its appropriateness as an instrumental variable. Subsequent analysis in Column (2) reveals that the second-stage regression yields a strongly significant coefficient estimate of 8.301 ($p < 0.01$) for the chief explanatory factor. This empirical evidence substantiates the existence of a meaningful correlation between executive technological expertise (as measured by *CIT*) and organisational innovation capacity in digital transformation initiatives.

Table 7   Endogeneity test results

Variable	(1) PSM DI	(2) IV CIT	(3) IV DI
CIT	0.352***	–	4.3941***
	(6.652)		(0.7819)
Newceotech	–	0.129***	–
	–	(0.0178)	–
Size	0.392***	0.0131***	0.2787***
	(11.004)	(0.00299)	(0.0197)
Lev	0.094	−0.0458***	−0.0037
	(0.573)	(0.0162)	(0.0975)
Roa	1.624***	−0.00485	0.7335***
	(4.098)	(0.0467)	(0.2642)
Age	−0.207***	−0.0241***	−0.1525***
	(−4.118)	(0.00476)	(0.0333)
Growth	−0.117**	0.0124**	−0.1403***
	(−2.071)	(0.00620)	(0.0365)
Cfo	−0.098	−0.0388**	0.0720
	(−0.615)	(0.0173)	(0.1021)

Table 7   Endogeneity test results (continued)

Variable	(1) PSM DI	(2) IV CIT	(3) IV DI
Dual	0.063	0.00949*	0.0639**
	(1.287)	(0.00544)	(0.0318)
Board	0.059***	0.00256	−0.0071
	(3.038)	(0.00170)	(0.0098)
Tobinq	0.240***	0.0106***	0.1431***
	(5.311)	(0.00219)	(0.0213)
Pay	0.046**	0.0113***	0.0192
	(2.029)	(0.00330)	(0.0151)
Top1	−0.008***	−0.00109***	−0.0040**
	(−3.046)	(0.000255)	(0.0017)
Independent	1.132**	0.107**	0.1595
	(2.267)	(0.0493)	(0.2925)
Top10	−0.111***	−0.00159	−0.1089***
	(−2.770)	(0.00447)	(0.0253)
SOE	0.041	0.00612	0.0826**
	(0.589)	(0.00639)	(0.0363)
_cons	−12.263***	−0.451***	−7.7796***
	(−15.086)	(0.0712)	(0.5485)
IND	YES	YES	YES
Year	YES	YES	YES
N	3322	16,129	16,129
Adj R^2	0.380	0.098	
Cragg-Donald Wald F statistic		52.39	
Stock-Yogo weak ID test 10%		16.38	

t-Statistics are presented in parentheses. *, **, *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Furthermore, we conduct tests to validate the appropriateness of our instrumental variable choice. First, to address concerns regarding weak instrumental variables, we perform the weak instrument test we present the Stock-Yogo weak ID statistic at the 10% threshold, which is 16.38, surpassing 10 and further rejecting the weak instrument hypothesis. Second, to examine the exogeneity of our explanatory variables, we conduct an endogeneity test. The F-statistic for this test is 52.39, with a p-value of 0.000, confirming the absence of exogenous explanatory variables and strongly supporting the validity of the chosen instrumental variable. This suggests that, even after addressing endogeneity, CEOs with an IT background continue to have a significant positive effect on corporate digital innovation.

5   Further analysis

5.1   Cross-sectional tests

The above analysis establishes a positive effect of CEOs with an IT background on digital innovation. However, this impact varies across firms. We explore whether a firm belongs to the high-technology sector, the level of industry competition and the extend of its financing constraints to further validate our research findings.

