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Executive Imprint Beyond Tech Firms: CEO Demographics and Digital Transformation in China

(Jejak Eksekutif Melangkaui Firma Teknologi: Demografi CEO dan Transformasi Digital di China)

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ABSTRACT

Digital transformation has emerged as a key strategic priority for firms navigating the Fourth Industrial Revolution, particularly as digital technologies extend beyond traditional technology sectors. This study investigates how CEO demographics influence corporate digital transformation among Chinese non-technology listed firms. Drawing upon upper echelons theory, we argue that observable CEO attributes reflect executives' cognitive bases, values, and strategic preferences, which in turn influence firms' digital strategic choices. Our focus on non-technology firms is warranted because digital transformation in these contexts represents a substantive strategic shift rather than an inherent industry characteristic. Using unbalanced panel data from Chinese non-technology A-share listed firms from 2015 to 2024, we construct a text-based measure of digital transformation derived from the keyword analysis of annual reports. Our results indicate that CEO age is negatively associated with digital transformation, whereas female CEOs exert a significant positive effect; however, the relationship between founder status and digital transformation is not statistically significant. This research extends upper echelons theory beyond established strategic outcomes such as innovation and risk-taking to address digital transformation, a phenomenon requiring broader organisational change across processes and strategic activities. The findings offer practical implications for boards, managers, and policymakers concerned with corporate digital transformation.

Keywords: CEO demographics; CEO age; CEO gender; CEO founder; Digital transformation; Chinese non-technology firms

ABSTRAK

Transformasi digital telah muncul sebagai keutamaan strategik utama bagi firma yang mengemudi Revolusi Perindustrian Keempat, terutamanya apabila teknologi digital melangkaui sektor teknologi tradisional. Kajian ini menyiasat bagaimana demografi CEO mempengaruhi transformasi digital korporat dalam kalangan firma tersenarai bukan teknologi China. Berdasarkan teori upper echelon, kami berpendapat bahawa sifat CEO yang boleh diperhatikan mencerminkan asas kognitif, nilai dan keutamaan strategik eksekutif, yang seterusnya mempengaruhi pilihan strategik digital firma. Tumpuan kami pada firma bukan teknologi adalah wajar kerana transformasi digital dalam konteks ini mewakili anjakan strategik substantif dan bukannya ciri industri yang wujud. Menggunakan data panel tidak seimbang daripada firma tersenarai A-saham bukan teknologi China dari 2015 hingga 2024, kami membina ukuran transformasi digital berasaskan teks yang diperoleh daripada analisis kata kunci laporan tahunan. Keputusan kami menunjukkan bahawa umur CEO dikaitkan secara negatif dengan transformasi digital, manakala CEO wanita memberikan kesan positif yang ketara; walau bagaimanapun, hubungan antara status pengasas dan transformasi digital adalah tidak signifikan secara statistik. Penyelidikan ini memanjangkan teori upper echelon melangkaui hasil strategik yang ditetapkan seperti inovasi dan pengambilan risiko untuk menangani transformasi digital, fenomena yang memerlukan perubahan organisasi yang lebih luas merentas proses dan aktiviti strategik. Penemuan ini menawarkan implikasi praktikal untuk lembaga pengarah, pengurus dan penggubal dasar yang berkenaan dengan transformasi digital korporat.

Kata kunci: Demografi CEO; umur CEO; jantina CEO; CEO pengasas; transformasi digital; firma bukan teknologi

INTRODUCTION

As the Fourth Industrial Revolution unfolds, ongoing advances in digital infrastructure and technology have profoundly reshaped the economic landscape of major economies. For example, China has experienced rapid growth in its digital economy over the past decade; according to the China Internet Development Report 2022, it reached RMB 45.5 trillion in 2021, accounting for 39.8% of GDP and highlighting its increasingly important role in national economic development (Liu et al. 2024).

At the firm level, an increasing number of non-technology firms have integrated digital innovation into their operations and reshaped their business models; this process is commonly referred to as digital transformation (Gaspar et al. 2024). As digital transformation has become a key driver of competitive advantage (Verhoefa et al. 2021), identifying

important factors that shape digital transformation strategies among non-technology firms is increasingly important. This can provide practical insights for firms intending to initiate digital transformation as well as empirical evidence for those already engaged in this process. However, existing research on corporate digital transformation has been conducted primarily in Western contexts (Liu et al. 2024), which differ substantially from China in terms of institutional arrangements, market conditions, and governance environments. Furthermore, Vial (2019) and Rêgo et al. (2022) contend that digital transformation is a strategic rather than purely technological endeavour.

According to upper echelons theory, the strategic choices made by firms reflect the cognitive bases and values of their top executives (Hambrick & Mason 1984). Although existing studies have examined the roles of top management teams and boards of directors in corporate strategic decision-making, significant attention has recently been paid to the specific role of CEOs. Osei Bonsu et al. (2023) suggest that a CEO's personal characteristics, experiences, and underlying attributes can substantially influence corporate policies and strategic choices. Similarly, Bao et al. (2026) argue that, as the core decision-maker in strategic choices, the CEO plays a decisive role in shaping the pace, direction, and effectiveness of digital transformation.

Recent studies have increasingly examined the relationship between CEOs and digital transformation. Since digital transformation involves significant organisational change, its implementation often encounters resistance from employees (Cieslak & Valor 2025). Consequently, support from the CEO and top management teams is critical for successful digital transformation. This study draws on upper echelons theory to investigate how CEO age, gender, and founder status affect corporate digital transformation, with a focus on Chinese listed non-technology firms.

This research focus is justified for several reasons. First, CEO age and gender are among the most observable personal characteristics and have received substantial attention in recent studies. Younger CEOs are more likely to engage in risk-taking, while older CEOs tend to be more risk-averse (Serfling 2014). Female CEOs have also been linked to strategic innovation. For example, Javed et al. (2023) find that female CEOs in state-owned enterprises and economically developed regions played a significant role in promoting green innovation, while Mansour et al. (2024) report a positive association between female CEOs and green innovation in Asian firms. In addition, existing studies on CEO founder status have focused primarily on CEO duality, leaving the influence of founder CEOs on digital transformation relatively underexplored.

Second, previous research on CEO age and digital transformation has not adequately accounted for heterogeneity between technology and non-technology firms (Zou et al. 2024), thereby obscuring the relationship between CEO characteristics and firm-level digitalisation. Furthermore, although women are often stereotyped as risk-averse (Charness & Gneezy 2012; Eagly & Karau 2002), the persistence of the "glass ceiling" suggests that female executives are strongly achievement-oriented and exhibit a willingness to take risks in order to advance their careers (Dowling 2017). This potential difference warrants further investigation. In addition, the role of founder CEOs in digital transformation remains underexplored. Founder CEOs often have a strong emotional attachment to the firms they have established (Wasserman 2003), which may shape their strategic preferences, long-term commitment, and willingness to pursue transformative initiatives. Examining CEO founder status in this context is therefore both theoretically meaningful and empirically valuable.

Finally, we have chosen to focus on Chinese non-technology firms for two main reasons. First, non-technology and technology firms differ substantially in key financial characteristics such as market-to-book ratios, firm age, and stock return co-movement (Chen & Srinivasan 2024). This suggests that excluding technology firms is important when examining the influence of CEO traits on corporate digital transformation; otherwise, the estimated relationship may reflect inherent industry differences rather than CEO-level effects. Second, Chen and Srinivasan (2024) show that non-technology firms become more similar to technology firms after adopting digital technologies. This indicates that digital transformation among non-technology firms represents a substantive change process rather than an inherent industry attribute.

We find that younger and female CEOs are associated with higher levels of digital transformation among Chinese listed non-technology firms. However, founder CEO status is not significantly related to digital transformation overall. Regional heterogeneity analysis reveals a positive association between founder CEO status and digital transformation in western China at the 10% significance level, whereas no statistically significant relationship emerges in eastern or central China.

Our study makes three contributions to the literature. First, it extends upper echelons theory to digital transformation in Chinese non-technology firms by examining whether CEO age, gender, and founder status are associated with firm-level digital transformation. Although upper echelons theory has been widely applied to corporate strategy and innovation, digital transformation in non-technology firms represents a strategic decision requiring substantial organisational and technological change; our study therefore provides further evidence on the relevance of observable CEO characteristics to this form of strategic transformation.

Second, the study extends the analysis beyond full-sample relationships by examining whether the associations between CEO characteristics and digital transformation vary across eastern, central, and western China. The regional analyses provide additional evidence that the statistical significance of CEO age and female CEOs is not identical across regions. This contributes to the upper echelons literature by demonstrating the value of considering organisational and regional context when examining how CEO characteristics are associated with strategic outcomes.

Third, this study clarifies the theoretical role of founder status in research on executive characteristics and strategic choice. Within upper echelons theory, founding experience may shape CEO knowledge, cognitive orientations, and strategic preferences. Agency theory and stewardship theory offer complementary perspectives on how managerial incentives, organisational identification, and alignment with long-term organisational objectives may further distinguish founder CEOs from professional managers. By integrating these perspectives, the study provides a clearer theoretical foundation for examining founder status as an executive characteristic that influences corporate strategic choices, including digital transformation.

This paper is organised as follows. Section 2 reviews extant literature and develops hypotheses. Section 3 describes the methodology and data selection. Results and their interpretation are presented in Section 4. Sections 5 through 8 present key findings, discussion, implications, and conclusions, respectively.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

UPPER ECHELONS THEORY

Upper echelons theory argues that the strategic behaviours of executives are shaped by their characteristics, experiences, personalities, and values (Hambrick & Mason 1984). When facing internal and external contingencies, these boundedly rational decision-makers are constrained in their ability to perceive and interpret complex environments. In essence, the theory frames managerial decision-making as an interpretive process in which individual traits, cognition, and experience guide strategic interpretation, choice, and action. Since its formulation, research on upper echelons has diverged into multiple streams examining how the cognitive factors and observable experiences of top management teams or individual executives-either independently or collectively-influence the direction of corporate strategy and the outcomes of strategic choices.

