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Mechanism Analysis and Path Study of Digital Transformation on Corporate Governance: Evidence from Chinese Listed Companies

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Abstract: Corporate digital transformation, primarily driven by data and leveraging digital technologies and mathematical algorithms such as Internet+, big data, cloud computing, artificial intelligence, and blockchain, is a crucial enabler of sustainable development. This transformation integrates various aspects of corporate production and operations, enhancing the level of digital operations and ultimately contributing to high-quality and sustainable development. This paper, based on data from listed companies in China's A-shares from 2007 to 2021, theoretically articulates the intrinsic mechanism between corporate digital transformation and corporate governance level, with a focus on sustainability. It empirically finds that a higher degree of digital transformation correlates with an improved level of corporate governance, fostering sustainable practices. Further investigation reveals that digital transformation elevates corporate governance by enhancing innovation capabilities, reducing information asymmetry, and promoting sustainable strategies. This paper provides policy insights for promoting corporate digital transformation as a means to achieve sustainability goals and optimizing management's corporate governance level for long-term sustainable success.

Keywords: digital transformation; corporate governance; innovation capability; information asymmetry; sustainability

1. Introduction

With the accelerated innovation of technologies such as Internet+, big data, cloud computing, artificial intelligence, and blockchain permeating various domains of economic and social development (Akter et al., 2022) [1], major countries and regions around the world are hastening their digital strategic layouts. In December 2021, the Central Cyberspace Affairs Commission of China issued the "14th Five-Year National Informatization Plan", which assigned the significant task of "building an industrial digital transformation development system". This plan clarified the direction, main tasks, and key projects of digital transformation, providing a robust guideline for China's digital transformation over the next five years (Vial, 2021) [2].

President Xi Jinping, during the 34th collective study session of the Political Bureau of the CPC Central Committee, emphasized the need to promote the integrated development of the digital economy with the real economy (Ren et al., 2022) [3]. He highlighted the direction towards digitalization, networking, and intelligence, urging the digitalization of industries such as manufacturing, service, and agriculture. The "14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Long-term Goals for 2035" (Favoretto et al., 2022) [4] dedicated a section to "Accelerating Digital Development, Building Digital China". It proposed "to drive the transformation of production, lifestyle, and governance through digital transformation", setting a clear direction for digital transformation in the new era. It is imperative to deeply study and implement Xi Jinping's thought on socialism with Chinese characteristics for a

new era, especially the important thoughts on building a strong cyber nation. Standing on the new developmental stage, we must completely, accurately, and comprehensively implement the new development concepts, construct a new development pattern, promote high-quality development, grasp the trends and rules of digital economy development, and fully understand the significance and profound impact of digital transformation (ElMassah and Mohieldin, 2020) [5].

Enterprises are the most fundamental units of a nation's economy. Therefore, the core of "digital economy" infrastructure construction lies in "digital enterprises". Developing digital enterprises is the most crucial step in building the foundational support for China's digital economy (Pan et al., 2022) [6]. Traditional enterprises can only form the core of China's economic development through digital transformation. Without the rapid digitalization of the majority of Chinese enterprises, continuing to utilize traditional, inefficient operational, management, market, and sales methods, even with advanced digital technologies, such enterprises will still lack the capability for sustainable development. The victory of China's digital economy hinges on the digital transformation of most domestic enterprises (George and Schillebeeckx, 2022) [7]. Accelerating and efficiently carrying out the digital transformation of Chinese enterprises to form an industrial cluster of digital enterprises in China is an essential guarantee for building core competitiveness with the digital economy in the future.

Corporate governance refers to the relationships among various stakeholders, principally including shareholders, the board of directors, and the management team (Adams et al., 2010) [8]. These stakeholder relationships determine the company's development direction and performance level. The fundamental issue in discussions of corporate governance is how to ensure that managers, while deploying assets provided by capital providers to their best use, also fulfill their responsibilities towards capital providers (Keenan and Aggestam, 2001) [9]. By utilizing the structure and mechanisms of corporate governance, it clarifies the rights, responsibilities, and influence of different corporate stakeholders and establishes incentive-compatible arrangements between principals and agents. This is essential for enhancing corporate strategic decision-making capabilities and managing to create value for investors. Corporate governance, much like corporate strategy, represents two crucial aspects commonly overlooked by Chinese business managers (Young et al., 2008) [10].