5.1.1   Firm's technology nature

High-tech enterprises demonstrate stronger digital innovation outcomes than non-high-tech firms due to their inherent technological focus and competitive dynamics (Li and Zheng, 2016). Since digital technologies are central to their operations, these firms invest more heavily in digital adoption and R&D. This environment enables IT-background CEOs to exert greater influence, as leadership in high-tech firms is more attuned to technological advancements and better positioned to allocate resources toward digital initiatives. Following Yang et al. (2022), we compare high-tech and non-high-tech firms and find that the effect of CEO IT expertise on digital innovation is significantly stronger in high-tech industries ($\beta = 0.622$, $p < 0.01$) as indicated in Table 8 column (1) than in non-high-tech industries ($\beta = 0.007$, $p > 0.1$) as shown in Table 8 column (2), highlighting the importance of industry context in shaping CEO impact.

Table 8   Heterogeneity test results

	High-tech enterprise	Nonhigh-tech enterprise	Low financing constraints	High financing constraints	High industry competition	Low industry competition
	(1)	(2)	(3)	(4)	(5)	(6)
Variable	DI	DI	DI	DI	DI	DI
CIT	0.622***	0.007	0.711***	0.481***	0.684***	0.524***
	(7.221)	(0.071)	(6.094)	(4.709)	(6.217)	(5.199)
Size	0.378***	0.195***	0.288***	0.339***	0.318***	0.344***
	(8.612)	(4.717)	(5.983)	(7.669)	(7.331)	(7.863)
Lev	−0.085	−0.472**	0.015	−0.362*	0.000	−0.333*
	(−0.504)	(−2.273)	(0.081)	(−1.905)	(0.002)	(−1.887)
Roa	0.867**	−0.176	0.962**	0.525	1.005	0.340
	(2.316)	(−0.409)	(2.365)	(1.157)	(1.644)	(0.976)
Age	−0.347***	−0.015	−0.283***	−0.172***	−0.217***	−0.293***
	(−6.198)	(−0.285)	(−4.849)	(−2.609)	(−3.855)	(−5.051)
Growth	−0.091**	−0.114***	−0.090**	−0.093**	−0.140***	−0.062
	(−2.490)	(−3.339)	(−2.388)	(−2.075)	(−3.587)	(−1.444)
Cfo	−0.046	0.015	−0.098	−0.075	−0.148	0.020
	(−0.364)	(0.092)	(−0.667)	(−0.540)	(−1.029)	(0.140)
Dual	0.124**	−0.028	0.102	0.107*	0.105*	0.096
	(2.219)	(−0.606)	(1.473)	(1.849)	(1.782)	(1.645)

Table 8 Heterogeneity test results (continued)

Variable	High-tech enterprise	Nonhigh-tech enterprise	Low financing constraints	High financing constraints	High industry competition	Low industry competition
	(1)	(2)	(3)	(4)	(5)	(6)
	DI	DI	DI	DI	DI	DI
Board	−0.000	−0.006	0.015	−0.011	−0.007	0.008
	(−0.014)	(−0.279)	(0.655)	(−0.447)	(−0.310)	(0.328)
Pay	0.265***	0.054	0.139***	0.289***	0.176***	0.209***
	(5.997)	(1.615)	(3.244)	(5.517)	(3.662)	(4.912)
Tobinq	0.072***	0.018	0.037*	0.079***	0.072***	0.059***
	(3.804)	(0.819)	(1.778)	(3.631)	(3.500)	(2.629)
Top1	−0.011***	0.001	−0.011***	−0.004	−0.005	−0.011***
	(−3.518)	(0.402)	(−3.352)	(−1.331)	(−1.534)	(−3.363)
Independent	1.053*	−0.617	1.218**	−0.246	0.190	0.897
	(1.805)	(−1.325)	(2.012)	(−0.403)	(0.345)	(1.538)
TOP10	−0.154***	0.009	−0.177***	−0.054	−0.054	−0.170***
	(−3.187)	(0.184)	(−3.226)	(−1.058)	(−1.031)	(−3.480)
SOE	0.126	0.021	0.102	0.104	0.052	0.149**
	(1.491)	(0.270)	(1.226)	(1.053)	(0.509)	(1.965)
_cons	−11.498***	−4.704***	−8.211***	−10.906***	−9.179***	−10.104***
	(−12.293)	(−5.058)	(−8.022)	(−11.101)	(−9.240)	(−10.597)
chi2(1)	4.480		8.44		4.18	
Prob > chi2	0.034		0.004		0.041	
IND	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES
N	11917	4212	8053	8076	7941	8000
Adj R^2	0.253	0.162	0.238	0.301	0.275	0.257

t-Statistics are presented in parentheses. *, **, *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