In the context of corporate strategy, decision-making is primarily initiated at the top levels of the organisation (Hambrick & Mason 1984). Strategic leadership generally involves two key groups: the top management team, which formulates and implements strategies, and the board of directors, which provides approval and oversight (Fama & Jensen 1983). Early empirical research on senior executives and boards focused primarily on distinguishing their respective roles and responsibilities. However, since the late 1990s, increasing attention has been directed toward the interaction between these two groups and the strategic implications of such interactions (Rindova 2002; Terry & Andrew 1999). Finkelstein and D'aveni (1994) further argue that leadership in strategy is situated at the intersection of upper-echelon logic and corporate governance.

Furthermore, securing support from top management team members and the CEO is critical, as the adoption of new technologies is frequently hindered by stakeholders with vested interests (Goepel et al. 2012). Furthermore, Storbacka et al. (2016) emphasise that individual managers' preferences, expectations, and attitudes significantly influence how new technologies are adopted and utilised.

CEO AGE AND DIGITAL TRANSFORMATION

Age, a readily observable personal characteristic, has long been considered an important demographic attribute in upper echelons research. Upper echelons theory argues that managerial background characteristics, including age, may be associated with differences in strategic choices (Hambrick & Mason 1984).

Previous research indicates that younger CEOs tend to pursue strategies involving greater uncertainty and organisational change. For example, Borghesi et al. (2014) find that firms led by younger CEOs were more likely to invest in corporate social responsibility activities. Serfling (2014) documents a negative association between CEO age and corporate risk-taking, showing that older CEOs invest less in R&D and adopt less risky policies. Similarly, younger CEOs exhibit stronger preferences for investment activities (Li et al. 2017) and are more likely to pursue acquisitions (Yim 2013). Recently, Zou et al. (2024) found that Chinese listed firms led by younger CEOs are more likely to adopt digital transformation initiatives than those led by older executives, particularly when financial constraints are limited.

One explanation for these differences is associated with age-related changes in cognitive processes. From a cognitive perspective, ageing has been linked to declines in fluid intelligence and information-processing speed (Bugg et al. 2006). Such declines may affect how executives evaluate unfamiliar or uncertain strategic alternatives. This is consistent with the broader argument that CEO age is associated with differences in corporate decision-making; Han and Jo (2024) find that CEO age is positively associated with financial performance but negatively associated with risk-taking and innovation.

Another reason for the risk-taking difference between younger and older CEOs is related to career incentives and reputation building. Career-concern theory suggests that managers adjust their decisions in response to incentives to establish a reputation for managerial ability (Prendergast & Stole 1996). Consistent with this argument, Li et al. (2017) find that younger CEOs engage in more active and bolder investment activities, reflecting stronger incentives to signal confidence and ability. More directly, Zou et al. (2024) identify reputation establishment as one of the mechanisms explaining why younger CEOs are more likely to engage in digital transformation. Digital transformation may therefore

provide younger CEOs with an opportunity to demonstrate their strategic capabilities through the pursuit of emerging growth opportunities.

However, it should be noted that Zou et al. (2024) examined A-share listed firms after excluding financial institutions and specially treated companies, but did not distinguish between technology and non-technology firms. As discussed earlier, digital transformation may represent a different strategic process across these two groups. For non-technology firms, it requires deliberate decisions regarding the adoption of digital technologies and the adjustment of established organisational processes and business activities. Examining non-technology firms separately thus provides a more clearly defined setting for assessing whether the relationship between CEO age and digital transformation identified in broader samples is also observed among Chinese non-technology listed firms. Taken together, examining this relationship within non-technology listed firms in China is necessary. Hypothesis 1 is formulated accordingly:

H_1 A younger CEO has a positive effect on digital transformation in Chinese non-technology listed firms.

CEO GENDER AND DIGITAL TRANSFORMATION

CEO gender, as an observable demographic characteristic and managerial attribute within upper echelons theory, exerts a significant influence on corporate decision-making and strategic choices (Hambrick & Mason 1984). For instance, Lakhal et al. (2024) demonstrate that female leaders contribute unique perspectives and experiences to collective decision-making processes, thereby shaping the paradigms of strategic choice formation.

Furthermore, as noted above, upper echelons theory argues that top management team characteristics are closely linked to strategic choice through their underlying cognitive foundations (Hambrick & Mason 1984). This perspective suggests that corporate strategy is shaped by the risk preferences of executives and managers (Kisfalvi 2002).

Consequently, the differences in strategic orientations of male and female CEOs may be partly explained by their attitudes toward risk. The stereotype that women are more risk-averse than men has long been prevalent in both management theory and practice (James et al. 1999). Gender role (in)congruity theory argues that men are typically associated with individualism, competitiveness, and risk-taking (traits traditionally viewed as essential for executive leadership), whereas women are generally characterised by collectivism, altruism, and social orientation, which contribute to a tendency toward risk aversion (Eagly & Karau 2002).

In the Chinese context, Confucianism has profoundly shaped social norms for thousands of years. Although legal gender equality was formally established in 1954 (Liu et al. 2022), traditional beliefs that women should remain subordinate to men persist and often discourage women from engaging in risk-taking behaviour. Empirical evidence supports this cultural tendency, with men generally exhibiting higher levels of risk-taking than women (Croson & Gneezy 2009). Charness and Gneezy (2012) further found that women display greater financial risk aversion than men, offering a behavioural explanation for these gender-based differences.

Nevertheless, more recent studies challenge the assumption that risk aversion among women necessarily hinders innovation. Javed et al. (2023) show that female CEOs in state-owned enterprises and firms located in economically developed regions perform particularly well in promoting green innovation. Similarly, Mansour et al. (2024) find a significant relationship between female CEOs and green innovation among Asian enterprises. These findings suggest that the presence of female executives does not necessarily inhibit innovation or digital transformation. Torchia et al. (2011) lent further support to this view, arguing that female leaders often exhibit a higher propensity for innovation when formulating corporate strategies compared with their male counterparts.

Consequently, several mechanisms may explain findings that run counter to these stereotypes. First, as previously mentioned, women's collectivist and socially oriented tendencies foster open, inclusive, and innovative organisational environments conducive to creative idea generation. Second, the persistence of glass ceiling barriers in managerial practice suggests that women who do reach executive positions, having survived the rigorous selection process, often possess strong risk-taking and achievement-oriented traits (Dowling 2017). Female directors and CEOs therefore tend to exhibit greater risk tolerance than other women (Adams & Funk 2012), enhancing their willingness to pursue innovation and digital transformation initiatives. Third, women's heightened sensitivity to risk-related changes may further motivate them to initiate digital transformation, as such efforts help firms manage uncertainty and improve risk resilience (Tian et al. 2022).

Despite growing scholarly attention to gender diversity, many previous studies have focused on the influence of female CEOs on green innovation (Javed et al. 2023) or on the impact of gender diversity within top management teams and boards on strategic decision-making and innovation outcomes (Triana et al. 2019); CEO-specific evidence concerning digital transformation remains comparatively limited. Given that executive risk preferences may shape strategic decisions, and that digital transformation entails organisational change, innovation, and substantial commitment under uncertainty, this study proposes H_2:

H_2 Female CEOs have a positive effect on the digital transformation of Chinese non-technology listed firms.

Unlike age or gender, founder status reflects a distinctive experiential and role-based attribute of the chief executive. According to upper echelons theory (Hambrick & Mason 1984), the strategic choices of executives are shaped by their experiences, values, cognitive orientations, and interpretations of organisational situations. From this perspective, founding experience is particularly relevant because creating a venture requires entrepreneurs to identify and pursue opportunities, mobilise resources, and act under substantial uncertainty (Bhave 1994; Clough et al. 2018). Founders are also directly involved in their organisations' formation and early development, during which initial organisational arrangements and strategic orientations are established (Boeker 1997; Gartner 1985).

Existing research on founder-CEOs supports this distinction. Founder-CEOs tend to develop a strong identification with the organisations they create, which in turn shapes their strategic behaviour and ongoing involvement with the firm (Lee et al. 2018). Research also links founder identity to greater entrepreneurial orientation and distinctive strategic behaviour (Miller et al. 2011). More broadly, a systematic review of founder-CEO research demonstrates that founder status carries important implications for corporate strategy and organisational design (Abebe et al. 2020). These characteristics are particularly relevant to digital transformation because such initiatives typically require executives to recognise emerging technological opportunities, tolerate uncertainty, commit resources to long-term organisational renewal, and challenge established routines.

However, founder status differs conceptually from conventional demographic attributes because it captures not only a distinctive executive experience but also a particular structural and relational position within the firm (Fahlenbrach 2009). Through their involvement in creating and developing the organisation, founder CEOs may accumulate substantial firm-specific managerial knowledge and capabilities (Castanias & Helfat 2001), while their continued leadership is often closely associated with strong organisational identification (Lee et al. 2018). Founder CEOs may also retain ownership interests and substantial influence over corporate decision-making, thereby linking founder status to broader questions concerning ownership, control, and managerial incentives.

This study draws on insights from agency theory and stewardship theory to clarify the multidimensional nature of founder status and to understand why founder CEOs may differ from professional CEOs in their cognitive orientations and strategic preferences. In the case of founder CEOs, the experience of establishing and developing a firm represents a distinctive form of executive experience that can substantially shape how they perceive strategic opportunities, uncertainty, and long-term organisational development (Abebe et al. 2020; Fahlenbrach, 2009).

Agency theory addresses the principal-agent relationship between owners and managers, arguing that divergent interests and information asymmetries can generate agency costs (Jensen & Meckling 1976). Fama and Jensen (1983) extend this logic by highlighting governance implications arising from the separation of decision-making authority and residual risk bearing. Eisenhardt (1989) further systematises the agency perspective by identifying goal conflict, information asymmetry, differences in risk preferences, monitoring mechanisms, and incentive alignment as central elements of principal–agent relationships. Under these conditions, misalignments between the incentives of professional managers and the long-term interests of shareholders become particularly consequential when strategic initiatives require substantial current investment but yield uncertain and delayed returns. Consequently, agency theory provides a framework for understanding how managerial incentives and risk-bearing considerations may shape the willingness of executives to pursue long-term strategic investments such as digital transformation.