Studying the relationship between digital transformation and corporate governance is crucial in contemporary enterprise management. This is because digital transformation demands innovations not just in technology but also in organizational structure, management, and culture, which directly impact core corporate governance areas like shareholders' rights, board functions, and executive incentives. An in-depth study revealed how digital transformation reshapes governance requirements and how governance can either support or hinder transformation. The benefits include enabling enterprises to build a more digital-era-adapted governance system, ensuring effective strategy implementation, and providing valuable insights for policymakers and regulators. Furthermore, it fosters collaboration between academia and industry, driving innovation in corporate governance theory and practice.

Based on the data of China's A-share listed companies from 2007 to 2021, this paper theoretically elaborates the intrinsic mechanism between the digital transformation of enterprises and the level of corporate governance, focusing on sustainable development. The empirical study finds that the higher the degree of digital transformation, the higher the level of corporate governance, which in turn promotes sustainable development practices. Further investigations show that digital transformation enhances corporate governance levels by increasing innovation capabilities, reducing information asymmetry, and promoting sustainable strategies. Compared with previous studies, the marginal contributions of this paper are primarily reflected in three aspects: First, it extends research on the consequences of digital transformation from the perspective of corporate governance, finding that digital transformation enhances corporate governance levels by improving firms' innovation capabilities and reducing the level of information asymmetry, thus providing

new empirical evidence to support the advancement of digital transformation. Second, it enriches the research on corporate governance levels from the perspective of digital transformation. Third, the conclusions of this study offer valuable theoretical support and decision-making references for enhancing the level of corporate governance decisions. Our study highlights the value of corporate digital transformation as a means to achieve the Sustainable Development Goals (SDGs) and optimize corporate governance for lasting success. This contribution fills a gap in the existing literature and provides actionable guidance for policymakers and practitioners to capitalize on the synergies between digital transformation and corporate governance for sustainable development.

2. Literature Review

2.1. The Literature on Digital Transformation

Nations have strategically positioned their digital economies through top-level designs to strengthen, enlarge, and optimize our digital economy. Reflecting on the past three years of the pandemic, an increasing number of companies have begun exploring modes of digital transformation. Current literature has examined digital transformation from various aspects. Li (2022) explores the relationship between digital transformation and sustainable performance and focuses on the moderating role of market turbulence in this relationship [11]. Hanelt et al. (2021) found that digital transformation not only changes the operation mode of a firm but also profoundly affects its strategic decisions and organizational structure [12]. Liu et al. (2023) investigated the impact of corporate digital transformation on stock ownership breadth and stock price volatility [13]. Zheng and Zhang (2023) found that digital transformation can promote the fulfillment of corporate social responsibility and the innovation of green technology, thus promoting the sustainable development of enterprises [14]. Ren and Li (2022) found that digital transformation and green technology innovation can significantly enhance the financial performance of enterprises [15]. These studies provide a solid reference and theoretical foundation for researching digital transformation. In the digitalization process, enterprises' production becomes more intelligent, management more standardized and automated, and services more refined and precise, better realizing high-quality development for businesses.

2.2. The Literature on Corporate Governance

The modern corporate system was first introduced in the Netherlands in the 17th century, gradually bringing the theoretical issue of corporate governance into public attention. Within the framework of neoclassical economics, corporate governance is defined as institutional arrangements for ensuring shareholders smoothly realize investment returns and control over the company (Shleifer and Vishny, 1997) [16]. The ultimate goal of corporate governance is to maximize the interests of shareholders (Hermalin and Weisbach, 2017; Vives, 2000) [17,18]. The theory of principal-agent cost is a critical research topic and theoretical foundation of corporate governance. It guides scholars, both domestic and international, to maintain shareholders' legal rights by reducing the problem of information asymmetry (Becht et al., 2003) [19]. Unlike the classical vertical agency problems in Western countries, the dominant agency problem in China is the horizontal agency conflict between controlling and minority shareholders arising from concentrated ownership structure (Jiang and Kim, 2020) [20].