5.1.2 Firm's financing constraints

Numerous enterprises engaged in digital transformation initiatives experience suboptimal performance due to resource limitations, particularly financial constraints (Wang et al., 2023). These limitations compel a reallocation of focus from innovation to the procurement of essential resources, despite having CEOs with IT backgrounds. In contrast, organisations with ample financial resources are more effectively able to leverage their CEOs' technical expertise to promote digital innovation and create value.

To examine this moderating effect, we utilise the SA index (Whited and Wu, 2006) to assess financing constraints, dividing firms into low-constraint firms and high-constraint firms, according to whether their SA index surpasses the median value year and industry or not. The findings demonstrate that the effect of CEO IT expertise on digital innovation is significantly stronger in low-constraint firms ($\beta = 0.711$, $p < 0.01$) as indicated in Table 8 column (3) than in high-constraint firms ($\beta = 0.481$, $p > 0.1$) as shown in Table 8 column (4).

5.1.3 *Industry competition*

In highly competitive industries, where digitalisation functions as a crucial strategic lever (Mikalef et al., 2019), CEOs with IT backgrounds demonstrate exceptional proficiency in rapidly processing technological information (Melville et al., 2007), conducting precise cost-benefit analyses of digital investments, and reallocating resources agilely toward emerging opportunities. These activities necessitate their focused attention to capitalise on the digital landscape, thereby facilitating faster and more impactful digital adoption. Conversely, in less competitive environments, even technically skilled CEOs encounter a diminished urgency for transformation, fewer benchmarks for technology investment, and heightened organisational inertia, which collectively attenuate their influence. We use the Herfindahl-Hirschman Index (HHI) to measure industry competition, firms with an HHI below the median are classified as belonging to highly competitive industries, whereas those with an HHI above the median are categorised as belonging to less competitive industries. Our analysis confirm that the result is more pronounced in high-competitive industry ($\beta = 0.684$, $p < 0.01$) as presented in Table 8 column (5) than low-competitive industries ($\beta = 0.524$, $p > 0.1$) as indicated in Table 8 column (6).

5.2 *The primary driver in digital innovation*

Current literature establishes the strategic value of CIOs in top management teams, highlighting their role in strengthening organisational IT capabilities, streamlining digital processes, and enhancing responsiveness to technological disruptions (Benaroch and Chernobai, 2017; Feng et al., 2021; Zafar et al., 2016). While both CIOs and IT-background CEOs contribute to digital innovation, their differing responsibilities and decision-making authority may produce distinct innovation outcomes. This study consequently investigates the relative influence of CIOs vs. CEOs with IT backgrounds in driving corporate digital innovation.

We further examine the differential impact of two senior executives and identify the primary driver of digital innovation. Specifically, we introduce a variable representing the presence of a CIO in model (1) and compare the coefficients and significance levels of both the *CIT* and the *CIO*. The results are detailed in Table 9. We can see that across all columns the coefficient and significant levels of *CIT* are more pronounced than those of the *CIO*. The results suggests that while a *CIO* primarily focuses on the technical aspects and digital infrastructure of the organisation, a CEO with an IT background is capable of integrating technological insights into the broader corporate strategy, potentially providing a more comprehensive approach to innovation.