Stewardship theory offers an alternative behavioural perspective. Donaldson and Davis (1991) argue that managers can function as stewards whose interests align with organisational objectives, while Davis et al. (1997) extend this view by characterising managerial behaviour as collectivistic, pro-organisational, and intrinsically motivated. This framework is especially pertinent to founder CEOs, whose deep involvement in creating and developing the firm often fosters strong organisational identification (Lee et al. 2018). Such identification links founders' personal goals and self-concept closely with organisational success. As a result, compared with professional CEOs, founder CEOs may be more willing to accept short-term uncertainty and delayed returns when they view a strategic initiative as critical to the firm's long-term development and competitiveness.

Taken together, these perspectives suggest that founder status influences strategic choices through two interconnected dimensions: an experience-cognition dimension rooted in upper echelons theory and a motivation-governance dimension grounded in agency and stewardship theories. Accordingly, this study integrates the elements of agency and stewardship theories that are most relevant to executive cognition and motivation within the broader framework of upper echelons theory, thus clarifying how founder status may reinforce or constrain the translation of executive perceptions and strategic preferences into organisational action.

This theoretical distinction is particularly relevant to digital transformation because such initiatives typically involve substantial resource commitments, organisational restructuring, considerable uncertainty, and benefits that accrue over an extended period (Vial 2019; Warner & Wäger 2019). The entrepreneurial and managerial experiences of CEO founders may shape their cognitive evaluations of digital opportunities, while their stronger identification with the organisation and closer alignment with its long-term objectives may influence their willingness to bear associated uncertainty and delayed returns.

At the same time, founder status is often associated with ownership, control, and incentive structures, as well as several observable executive characteristics that may themselves influence strategic decision-making. To isolate the incremental effect of CEO founder status on digital transformation beyond differences in tenure, ownership incentives, compensation, and formal leadership structure, CEO tenure, CEO shareholding, CEO compensation, CEO duality, and board size were included as control variables in the model. Accordingly,

H_3 is proposed as follows:

H_3 Founder CEOs have a positive effect on digital transformation in Chinese non-technology listed firms.

The theoretical framework is outlined in Figure 1.

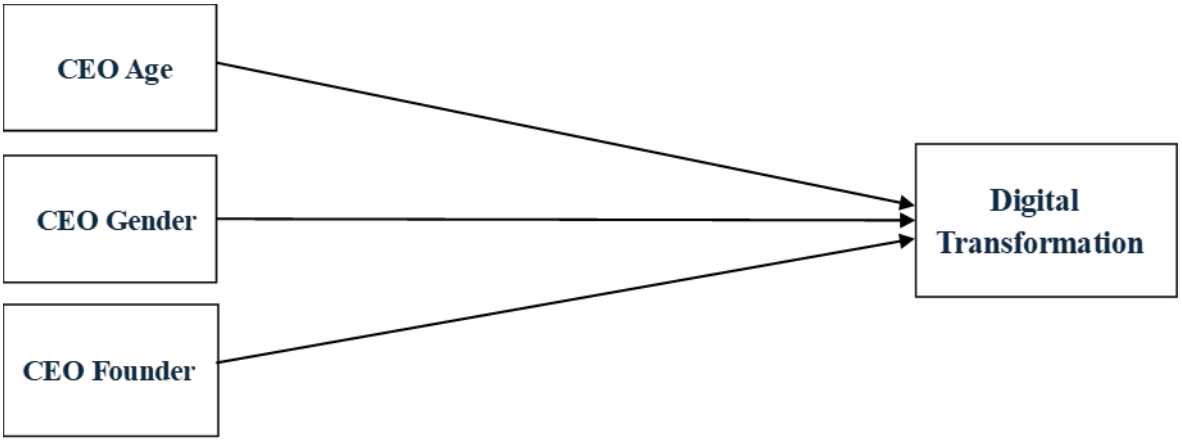


FIGURE 1. Theoretical framework

DATA AND METHODS

SAMPLE SELECTION AND DATA COLLECTION

This study examines Chinese non-technology public firms listed on the main boards of the Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE) from 2015 to 2024. All independent and control variables are sourced from the China Stock Market and Accounting Research (CSMAR) database. The initial sample comprises 17,594 firm-year observations; following data cleaning and screening procedures, the final sample for baseline regression analysis consists of 17,522 firm-year observations, forming an unbalanced panel. Sample selection adheres to multiple criteria to ensure data reliability and industry consistency.

This study focuses on non-technology firms because digital transformation has different implications for technology and non-technology firms; excluding the former reduces industry heterogeneity and facilitates identification of CEO-driven digital transformation. Firms listed on the STAR Market and ChiNext are also excluded from the sample; these are designed to support technology-oriented firms and innovation-driven start-ups through specialised financing channels[1], which fall outside the scope of this study. Non-technology firms are identified using the Shenwan Industry Classification System, widely used in recent empirical research (e.g., Ding et al. (2025). Specifically, we exclude firms classified under the broad technology category according to the 2021 Shenwan first-level industry codes from the population of companies listed on the main boards of the Shanghai and Shenzhen Stock Exchanges in the CSMAR database. Table A1 in Appendix A provides details on the Shenwan industry classification and their corresponding codes.

Second, financial firms and specially treated firms are excluded from the sample because their distinctive financial characteristics and abnormal financial conditions, respectively, may introduce sample heterogeneity and bias the empirical estimates (Fama & French 1992; Li 2020). Finally, the dataset is further refined by removing observations with missing values and winsorising continuous variables at the 1% and 99% levels to mitigate the influence of extreme values on the empirical results.

MEASUREMENT OF DIGITAL TRANSFORMATION (DEPENDENT VARIABLE)

To measure the digital transformation activities of firms, this study constructs a text-based indicator from annual report disclosures. Since A-share listed firms in China do not file 10-Ks or publish shareholder letters, annual reports were used as the primary textual source for analysis. Previous research in management and accounting has established the readability of financial reports and their reliability when it comes to analysing corporate strategic information (Han et al. 2023).

Accordingly, we build a keyword dictionary from annual report text to create our digital transformation proxy using Python and its associated libraries. All subsequent data analyses are conducted in Stata 18, which serves as the primary statistical software for managing and analysing the panel dataset described above.

Based on the above considerations and in accordance with the methodology developed by Chen and Srinivasan (2024), we measure digital transformation through a five-stage process:

Constructing a Keyword Dictionary for Digital Transformation Drawing on established dimensions of digital transformation from the literature (Chen & Srinivasan 2024; Zou et al. 2024), this study evaluates corporate digital transformation across five technological domains: cloud computing, big data, blockchain, artificial intelligence, and the application of digital technology. These categories capture the core technological components commonly associated with digital transformation in existing literature. To ensure that the thesaurus accurately reflects the evolving nature of digital technologies, additional keywords are incorporated to expand and refine the dictionary. The complete list of keywords for each technological dimension is provided in Table A2.

Keyword Extraction Using Python-Based Textual Analysis Following the approach proposed by Chen and Srinivasan (2024), this study measures digital transformation by counting the frequency of relevant keywords in the firms' annual reports. Specifically, we convert PDF files into machine-readable text using the Python library PyMuPDF (fitz) to extract and process report content for analysis.

Given that annual reports of Chinese listed firms are primarily written in Chinese, the extracted texts were cleaned using Python's re regular expression module. Numerical expressions, punctuation, English words unrelated to digitalisation, and other non-Chinese characters were removed to reduce textual noise while retaining meaningful disclosure content. The jieba package was used for Chinese word segmentation and auxiliary verification of keyword expressions. Finally, the extracted keyword frequencies were organised into structured firm-year observations using the pandas library and exported for further processing in Stata.

Aggregation of Digital Technology Dimensions After obtaining firm-year keyword frequency data, the extracted keywords were aggregated according to a structured classification system that maps them onto the five technological dimensions. For each dimension, the frequencies of all associated keywords were summed to construct dimension-level digital technology indicators. The overall digital transformation indicator is then computed by aggregating these dimension-level measures across all five categories. This composite indicator captures the total intensity of digital transformation-related disclosure before normalisation and further transformation.

Normalisation and Logarithmic Transformation Since annual reports vary substantially in length across firms, longer documents may mechanically contain more keywords. To control for this effect, total keyword counts were normalised by dividing them by the report's text length and multiplying by 10,000. This procedure ensures that the metric used in this study captures the relative intensity of digital transformation disclosure rather than simple differences in document length. In addition, to address the right-skewed distribution typical of keyword frequency variables, a logarithmic transformation using $\ln(x+1)$ was applied. This transformation mitigates the influence of extreme values and improves the variable's distributional properties while preserving observations with zero keyword counts.

Classification of Digital Transformation Intensity Firms were classified into terciles based on the yearly distribution of the logarithmically transformed digital transformation indicator to capture differences in digital transformation intensity. Firms in the bottom, middle, and top terciles were assigned values of 1, 2, and 3, representing low, medium, and high levels of digital transformation intensity, respectively. This procedure yields a three-level categorical variable reflecting each firm's relative position within its year cohort. The resulting variable serves as a proxy for the dependent variable; higher values indicate greater emphasis on digital technologies in the firms' annual report disclosures.

MEASUREMENT OF INDEPENDENT VARIABLES

Following Zou et al. (2024), this study applies a natural logarithmic transformation to CEO age to mitigate scale heterogeneity and potential skewness in the distribution of age data. This transformation also facilitates more robust interpretation of coefficient estimates in the regression models. To measure CEO gender, a binary dummy variable was constructed that takes a value of 1 if the firm's CEO is female and 0 otherwise.

CEO founder status is measured using a similar dummy-variable approach. For each firm-year observation, the study identified whether the CEO was a founder of the focal firm; if so, the variable was coded as 1, and otherwise it was coded as 0. To enhance the accuracy and reliability of this classification, a two-step identification procedure was adopted:

First, an initial founder classification was constructed by matching each firm-year observation's CEO name against the list of original contributors or founding shareholders at corporate inception. This provides a preliminary identification of whether the incumbent CEO belongs to the group of individuals involved in establishing the firm.