Chinese policymakers began to build a modern legal protection framework in the mid-1980s. Since then, the Chinese government has enacted a series of laws and regulations to strengthen investor protection and improve corporate governance. The 1985 Accounting Law, which aimed to ensure the quality of accounting information, was the beginning of China's efforts to build a complete legal system. In 1986, China first introduced the concept of restructuring and bankruptcy of state-owned enterprises (SOEs) and enacted the Enterprise Bankruptcy Law, which proposed a new way of improving the quality of enterprises through the elimination of inefficient enterprises. It proposed a new way to improve the quality of enterprises by eliminating inefficient ones. The introduction of

corporate and securities laws is widely recognized as one of the most important elements of the legal reform process (MacNeil, 2002) [21]. In addition to the laws, securities regulation and enforcement by the CSRC have been improving. A well-known CSRC regulation requires companies to demonstrate profitability before they are allowed to issue new shares to existing shareholders. The regulation was designed to direct capital flows to more efficient sectors of the economy. Chen and Yuan (2004) find that during 1996–1998 (a more stringent period), many firms managed earnings through the use of excessive non-operating income in order to achieve a ROE target of 10 percent per year [22]. The CSRC has made continuous efforts to improve the operations and capabilities of financial intermediaries and other institutions.

2.3. The Impact of Digital Transformation on Corporate Governance

Preliminary discussions have been made on the relationship between enterprise digital transformation and corporate governance (Williamson, 1988) [23]. Believe that digitalization at the operational level can effectively enhance operational efficiency and reduce the degree of information asymmetry, thereby lowering the level of real earnings (Chen and Jiang, 2024) [24]. With well-developed financial technology and digital finance, the impact of enterprise digital transformation on improving stock liquidity becomes more evident. Zhou and Li (2023), oriented by the demand for corporate governance concept innovation and corporate governance model innovation driven by the digital economy, combined with the logic and path of corporate governance boundary breakthrough in the digital economy era, have extracted and summarized the research paradigms and frameworks under the new economy [25]. Mithas et al. (2011) found that enterprise digital transformation could enhance the quality of performance forecasts by improving management's data application capabilities, enhancing disclosure motivation, and increasing disclosure pressure [26]. However, some studies have proposed opposing viewpoints. Bedard and Johnstone (2004) suggest that the internet business model not only provides internal personnel with greater space for earnings management, significantly reducing the earnings quality of listed companies, but also increases the complexity of corporate organizational structures and business processes, raising the difficulty and cost of supervision by external stakeholders (Bedard and Johnstone, 2004) [27]. Within the framework of agency theory, digital technology empowers shifts in corporate governance models, enabling process-based behavioral monitoring and constraining governance mechanisms, thereby reducing reliance on outcome-based incentive mechanisms (Li et al., 2024) [28]. And a U-shaped relationship between positive performance feedback and enterprise digital transformation (Li et al., 2024) [29].

Previous research has shown that enterprise digital transformation can enhance operational efficiency, reduce information asymmetry, and improve stock liquidity, while also having the potential to enhance the quality of performance forecasts. However, these studies have also revealed some limitations, such as the lack of a comprehensive framework for measuring the interplay between digital transformation and governance and the under-exploration of the mechanisms underlying this relationship, especially in the context of sustainable development. Our study highlights the value of corporate digital transformation as a means to achieve the SDGs and optimize corporate governance for lasting success. This contribution fills a gap in the existing literature and provides actionable guidance for policymakers and practitioners to capitalize on the synergies between digital transformation and corporate governance for sustainable development.

3. Theoretical Analysis and Research Hypotheses

Corporate governance, broadly understood, is the science of studying the arrangement of corporate power. In a narrower sense, it focuses on the level of corporate ownership, exploring the science of how to delegate authority to professional managers and supervise their duty-related behaviors (Anderson et al., 2007) [30].

From an economic standpoint, a corporation possesses two rights: ownership and operational rights, which are distinct. Corporate management, built upon the "operational rights level", revolves around the delegation of authority from owners to operators (Nenova, 2003) [31]. In this scenario, operators, once authorized, employ all means to achieve operational objectives. Conversely, corporate governance, established on the "ownership level", emphasizes scientifically delegating to and supervising professional managers. It encompasses rules, relationships, institutions, and procedures, all exercised and controlled within this framework by trust authorities in the company (Langfield-Smith and Smith, 2003) [32]. Proper rules include applicable local laws and the company's internal regulations.

According to the definition by the Development Research Center of the State Council, digital transformation refers to the utilization of new generation information technologies, including Internet+, big data, cloud computing, artificial intelligence, and blockchain (Dąbrowska et al., 2022) [33]. This process constructs a closed loop for data collection, transmission, storage, processing, and feedback, breaking down data barriers between different levels and industries to enhance the overall operational efficiency of the industry, thus building a new digital economy system (Kristoffersen et al., 2020) [34].