Table 9 Further analysis results

Variable	(1) DI	(2) DI	(3) DI
CIT	0.9343***	0.4388***	0.3651***
	(10.034)	(5.086)	(4.824)
CIO	0.2083*	0.2137**	0.1458*
	(1.758)	(2.274)	(1.770)
Size			0.3391***
			(10.773)
Lev			−0.0317
			(−0.242)
Roa			0.9628***
			(3.363)
Age			−0.2357***
			(−5.677)
Growth			−0.1155***
			(−4.353)
Cfo			−0.0815
			(−0.803)
Dual			0.0765*
			(1.826)
Board			0.0135
			(0.811)
Pay			0.1475***
			(4.742)
Tobinq			0.0404***
			(2.761)
Top1			−0.0062***
			(−2.688)
Independent			0.2010
			(0.493)
TOP10			−0.0939***
			(−2.676)
SOE			0.1381**
			(2.230)
_cons	1.0924***	−0.2072	−9.3201***
	(37.364)	(−1.275)	(−13.161)
IND	NO	YES	YES
Year	NO	YES	YES
N	16129	16129	16129
Adj R^2	0.0414	0.2637	0.3440

t-Statistics are presented in parentheses. *, **, *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

6   Conclusions

6.1   Research conclusion

The digital revolution, marked by the advent of technologies such as big data and cloud computing, has profoundly reshaped the real economy. Consequently, comprehending the factors driving corporate digital innovation has become increasingly critical for both academics and industry professionals. This study utilises data from A-share non-financial listed companies on Shanghai and Shenzhen Stock Exchanges spanning from 2007 to 2020 to examine the impact of CEOs' IT backgrounds on corporate digital innovation. Our analysis indicates that CEOs with IT expertise significantly enhance digital innovation, the conclusion that remains robust across a various of robustness tests and endogeneity tests. Further investigation identifies CEOs' digital attention plays as a pivotal mechanism through which CEOs with IT backgrounds promote innovation. This effect is particularly pronounced in high-tech firms, organisations with fewer constraints, and highly competitive industries. Importantly, our findings illustrate that within top management teams, CEOs with IT expertise exert a more substantial influence on digital innovation outcomes.

Our findings offer several important implications for practice:

First, firms should give strong consideration to candidates with IT backgrounds when appointing CEOs. Our results demonstrate that such technology-competent leaders are particularly effective in establishing organisational systems for digital innovation and driving successful digital transformation initiatives. This suggests that technical expertise should be weighted alongside traditional leadership qualities in CEO selection processes.

Second, improving the quality of corporate information disclosure emerges as a critical supporting factor. High-quality disclosure helps alleviate financing constraints, enabling firms to secure necessary resources for digital innovation projects. This support mechanism proves especially valuable when innovation outcomes are uncertain or when projects face higher risk of failure.

Third, policymakers should focus on cultivating business ecosystems that facilitate digital economy development. A supportive institutional environment allows IT-savvy CEOs to allocate their attention more effectively to digital strategy implementation. Conversely, in less developed digital ecosystems, even technically competent executives may become distracted by institutional voids, potentially diminishing the effectiveness of digital transformation efforts.

6.2   Limitation and further research directions

While this study adopts a new perspective of ABV and provide the empirical evidence of how CEO IT education and professional experience promotes corporate digital innovation, it is important to acknowledge that our study has a few limitations.

On the one hand, due to limitations in the length of this study, we focus solely on internal factors that determine digital innovation, ignoring the potential external determinants. CEO's digital attention may be affected by the industrial policy, country competency. Future research could explore how changes in the external environment affect digital attention.

On the other hand, although we explore the mechanism of CEOs' IT background influences corporate digital innovation through CEO's digital attention, other potential

mechanisms may not have been considered. For instance, a CEO with an IT background may initiate a trickle-down effect, leading to greater alignment in digital innovation cognition across the organisation and thereby enhancing digital innovation. Future research could incorporate the trickle-down effect into the framework from a cognitive perspective to further investigate its impact on digital innovation.

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