Second, the preliminary matches are cross-validated against publicly available textual disclosures, including annual reports, prospectuses, and corporate websites. Annual reports and prospectuses in PDF format were collected and converted to machine-readable text using Python-based extraction tools; where necessary, relevant information was retrieved from corporate websites via Python web-scraping scripts. The resulting documents were then processed to identify explicit founder-related language, such as "founder," "co-founder," or "founding member", in executive biographies, firm history sections, company profiles, and other pertinent disclosure areas. Excel was used to organise the extracted records and

facilitate manual verification of ambiguous cases. Observations in which these disclosures explicitly confirm that the CEO is a founder are retained as verified founder-CEO cases.

Accordingly, the CEO-founder indicator was coded as 1 only when both the initial name-match and the subsequent text-based verification confirm founder status; in all other cases it was set to 0.

MEASUREMENT OF CONTROL VARIABLES

We controlled for CEO duality, CEO tenure, CEO compensation, CEO shareholding, board size, firm size, and firm age. The choice of controls follows prior research and is guided by theoretical relevance and causal considerations. Variables that jointly influence both the explanatory variable and the outcome can produce omitted-variable bias; thus, careful covariate selection helps distinguish the focal relationship from alternative explanations (Cinelli et al. 2024; Wooldridge 2010). Conversely, including inappropriate controls may introduce included-variable bias or block theoretically meaningful pathways (Angrist & Pischke 2009; Cinelli et al. 2024). Accordingly, these variables were treated as plausible background covariates rather than arbitrary correlates of digital transformation.

The baseline controls include CEO-level and firm-level characteristics. CEO tenure, shareholding, and compensation capture differences in managerial experience, ownership incentives, and financial incentives; firm size, age, and board size reflect organisational resources, maturity, and governance structure (Hambrick & Mason 1984). These variables are conceptually related to, but distinct from, the focal CEO attributes. For example, CEO tenure measures the length of time an executive has served in the role and is conceptually separate from chronological age (Darouichi et al. 2021). Similarly, shareholding and founder status represent related but distinct dimensions of ownership and influence, with prior research treating them as separate constructs that may have different implications for corporate decision-making (Brahma & Economou 2024).

These controls reflect relatively stable organisational and managerial conditions that predate both the focal CEO attributes and digital transformation efforts. Their inclusion is intended to reduce spurious associations without obscuring the substantive pathways through which CEO characteristics may shape strategic choices. Although these archival measures serve as imperfect proxies for broader constructs, they represent widely observable indicators of relevant background factors.

Finally, year and province fixed effects are included to control for unobserved temporal and regional heterogeneity. Together, these controls help mitigate alternative explanations and strengthen the interpretability of the estimated relationships between CEO attributes and digital transformation. Definitions and measurement approaches for all variables are provided in Table 1.

TABLE 1. Variable definition, measurement, and data sources

Variables	Variable Name	Definition/Measurements	Data Source
Independent Variables	CEO Age	The natural logarithmic value of CEO age	CSMAR Database
	CEO Gender	Female CEOs coded as 1; male CEOs coded as 0	CSMAR Database
	CEO Founder	Founder CEO coded as 1; non-founder CEO coded as 0	CSMAR Database and Information Disclosed on Official Websites
Dependent Variable	Digital Transformation	Five steps of constructing the proxy to measure Digital Transformation (Chen & Srinivasan, 2024): 1. Construction of the Digital Transformation Keyword Dictionary: selected keywords were related to cloud computing, big data, blockchain, artificial intelligence, and the application of digital technology. 2. Keyword Extraction Using Python-Based Textual Analysis: annual reports were converted from PDF to machine-readable text using *PyMuPDF*; irrelevant content (numerical expressions, punctuation, non-Chinese characters, and unrelated English words) was removed via regular expressions; a dictionary-based matching approach identified keyword frequencies in the cleaned texts; *pandas* was used to organise these frequencies into firm-year observations. 3. Aggregation of Digital Technology Dimensions: keywords were categorised into five technological dimensions, with dimension-level indicators constructed by summing keyword frequencies within each category. 4. Normalisation and Logarithmic Transformation: digital transformation intensity was calculated as total keyword frequency divided by annual report text length, multiplied by 10,000. 5. Classification of Digital Transformation Intensity: firms were classified into three terciles within each year, with bottom, middle, and top terciles assigned values of 1, 2, and 3, representing low, medium, and high digital transformation intensity, respectively.	Annual Reports
Control Variables	CEO Tenure	Years the CEO has served at the firm	CSMAR Database
	CEO Shareholding	Natural log of CEO shareholdings	CSMAR Database
	CEO Compensation	Natural log of CEO compensation	CSMAR Database
	CEO Duality	CEO also serves as chairman coded as 1; otherwise 0.	CSMAR Database
	Firm Size	Logarithm of total assets	CSMAR Database
	Firm Age	Logarithm of years since the firm's establishment	CSMAR Database
	The Board Size	Total number of directors	CSMAR Database

EMPIRICAL MODEL

The baseline model is designed to test Hypotheses 1, 2, and 3. The model is specified as follows:

$$DT_{it}=\beta_0+\beta_1 CEO\ Attribute_{it}+\theta' Controls_{it}+\gamma_t+\delta_{p(i)}+\varepsilon_{it} \quad (1)$$

where "CEO Attribut" "e" _"it" represents the CEO age, gender, and founder status. In addition, DTit is the digital transformation level of enterprise i in year t. β0 is the intercept term, the baseline level of digital transformation when all predictors equal zero, while β1 is the marginal effect of CEO attributes on firm digital transformation. Following Zou et al. (2024), we include controls for CEO duality, CEO tenure, CEO shareholding, CEO compensation, firm size, firm age, and board size. In addition, γ_t represents year fixed effects, "δ" _"p" ("i") represents province fixed effects, and standard errors are clustered at the firm level (i).

This study employs a high-dimensional fixed effects specification as its baseline regression model, incorporating year and province fixed effects with standard errors clustered at the firm level. The choice between fixed and random effects in panel data analysis depends on the research objectives and whether unobserved individual-specific effects are correlated with the explanatory variables. Fixed effects are generally preferred when consistent estimation is required after controlling for time-invariant factors that may be correlated with regressors. In contrast, random effects are appropriate only under the assumption that unobserved individual-specific effects are uncorrelated with the explanatory variables; this assumption permits more efficient use of both within-entity and between-entity variation. The Hausman test (Hausman 1978; Wooldridge 2010) is commonly used to distinguish between these two approaches.

In this study, however, model selection was not determined by the Hausman test. In panel-data research, the selection of an appropriate specification should reflect the theoretical context and the nature of the explanatory variables. Here, the key assumption underlying the random-effects model is unlikely to hold: CEO characteristics (age, gender, founder status) are plausibly correlated with corporate governance structures, ownership arrangements, strategic orientations, managerial selection processes, and other persistent but unobserved firm attributes that influence both CEO appointment decisions as well as a firm's propensity or capacity for digital transformation. Under these conditions, it is difficult to assume orthogonality between the explanatory variables and the unobserved effects. Therefore, a fixed-effects specification is more appropriate than a random-effects specification in this study.

Year fixed effects account for common macroeconomic shocks, policy changes, regulatory developments, and other time-varying factors that affect all firms within a given year. This is particularly important because digital transformation is driven not only by firm-level managerial decisions but also by broader economic and technological trends. Province fixed effects are included to control for differences in the external environment across provinces where firms operate.

Although firm fixed effects are widely used in panel-data studies, they are not appropriate for our baseline specification. Several key CEO characteristics examined here, especially CEO gender and founder status, exhibit very limited within-firm variation over time. Including firm fixed effects would absorb most of the cross-sectional variation in these relatively stable traits, leaving insufficient residual variation to identify their effects and thereby preventing the estimation of the role of CEO attributes central to our research question.

Finally, because multiple yearly observations are available for each firm, the assumption that all firm-year observations are statistically independent may not hold. Unobserved firm-specific factors may persist over time and induce correlation in the regression disturbances within the same firm (Petersen 2009). Therefore, standard errors are clustered at the firm level to allow for heteroskedasticity and arbitrary within-firm correlation over time (Cameron & Miller 2015).

RESULTS

DESCRIPTIVE STATISTICS

Table 2 presents the descriptive statistics for the key variables used in this study.

The dependent variable, digital transformation (DT), is measured using a tertile-coded index ranging from 1 to 3. The sample mean of 1.983 suggests that, on average, firms exhibit moderate levels of digital transformation intensity. According to the recorded CEO characteristics, the average age is 51.26 years, indicating that most CEOs are middle-aged executives. Female CEOs comprise only 6.2% of the sample, reflecting a persistent gender imbalance in top management positions. Approximately 18% of CEOs are founders, and about 23% concurrently hold the position of board chairperson, highlighting the variation in managerial power concentration across firms.

TABLE 2. Descriptive statistics

Variables	Obs.	Mean	S.D.	Min.	Median	Max.
DT	17538	1.983	0.826	1	2	3
CEO Age	17588	51.263	6.72	33	52	67
CEO Gender	17594	0.062	0.242	0	0	1
CEO Founder	17594	0.18	0.384	0	0	1
CEO Tenure	17593	4.543	3.584	1	3	17
CEO Duality	17589	0.234	0.424	0	0	1

Board Size	17593	8.535	1.665	5	9	15
Firm Size	17591	22.722	1.425	19.961	22.548	26.776
Firm Age	17594	3.093	0.276	2.303	3.135	3.664
CEO Compensation	17589	13.273	2.306	0	13.592	15.745
CEO Shareholding	17594	7.485	7.789	0	0	19.689

CORRELATION ANALYSIS

Given that the DT index and several CEO-related variables (CEO gender, founder status, and duality) are ordinal or non-normally distributed, this study uses the Spearman rank correlation coefficient to assess bivariate associations. Unlike the Pearson correlation coefficient, the Spearman method does not assume linearity or normality and is less sensitive to outliers (Field 2013; Sedgwick 2014). The results of the Spearman correlation analysis are presented in Table 3.

TABLE 3. Correlation analysis - Spearman matrix

Variables	DT	CEO Age	CEO Gender	CEO Founder	CEO Tenure
DT	1.000				
CEO Age	-0.030***	1.000			
CEO Gender	0.049***	-0.062***	1.000		
CEO Founder	0.073***	0.161***	0.008	1.000	
CEO Tenure	0.050***	0.254***	0.019**	0.236***	1.000
CEO Duality	0.069***	0.162***	-0.016**	0.495***	0.183***
Board Size	-0.017**	0.032***	-0.067***	-0.164***	-0.039***
Firm Size	0.051***	0.029***	-0.007	-0.176***	-0.026***
Firm Age	0.010	0.044***	0.023***	-0.208***	-0.005
CEO Compensation	0.106***	0.099***	0.023***	0.040***	0.103***
CEO Shareholding	0.089***	0.100***	0.051***	0.524***	0.288***

**** p<0.01, ** p<0.05, * p<0.10*

TABLE 3. Correlation Analysis-Spearman Matrix, continued

	CEO Duality	Board Size	Firm Size	Firm Age	CEO Compensation	CEO Shareholding
DT						
CEO Age						
CEO Gender						
CEO Founder						
CEO Tenure						
CEO Duality	1.000					
Board Size	-0.165***	1.000				
Firm Size	-0.125***	0.119***	1.000			
Firm Age	-0.095***	0.061***	0.115***	1.000		
CEO Compensation	0.085***	0.020***	0.093***	0.066***	1.000	
CEO Shareholding	0.365***	-0.106***	-0.138***	-0.172***	0.181***	1.000

**** p<0.01, ** p<0.05, * p<0.10*

In general, the observed correlations are moderate in magnitude and fall below the conventional multicollinearity threshold ($|r|<0.6$). This suggests that multicollinearity is unlikely to significantly bias the regression estimates.

VIF ANALYSIS

The reported VIF values range from 1.01 to 1.63, well below conventional thresholds of 5 or 10 (O'brien, 2007), suggesting that there are no multicollinearity concerns and confirming that the estimated coefficients are statistically reliable and not distorted by high correlations among explanatory variables. Detailed results are presented in Table B1.

RESULTS OF BASELINE MODEL

Table 4 presents the baseline results and robustness tests; the tests used for each column are described in the table notes. Column (1) of Table 4 shows that CEO age is negatively and significantly associated with digital transformation, suggesting that older CEOs are more likely to impede digital innovation among Chinese non-technology listed firms. In other words, younger CEOs are associated with higher levels of digital transformation in firms, supporting Hypothesis 1.

There is a significant positive relationship between female CEOs and digital transformation, implying that in Chinese non-technology listed firms, female CEOs are more inclined to adopt digital transformation than their male counterparts, thus supporting Hypothesis 2. This result also demonstrates that female leaders may be characterised by a willingness to break through the "glass ceiling" of their careers, which involves risk-bearing and risk-taking orientations.

The coefficient for founder CEOs is positive but not statistically significant, indicating that although founder CEOs may bring greater strategic vision and entrepreneurial orientation, their effect on digital transformation is not consistently observable across established firms. Thus, Hypothesis 3 is not supported.

TABLE 4. Results of high-dimension fixed effect regression and robustness test

Variables	(1) Baseline Model	(2) Alternative FE-excluding Province	(3) Ordered Logit Model	(4) Continuous DT	(5) Lagged Variables	(6) Excluding COVID-19
CEO Age	-0.0079***	-0.0074***	-0.0182***	-0.0406***		-0.0075***
	(0.0020)	(0.0020)	(0.0047)	(0.0096)		(0.0020)
CEO Gender	0.1452***	0.1459***	0.3427***	0.6871**		0.1390***
	(0.0523)	(0.0530)	(0.1242)	(0.3495)		(0.0532)
CEO Founder	0.0521	0.0822*	0.1290	0.2720		0.0478
	(0.0460)	(0.0463)	(0.1095)	(0.2815)		(0.0463)
CEO Tenure	0.0128***	0.0116***	0.0288***	0.0318**		0.0123***
	(0.0035)	(0.0036)	(0.0081)	(0.0141)		(0.0035)
CEO Duality	0.0802**	0.0844**	0.1791**	0.3480		0.0884***
	(0.0327)	(0.0332)	(0.0766)	(0.2181)		(0.0333)
Board Size	0.0093	0.0038	0.0215	0.0168		0.0077
	(0.0077)	(0.0078)	(0.0175)	(0.0370)		(0.0079)
Firm Size	0.0388***	0.0384***	0.0894***	0.0090		0.0377***
	(0.0095)	(0.0095)	(0.0218)	(0.0344)		(0.0095)
Firm Age	-0.0359	0.0081	-0.0937	0.0225		-0.0447
	(0.0536)	(0.0533)	(0.1236)	(0.2614)		(0.0534)
CEO Compensation	0.0014	0.0061	0.0043	0.0086		0.0006
	(0.0042)	(0.0044)	(0.0097)	(0.0114)		(0.0044)
CEO Shareholding	0.0045**	0.0052***	0.0101**	0.0248**		0.0040**
	(0.0020)	(0.0020)	(0.0046)	(0.0115)		(0.0020)
Lagged CEO Age					-0.0090***	
					(0.0021)	
Lagged CEO Gender					0.1567***	
					(0.0543)	
Lagged CEO Founder					0.0624	
					(0.0467)	
Lagged CEO Tenure					0.0135***	
					(0.0036)	
Lagged CEO Duality					0.0726**	
					(0.0334)	
Lagged CEO Shareholding					0.0091	
					(0.0079)	
Lagged CEO Compensation					0.0397***	
					(0.0098)	
Lagged Board Size					-0.0253	
					(0.0606)	
Lagged Firm Size					0.0003	
					(0.0044)	
Lagged Firm Age					0.0051**	
					(0.0020)	
Constant	1.3927***	1.2138***	-	2.4554**	1.4110***	1.4446***
	(0.2869)	(0.2888)	-	(1.0723)	(0.3068)	(0.2875)
Observations	17,522	17,522	17522	17,522	15,415	13,729
Within R-squared	0.0178	0.0204	-	0.0172	0.0199	0.0165
Pseudo R-squared	-	-	0.0223	-	--	
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	No	Yes	Yes	Yes	Yes
Firm-clustered SE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Notes:
Column (1) presents baseline regression results testing hypotheses H_1, H_2, and H_3.
Column (2) reports alternative model specifications as a robustness check, employing an alternative fixed-effects specification that excludes province-level fixed effects.
Column (3) displays ordered logit model results to assess whether treating the tercile-based dependent variable as ordinal rather than continuous affects baseline findings.
Column (4) presents results using a continuous digital transformation measure (DT_rate), constructed following the first four steps of the measurement procedure described in "Measurement of Digital Transformation (Dependent Variable)". This robustness test examines whether baseline findings depend on the discrete tercile classification.
Column (5) reports lagged-variable specifications as a robustness test, employing one-year-lagged explanatory variables to address potential simultaneity concerns.
Column (6) presents results excluding years affected by COVID-19 to assess the influence of the pandemic on baseline findings.

ROBUSTNESS TEST

Alternative Model Specification Column (2) of Table 4 presents a robustness specification that includes only year fixed effects, omitting province fixed effects to retain between-province variation in the model. This approach follows Wooldridge (2010) and Cameron and Miller (2015), who note that varying the level of fixed effects provides a robustness check on the sensitivity of coefficient estimates to unobserved group-level factors. By excluding province fixed effects, the specification captures genuine differences across provinces in the digital transformation of firms, which reflect variations in local economic development, digital infrastructure, and policy intensity (Fan et al. 2024; Wu et al. 2023). If the estimated coefficients remain similar in sign and significance to those from the baseline two-way fixed effects model (year and province), this indicates that the main results are not driven solely by regional policy or institutional heterogeneity, but instead reflect firm-level and managerial dynamics.

Consistent with this expectation, the regression results show that CEO age remains significantly negative, while female CEOs continue to be positively associated with digital transformation. The stability of both the magnitude and

direction of these coefficients relative to the baseline model suggests that the relationship between CEO characteristics and digital transformation is robust to the exclusion of provincial fixed effects. However, the relationship between founder status and digital transformation becomes only marginally significant in this specification, highlighting the importance of geographic heterogeneity and further justifying our subsequent heterogeneity analysis.

Robustness in the Quantisation of Digital Transformation Column (3) of Table 4 reports an ordered logit specification because the baseline dependent variable is constructed as a three-category ordinal measure. Ordered-response models are appropriate for such outcomes because they explicitly account for ordinality without requiring equal numerical distances between adjacent categories (McCullagh 1980). This additional test therefore examines whether the baseline findings depend on treating the tercile-based dependent variable as a continuous score, which may impose stronger metric assumptions on an ordinal outcome (Liddell & Kruschke 2018). The results remain consistent with the baseline specification: CEO age is significantly and negatively associated with digital transformation, CEO gender is significantly and positively associated with digital transformation, and founder CEO status remains positive but statistically insignificant.

Column (4) re-estimates the model using the continuous digital transformation score rather than the tercile classification, testing whether our baseline results depend on the information loss inherent in quantisation. Although we followed Chen and Srinivasan (2024) in constructing our dependent variable, converting a continuous measure into discrete categories inevitably discards some of the underlying variation (Benmelech & Frydman 2015). This specification does not introduce an alternative metric or data source; instead, it retains the full continuous form of the same underlying text-based indicator. The results remain largely consistent with our baseline findings, indicating that the observed relationships between CEO attributes and digital transformation are robust to this measurement choice.

Overall, the results from both the continuous and ordered logit specifications confirm that the direction and significance of the key CEO-trait effects remain consistent across alternative treatments of digital transformation. These findings mitigate concerns that the baseline results are driven either by the tercile transformation of the digitalisation index or by treating the ordinal dependent variable as a numerical score.

Lagged Variables: Endogeneity Test The baseline high-dimensional fixed effects specification includes year and province fixed effects to control for common time-specific shocks and time-invariant regional heterogeneity. However, these fixed effects do not eliminate potential endogeneity arising from time-varying omitted variables, simultaneity, or reverse causality. In addition, standard errors are clustered at the firm level to account for heteroskedasticity and within-firm correlation over time; this adjustment improves statistical inference but does not itself address endogeneity (Cameron & Miller 2015; Wooldridge 2010).

To further mitigate concerns about simultaneity and reverse causality, the key explanatory variables are lagged by one year. This temporal separation between CEO characteristics and subsequent digital transformation reduces the likelihood that the estimated relationships reflect same-period adjustments or contemporaneous feedback. However, lagging the explanatory variables does not fully address other potential sources of endogeneity, such as time-varying omitted factors or persistent reverse-causality mechanisms (Angrist & Pischke 2009; Cameron & Trivedi 2005; Wooldridge 2010).

Column (5) of Table 4 presents the results using lagged independent variables. One-year-lagged CEO age continues to be significantly and negatively associated with subsequent digital transformation, whereas one-year-lagged female CEO status remains significantly and positively associated with it. These coefficient signs and their statistical significance align with the baseline findings.

The inclusion of lagged variables provides further support for the conclusion that the baseline associations are not attributable to contemporaneous simultaneity alone; however, this specification should be regarded as a robustness exercise rather than as a definitive resolution of potential endogeneity concerns.

Deleting Years Influenced by Covid-19 Column (6) of Table 4 reports results from a robustness specification that excludes the years 2020 and 2021, which correspond to the onset and peak of the COVID-19 pandemic. This adjustment ensures that the estimated baseline relationship between CEO characteristics and DT reflects the strategic behaviour of firms under normal operating conditions rather than temporary responses to extraordinary external shocks. Previous research has shown that the pandemic period introduced significant exogenous disruptions, including mandatory lockdowns, accelerated digital adoption policies, and liquidity constraints (McKibbin & Fernando 2021). These factors may have induced short-term adjustments in firms' digital transformation strategies that do not reflect their long-run strategic orientation. Excluding these years allows for an assessment of whether the main findings remain robust in a more stable macroeconomic environment. The results are broadly consistent with those of the baseline model. CEO age remains significantly negatively associated with digital transformation, whereas female CEOs continue to have a positive and significant effect. Founder CEOs also show a positive coefficient, although it is not statistically significant.

The consistent signs and statistical significance of the coefficients after excluding pandemic years indicate that the main findings do not depend on observations from the COVID-19 period, providing additional evidence that the associations between CEO attributes and digital transformation persist when the analysis is restricted to non-pandemic years.

As noted above, the relationship between CEO founder status and digital transformation becomes insignificant when regional conditions vary. Furthermore, China exhibits significant regional disparities in economic development, digital infrastructure, and institutional environments (Fan et al. 2024), making heterogeneity analysis essential (Li et al. 2026).

A regional heterogeneity analysis was conducted to examine whether the relationship between CEO characteristics and DT varied systematically across China's three major geographic regions: Eastern, Central, and Western. Table 5 presents the results of this regional heterogeneity analysis for each subsample.

In the Eastern region, CEO age exhibits a negative and statistically significant association with digital transformation, whereas both CEO gender and founder status are positively associated but not statistically significant. In the Central region, the CEO age coefficient remains negative but becomes statistically insignificant; notably, unlike the Eastern results, female CEOs show a positive and statistically significant relationship with digital transformation, while founder status remains positive yet insignificant. Finally, in the Western region, CEO age is negatively associated with digital transformation but not statistically significant, whereas female CEOs are positively and significantly associated, and founder status is positive and marginally significant.

Taken together, these heterogeneity tests reveal distinct regional patterns in the statistical support for the three focal CEO attributes. The negative relationship between digital transformation and CEO age is statistically supported in the Eastern region, whereas the positive relationship involving female CEOs is supported in the Central and Western regions. Finally, the positive relationship involving founder CEOs appears only in the Western region, where it is significant at the 10 per cent level.

TABLE 5. Heterogeneity test by region (East, Central, and West)

Variables	Eastern	Central	West
CEO Age	-0.00806***	-0.00729	-0.00734
	(0.00245)	(0.00480)	(0.00470)
CEO Gender	0.0898	0.405***	0.264**
	(0.0619)	(0.154)	(0.113)
CEO Founder	0.0318	0.0481	0.212*
	(0.0524)	(0.141)	(0.127)
CEO Tenure	0.0153***	0.00624	0.00929
	(0.00425)	(0.00966)	(0.00768)
CEO Duality	0.0651*	0.195**	0.0661
	(0.0388)	(0.0918)	(0.0825)
Board Size	0.00494	0.0295	0.0123
	(0.00965)	(0.0180)	(0.0181)
Firm Size	0.0231**	0.0777***	0.0728***
	(0.0115)	(0.0251)	(0.0205)
Firm Age	-0.0352	-0.156	0.0753
	(0.0629)	(0.164)	(0.126)
CEO Compensation	0.00391	0.00875	-0.00835
	(0.00531)	(0.0110)	(0.00870)
CEO Shareholding	0.00487**	0.00325	0.00170
	(0.00236)	(0.00500)	(0.00475)
Constant	1.793***	0.476	0.277
	(0.340)	(0.794)	(0.679)
N	12088	2389	3045
R-Squared	0.0361	0.0673	0.0706

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes:
Regions are classified according to province codes.
The Eastern region includes Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan.
The Central region includes Shanxi, Anhui, Jiangxi, Henan, Hubei, and Hunan.
The Western region includes Inner Mongolia, Liaoning, Jilin, Heilongjiang, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

However, differences in statistical significance across regions do not necessarily imply that the estimated coefficients themselves differ significantly. To address this, four additional robustness checks were conducted on the baseline model to assess the stability of the heterogeneity findings. Specifically, we re-estimated the models using an alternative specification without province fixed effects, a continuous measure of digital transformation, lagged explanatory variables, and a sample excluding the COVID-19 period. The complete results are reported in Tables C1–C3 in Appendix C.

The negative association between CEO age and digital transformation remains statistically significant across the corresponding robustness specifications in the Eastern region. The positive association between female CEO status and digital transformation is statistically significant in most specifications for the Central region and in all corresponding specifications for the Western region. In contrast, founder CEO status is positively associated with digital transformation at the 10% significance level in the Western baseline regression, but this coefficient is not statistically significant in any of the corresponding robustness specifications. These results indicate that the statistical evidence for these three CEO characteristics varies across the Eastern, Central, and Western regional subsamples.

KEY FINDINGS

The baseline and supplementary analyses yielded mixed results: some were consistent with the proposed hypotheses, while others diverged from them.

Based on the baseline model and relevant robustness tests, younger CEOs and female CEOs are significantly and positively associated with digital transformation in Chinese listed non-technology firms, supporting the H_1 and H_2 hypotheses. This is consistent with the premise of upper echelons theory, which states that executive characteristics are associated with the strategic choices of firms. However, contrary to expectations, founder CEO status was not significantly associated with digital transformation in this context. These findings suggest that different executive characteristics should not be treated as equivalent proxies for managerial cognition or strategic orientation.

Regional heterogeneity was assessed using robustness checks. The results indicate a marginally significant positive relationship between founder-CEO status and digital transformation in Western China; however, this effect is not consistently significant across all the corresponding robustness specifications.

DISCUSSION

First, firms led by younger CEOs exhibit higher levels of digital transformation, and the negative association between CEO age and digital transformation remains statistically significant across the baseline model and relevant robustness analyses. This result answers our first research question by showing that CEO age is negatively associated with digital transformation among Chinese listed non-technology firms. The finding is consistent with the premise of upper echelons theory, which states that executive characteristics influence the strategic choices of firms. Hambrick and Mason (1984) argue that observable executive traits reflect differences in experience, cognitive orientation, values, and information processing that subsequently manifest in organisational decisions. Age is particularly relevant because it accompanies changes in career horizon, accumulated professional experience, exposure to new technologies, reputation incentives, and attitudes toward uncertain investment.

Our findings are consistent with those of Zou et al. (2024), who document a negative association between CEO age and corporate digital transformation among Chinese listed firms, identifying reputation establishment and tolerance for failure as key underlying mechanisms. We complement this work by demonstrating that the age effect persists when the analysis is restricted specifically to listed non-technology firms.

The current result does not, however, imply that the relationship between CEO age and digital transformation must be strictly linear. Recent evidence from Weng et al. (2026) suggests that CEO age can exhibit a nonlinear relationship with digital transformation. Their findings suggest a nonlinear association: executives at intermediate career stages may combine accumulated experience with ongoing career incentives and sufficient willingness to pursue change.

The linear relationship identified in the present study does not necessarily contradict prior findings. The two studies differ in their samples and model specifications, including the functional form used to examine CEO age. Therefore, our finding should be interpreted as evidence that the negative relationship reported by Zou et al. (2024) also holds for Chinese listed non-technology firms, while recent nonlinear evidence suggests that the relationship between CEO age and digital transformation may warrant further examination using alternative functional forms.

Second, firms led by female CEOs exhibit higher levels of digital transformation, and this positive relationship holds across most supplementary analyses. This finding is particularly noteworthy given that previous research offers competing predictions about the risk-taking behaviour of female executives. Faccio et al. (2016) find that firms with female CEOs pursue less risky financial policies, including lower leverage and reduced earnings volatility. A straightforward extension of this evidence would suggest that female executives might avoid digital transformation, which entails uncertain investments and substantial implementation risks. Our results do not support a direct extrapolation from general financial risk aversion to strategic conservatism in the digital domain. Instead, they are consistent with studies such as Javed et al. (2023), who report a positive association between female CEOs and green innovation, and Mansour et al. (2024), who report similar findings among Asian firms.

One possible explanation lies in the distinction between the risks of taking action and those of inaction. Digital transformation involves implementation risk, as firms must commit resources to technologies and organisational changes whose outcomes are uncertain. However, delaying such transformation may also expose firms to technological obsolescence, declining operational efficiency, reduced customer relevance, and weakened competitive capability. Thus, greater risk sensitivity does not necessarily imply opposition to digital transformation. A second explanation concerns the selection process for top executive positions: women who become chief executives represent a highly selected subset of senior managers. Adams and Funk (2012) provide evidence that women who reach senior corporate roles do not necessarily exhibit the preferences commonly attributed to women in the general population. The present findings are consistent with this selection argument. Accordingly, the female CEO results complement rather than contradict the risk aversion literature. Research such as Faccio et al. (2016) shows that female leadership can be associated with more conservative financial risk choices; the current evidence indicates that this does not necessarily extend to avoidance of digital transformation.

Third, unlike the results for CEO age and female CEO status, there was no statistically significant evidence of a positive relationship between founder CEO status and digital transformation in the full sample. This finding contrasts with

emerging studies that report on the beneficial effects of founder leadership: He et al. (2025) show that founder control facilitates substantive digital transformation in Chinese family firms, while Li et al. (2026) associate founder CEOs with stronger digitalisation orientation through long-term thinking and risk tolerance.

Unlike age or gender, founder status captures not only executive experience and cognition but also organisational identification, ownership interests, decision authority, and governance position. Stewardship theory predicts that strong identification with the organisation can align founder motivation with long-term organisational interests and increase willingness to tolerate short-term uncertainty (Davis et al. 1997; Donaldson & Davis 1991). However, such commitment does not necessarily imply a preference for digital renewal. Drawing on March (1991), founder CEOs may pursue long-term survival either through exploration of new technological trajectories or through continued exploitation of established capabilities. Strong organisational attachment may therefore encourage strategic commitment while simultaneously reinforcing established routines and business practices. Agency theory also provides a complementary explanation: founder CEOs often combine managerial authority with ownership and substantial influence over strategic decisions. Such alignment can reduce conventional principal-agent conflicts and support long-horizon investment. At the same time, concentrated control can weaken external monitoring and increase the ability of powerful founders to preserve strategies with which they strongly identify. Founder status can therefore generate both stewardship benefits and governance constraints. The insignificant average effect may reflect the coexistence of these competing mechanisms rather than the absence of founder influence.

This finding thus highlights an important boundary condition: founder cognition, stewardship motivation, ownership alignment, and managerial power should not be assumed to operate in the same direction. Future research could aim to distinguish between these dimensions to determine when founder control facilitates digital transformation and when organisational attachment, governance structure, or implementation constraints offset its potential advantages.

IMPLICATIONS

ACADEMIC IMPLICATIONS

This study has several academic implications for theory and research. First, it extends upper echelons theory into non-technology firms where strategic outcomes are both technologically demanding and organisationally disruptive. Digital transformation involves changes in processes, structures, resource allocation, and business models (Vial 2019; Warner & Wäger 2019). The consistent relationships between CEO age, CEO gender, and digital transformation indicate that executive cognition and orientation remain relevant even when strategic change depends on complex organisational implementation. This extends upper echelons research from established outcomes such as innovation and risk-taking to the broader organisational reconfiguration represented by digital transformation.

Second, our study refines upper echelons theory by demonstrating that the empirical expression of CEO characteristics is context-dependent. While the full sample provides evidence of significant effects for age and gender, regional analysis reveals distinct geographic patterns: CEO age is most consistently related to digital transformation in Eastern China, whereas female CEOs have a stronger and more robust association with digital transformation in the Central and Western regions. These findings suggest that observable executive characteristics should not be interpreted as having effects that operate independently of their environment; rather, regional conditions may influence the extent to which managerial preferences are translated into strategic outcomes. Future research could build on this insight by examining executive attributes alongside institutional development, digital infrastructure, market maturity, and other contextual factors that shape managerial discretion and implementation capacity.

Third, our findings on CEO founders refine the relationship between upper echelons theory and stewardship theory. The positive but statistically insignificant coefficient for founder CEOs suggests that organisational identification and long-term alignment are not sufficient to drive greater digital transformation. Stewardship theory explains why founder CEOs may be motivated to protect future organisational value, while upper echelons theory accounts for how founding experience shapes interpretations of opportunity and risk. Our results indicate that these mechanisms should not be assumed to reinforce each other automatically. Founder attachment can foster commitment while simultaneously coexisting with entrenched routines or a preference for continuity. Consequently, founder status is better conceptualised as a combination of experience, cognition, motivation, and governance position rather than as a simple proxy for entrepreneurial orientation. Future research could disentangle these dimensions by examining founder ownership, control rights, organisational identification, succession stage, and direct measures of strategic preferences.

PRACTICAL AND MANAGERIAL IMPLICATIONS

Our findings offer practical implications and actionable guidance for boards, managers, and policymakers. For boards of directors, the negative relationship between CEO age and digital transformation suggests that younger CEOs are more inclined to pursue this strategic choice. However, leadership assessment for major digital programs should emphasise openness to emerging technologies, willingness to challenge existing routines, and capacity to process new information,

regardless of a CEO's age. While age may signal differences in strategic orientation, it should not become a mechanical selection criterion.

The positive association between female CEOs and digital transformation suggests that gender-based assumptions about risk tolerance should not inform leadership selection or the assignment of strategic responsibilities. Female leadership is compatible with, and across the full sample positively associated with, greater digital transformation. Boards and nomination committees can strengthen the pipeline for women in leadership by eliminating barriers that prevent qualified candidates from assuming roles with strategic authority. Firms can complement this diversity with access to resources for digital investment, cross-functional transformation teams, and clear implementation mandates.

The findings regarding founder CEOs call for a more discerning governance approach. Founder leadership should not be assumed to automatically enhance transformational capacity. In founder-led firms, boards should evaluate whether the founder's commitment is accompanied by a willingness to replace legacy processes, incorporate external expertise, and share authority with technology and operations specialists. Independent directors, digital strategy committees, and external advisers can provide constructive challenges and mitigate the risk that organisational attachment becomes resistance to renewal. Founder status should therefore be treated as a contextual leadership characteristic rather than a universal strategic advantage.

For policymakers, the regional findings suggest that a one-size-fits-all digital transformation policy may fail to account for how leadership and local conditions interact. Policy support should combine infrastructure investment with managerial capability development. In regions with weaker digital ecosystems, programs that expand access to technical expertise, training, and transformation financing can help firms translate strategic intent into implementation. Leadership development initiatives should also ensure equal participation by female executives and avoid reinforcing traditional assumptions about who is suited to lead high-uncertainty transformations.

CONCLUSION

This study examines how CEO age, gender, and founder status relate to digital transformation among Chinese listed non-technology firms. Results show that younger CEOs are consistently associated with greater digital transformation, and female CEOs have a positive relationship with transformation intensity. Regional analysis further reveals that the CEO age effect is most pronounced in Eastern China, whereas the female CEO effect is stronger in the Central and Western regions. In contrast, founder status receives only limited and context-specific support. These findings extend upper echelons theory by demonstrating that executive attributes matter for digital strategic change while their expression varies across regional environments in China.

Overall, our study sheds light on how CEO age, gender, and founder status influence firms' strategic decisions regarding digital transformation. Younger and female CEOs play valuable roles that extend existing research on the relationship between CEO characteristics and digital transformation. Furthermore, founder status emerges as a variable worthy of further investigation in the context of digital transformation.

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NOTES

[1] https://resourcehub.bakermckenzie.com/en/resources/cross-border-listings-guide/asia-pacific/shanghai-shenzhen-and-beijing-stock-exchanges/topics/overview-of-exchange

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APPENDICES

APPENDIX A

TABLE A1. The interpretation of Shenwan industry classification code

First-Level Industry Code	Industry Description in English	Industry Description in Chinese
110000	Agriculture, Forestry, Animal Husbandry and Fishery	农林牧渔
220000	Basic Chemicals	基础化工
230000	Steel	钢铁
240000	Nonferrous Metals	有色金属
270000	Electronics	电子
280000	Automobile	汽车
330000	Home Appliances	家用电器
340000	Food and Beverage	食品饮料
350000	Textile and Apparel	纺织服饰
360000	Light Manufacturing	轻工制造
370000	Pharmaceuticals and Biotechnology	医药生物
410000	Utilities	公用事业
420000	Transportation	交通运输
430000	Real Estate	房地产
450000	Commercial Trade and Retail	商贸零售
460000	Social Services	社会服务
480000	Banking	银行
490000	Non-bank Financial Services	非银金融
510000	Conglomerates	综合
610000	Construction Materials	建筑材料
620000	Construction and Engineering	建筑装饰
630000	Power Equipment	电力设备
640000	Machinery	机械设备
650000	Defense and Military Industry	国防军工
710000	Computer and IT	计算机
720000	Media	传媒
730000	Telecommunications	通信
740000	Coal	煤炭
750000	Oil and Petrochemicals	石油石化
760000	Environmental Protection	环保
770000	Beauty and Personal Care	美容护理

TABLE A2. The thesaurus of digital transformation and translation in Chinese

Dimensions of Digital Transformation	Key Words	Translation in Chinese
Cloud 云	Cloud computing, Computing Storage, Image computing, Cognitive computin, Memory computing, Cloud Service, Internet of things , Cyber-physical system, Cloud Platforms, IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service,), FaaS (Function as a Service), Thin Clients, Fat Clients, Intranet, Intercloud, Distributed File System, Cloud Computing Access Control, Private Cloud, Public Cloud, Hybrid Cloud, AWS, Ali Cloud, IBM Cloud, Tencent Cloud, Baidu Cloud, Huawei Cloud, China Mobile Cloud, China Unicom Cloud, China Telecom Cloud	云计算, 计算储存, 图像计算，认知计算，云服务，物联网，网络物理系统， 云平台，基础设施即服务，平台即服务，软件即服务，功能即服务，瘦客户端、胖客户端、内联网、云际网、分布式文件系统、云计算访问控制、私有云、公有云、混合云、亚马逊云服务、阿里云、IBM云、腾讯云、百度云、华为云、中国移动云、中国联通云、中国电信云
Big Data 大数据	Big Data, Data Science, Data Integration, Data Mining, Data Lake, Edge Computing, Data Visualization, Digital Twin, Data Information, Data Warehouse, Data Management, Data Asset	大数据、数据科学、数据集成、数据挖掘、数据湖、边缘计算、数据可视化、数字孪生、数据信息、数据仓库、数据管理、数据资产
Block Chain 区块链	Block Chain, Consensus Mechanism (e.g., PoW, PoS, DPoS), Digital Currency, DeFi, Cryptocurrency, NFT, Distributed Computing, Privacy Technology, Smart Contract	区块链，共识机制（如工作量证明PoW、权益证明PoS、委托权益证明DPoS），数字货币，去中心化金融DeFi，加密货币，非同质化代币NFT，分布式计算，隐私技术，智能合约
Artificial Intelligence 人工智能	Artificial Intelligence, Biometric, Deep learning, Machine Learning, Natural Language Processing, Image Recognition, Speech Recognition, Artificial Intelligence, Large Language Model (LLM), Artificial General Intelligence (AGI), Virtual Reality, Augmented Reality, Neural Networks, ANNs (Artificial Neural Networks), Online Chatbots, AI-Agent, Computer Vision, Robotic Process Automation (RPA)	人工智能、生物识别、深度学习、机器学习、自然语言处理、图像识别、语音识别、人工智能、大语言模型（LLM）、通用人工智能（AGI）、虚拟现实、增强现实、神经网络、人工神经网络（ANNs）、在线聊天机器人、AI代理、计算机视觉、机器人流程自动化（RPA）
Application of Digital Technology 数字技术应用	Digital technology, Digitization, Digital marketing, Digital operations, Digital economy, Digital trade, Digital system, Digital supply chain, Digital finance, Fin-tech, Internet finance, Information technology, Information integration, Information communication, E-commerce, Mobile payment, Third party payment, Electronic technique, Electronic technology, Cross border E-commerce, E-commerce platform, Online and offline, O2O, B2B, C2C, P2P, C2B, B2C	数字技术、数字化、数字营销、数字运营、数字经济、数字贸易、数字系统、数字供应链、数字金融、金融科技、互联网金融、信息技术、信息整合、信息通信、电子商务、移动支付、第三方支付、电子技术、跨境电子商务、电商平台、线上线下、组织对组织、企业对企业、顾客对顾客、公对公、顾客对企业、企业对客户

APPENDIX B

TABLE B1. Variance inflation factor analysis

Variable	VIF	1/VIF
CEO Age	1.13	0.887508
CEO Gender	1.01	0.986533
CEO Founder	1.63	0.615907
CEO Tenure	1.17	0.851938
CEO Duality	1.37	0.727424
Board Size	1.06	0.945051
Firm Size	1.05	0.953682
Firm Age	1.13	0.936904
CEO Compensation	1.03	0.974973
CEO Shareholding	1.38	0.722441
Mean VTF	1.19	

APPENDIX C

TABLE C1. Robustness test of heterogeneity test-eastern region

Variables	(1) Regression without Province FE	(2) Continuous DT	(3) Lagged Variables	(4) Excluding COVID-19
CEO Age	-0.0073***	-0.0443***		-0.0075***
	(0.0025)	(0.0109)		(0.0025)
CEO Gender	0.0920	0.7285		0.0743
	(0.0635)	(0.4563)		(0.0627)
CEO Founder	0.0509	0.3711		0.0281
	(0.0529)	(0.3409)		(0.0526)
Lagged CEO Age			-0.0092***	
			(0.0025)	
Lagged CEO Gender			0.1094*	
			(0.0643)	
Lagged CEO Founder			0.0423	
			(0.0534)	
CEO Tenure	0.0140***	0.0460**		0.0148***
	(0.0043)	(0.0197)		(0.0043)
CEO Duality	0.0653*	0.1570		0.0779**
	(0.0396)	(0.2267)		(0.0393)
Board Size	0.0035	0.0248		0.0032
	(0.0097)	(0.0531)		(0.0098)
Firm Size	0.0248**	-0.0255		0.0212*
	(0.0116)	(0.0460)		(0.0116)
Firm Age	0.0056	0.1170		-0.0343
	(0.0628)	(0.3330)		(0.0629)
CEO Compensation	0.0061	0.0068		0.0037
	(0.0054)	(0.0138)		(0.0054)
CEO Shareholding	0.0044*	0.0211		0.0043*
	(0.0024)	(0.0132)		(0.0024)
Lagged CEO Tenure			0.0162***	
			(0.0044)	
Lagged CEO Duality			0.0579	
			(0.0396)	
Lagged Board Size			0.0079	
			(0.0099)	
Lagged Firm Size			0.0230*	
			(0.0119)	
Lagged Firm Age			-0.0344	
			(0.0707)	
Lagged CEO Compensation			0.0014	
			(0.0056)	
Lagged CEO Shareholding			0.0054**	
			(0.0024)	
Constant	1.5744***	3.2146**	1.8559***	1.8247***
	(0.3430)	(0.3101)	(0.3631)	(0.3404)
Observations	12088	12088	10643	9438
Firm Clusters	1401	1401	1396	1401
Within R-squared	0.015	0.017	0.017	0.014

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TABLE C2 .Robustness test of heterogeneity test-central region

Variables	(1) Regression without Province FE	(2) Continuous DT	(3) Lagged Variables	(4) Excluding COVID-19
CEO Age	-0.0069	-0.0499		-0.0089*
	(0.0049)	(0.0422)		(0.0049)
CEO Gender	0.4010**	0.8646		0.4521***
	(0.1565)	(0.5532)		(0.1406)
CEO Founder	0.0323	-0.1300		0.0493
	(0.1437)	(0.5765)		(0.1399)
Lagged CEO Age			-0.0085*	
			(0.0050)	
Lagged CEO Gender			0.4020**	
			(0.1571)	
Lagged CEO Founder			0.0232	
			(0.1440)	
CEO Tenure	0.0082	-0.0344		0.0087
	(0.0099)	(0.0265)		(0.0096)
CEO Duality	0.2213**	1.7276		0.1662*
	(0.0929)	(1.2122)		(0.0924)
Board Size	0.0239	0.0431		0.0240
	(0.0185)	(0.0370)		(0.0185)
Firm Size	0.0704***	0.1019		0.0801***
	(0.0249)	(0.0804)		(0.0255)
Firm Age	-0.1607	-0.7193		-0.1719
	(0.1627)	(0.5412)		(0.1624)
CEO Compensation	0.0125	0.0266		0.0080
	(0.0116)	(0.0322)		(0.0111)
CEO Shareholding	0.0036	0.0650		0.0031
	(0.0050)	(0.0502)		(0.0052)
Lagged CEO Tenure			0.0055	
			(0.0103)	
Lagged CEO Duality			0.1950**	
			(0.0962)	
Lagged Board Size			0.0302	
			(0.0189)	
Lagged Firm Size			0.0734***	
			(0.0267)	
Lagged Firm Age			-0.1494	
			(0.1979)	
Lagged CEO Compensation			0.0149	
			(0.0117)	
Lagged CEO Shareholding			0.0048	
			(0.0050)	
Constant	0.6252	2.2572	0.5445	0.5935
	(0.7950)	(3.2962)	(0.8859)	(0.7951)
Observations	2389	2389	2102	1879
Firm Clusters	271	271	266	270
Within R-squared	0.043	0.050	0.044	0.043

Standard errors in parentheses
* *p < 0.10,* ** *p < 0.05,* *** *p < 0.01*

TABLE C3. Robustness test of heterogeneity test-western region

Variables	(1) Regression without Province FE	(2) Continuous DT	(3) Lagged Variables	(4) Excluding COVID-19
CEO Age	-0.0057	-0.0154		-0.0050
	(0.0049)	(0.0094)		(0.0047)
CEO Gender	0.2232*	0.3702*		0.2829**
	(0.1159)	(0.2127)		(0.1180)
CEO Founder	0.2583**	0.0292		0.1941
	(0.1295)	(0.2399)		(0.1340)
Lagged CEO Age			-0.0080	
			(0.0049)	
Lagged CEO Gender			0.2475**	
			(0.1203)	
Lagged CEO Founder			0.2491**	
			(0.1228)	
CEO Tenure	0.0060	0.0215		0.0063
	(0.0081)	(0.0144)		(0.0078)
CEO Duality	0.0527	0.1790		0.0842
	(0.0837)	(0.1687)		(0.0855)
Board Size	0.0073	-0.0260		0.0137
	(0.0191)	(0.0396)		(0.0187)
Firm Size	0.0657***	0.0791**		0.0716***
	(0.0208)	(0.0388)		(0.0208)
Firm Age	0.1386	0.2417		0.0170
	(0.1274)	(0.2247)		(0.1249)
CEO Compensation	-0.0041	-0.0082		-0.0106
	(0.0096)	(0.0164)		(0.0094)
CEO Shareholding	0.0035	0.0100		0.0014
	(0.0048)	(0.0094)		(0.0049)
Lagged CEO Tenure			0.0105	
			(0.0078)	
Lagged CEO Duality			0.0665	
			(0.0835)	
Lagged Board Size			0.0010	
			(0.0184)	
Lagged Firm Size			0.0824***	
			(0.0216)	
Lagged Firm Age			0.1275	
			(0.1428)	
Lagged CEO Compensation			-0.0117	
			(0.0088)	
Lagged CEO Shareholding			0.0017	
			(0.0048)	
Constant	0.1496	-0.7187	0.0795	0.3918
	(0.6945)	(1.3099)	(0.7190)	(0.6863)
Observations	3045	3045	2664	2412
Firm Clusters	347	347	343	347
Within R-squared	0.032	0.021	0.041	0.033

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$