Firstly, digital transformation can enhance a company's innovation capability (Shen et al., 2022) [35]. With the advent of the digital age, innovation becomes a critical breakthrough for industries to achieve digital transformation. The rapid development of digital technologies, represented by Internet+, big data, cloud computing, artificial intelligence, and blockchain, further boosts companies' innovation capabilities. In this process, digitalization is both the source of the innovation wave and a strong guarantee for the realization of innovation upgrades and reforms (Xu and Xu, 2023) [36].

In the digital era, the interconnection of a vast number of devices generates massive data, which not only helps companies achieve specific commercial value and promote business model transformation but also enhances user experiences and employees' innovation capabilities (Kindström et al., 2013) [37]. All these necessitate the infusion of new technological innovation DNA into companies. Compared to traditional businesses centered on products and business processes, companies with innovative DNA base their operations on personalized customer needs and complete digitalization of all business processes, constructing an all-digital system through cloud computing, mobile internet, the Internet of Things, and artificial intelligence. Therefore, digital transformation can foster companies' innovation capabilities. By enhancing technological innovation efficiency, it optimizes resource allocation and improves decision-making efficiency in companies, thereby promoting higher levels of corporate governance (Scherer and Voegtlin, 2020) [38].

Secondly, digital transformation can effectively reduce the level of information asymmetry (Zhao et al., 2023) [39]. Information asymmetry occurs in specific economic relationships where participants have unequal knowledge or probability distribution about relevant events, meaning the information held is not equal. Information asymmetry is prevalent in market operations, and when the party at an informational disadvantage rationally recognizes its disadvantage but struggles to allocate risks through contracts, transaction costs increase, leading to losses in transaction efficiency (Williamson, 2010) [40].

The digital era introduces several significant changes: the expression, transmission, and acquisition of information all undergo qualitative transformations. Information expression shifts from analog and visual forms to predominantly digital forms (Belk, 2013) [41], enabling instant and costless transmission (Schiller, 2014) [42]. Acquiring information, previously requiring time, money, and energy, can now be conveniently accessed through vast internet resources, fast computing methods, and free application services (Overby, 2008; Sultan, 2010) [43,44].

Digital transformation has a profound impact on the intrinsic mechanics of corporate governance. It enhances information transparency and decision-making efficiency, enabling enterprises to make more accurate forecasts and simulations based on data and optimize the decision-making process. It also reshapes organizational structure, promotes cross-departmental collaboration, and strengthens supervision and incentive mechanisms.

Ultimately, digital transformation promotes the innovation of corporate governance concepts and changes in governance models, enabling enterprises to better adapt to the digital economy and achieve sustainable development.

Based on the above analysis, this paper posits that the digital era brings significant transformations in information asymmetry, fundamentally altering the traditional paradigm. Traditionally, information-advantaged parties can no longer maintain their advantage in the digital era, and significant disparities in market resource allocation caused by vast differences in information power will no longer exist (Sambhara et al., 2017) [45]. These changes lead to significant shifts in industry boundaries and business models.

Therefore, corporate digital transformation can lower the level of information asymmetry, increase transparency, and reduce disclosure costs, ultimately improving the level of corporate governance. This theoretical analysis supports the following hypotheses:

Hypothesis 1. *Corporate digital transformation can enhance the level of corporate governance.*

Hypothesis 2. *Digital transformation can improve the firm's innovation capability and thus corporate governance.*

Hypothesis 3. *Digital transformation can reduce the degree of information asymmetry, which in turn improves the level of corporate governance.*

4. Research Design

4.1. Sample Selection and Data Source

This study selects companies listed on the Shanghai and Shenzhen A-share markets from 2007 to 2021 as research samples to explore the impact of digital transformation on corporate governance. All initial data were sourced from the WIND and CSMAR databases and underwent the following processing: (1) Exclusion of financial and insurance industry samples with unstable financial fluctuations; (2) Exclusion of samples marked as ST, *ST, or PT; (3) Exclusion of samples with missing data; (4) Winsorizing continuous variables at the 1% level at both tails, resulting in a final dataset of 31,222 observations.

4.2. Definition of Main Variables

(1) Dependent Variable: Corporate Governance Level (CGL)

Drawing on the methods of Larcker et al. (2007) [46], this study utilizes principal component analysis to construct a comprehensive index measuring corporate governance level from aspects of supervision, incentive, and decision-making. It includes executive compensation (Mana_Pay) and executive shareholding (Mana_Share) to represent the incentive mechanism in corporate governance, the proportion of independent directors (Outratio) and the size of the board (Board) to represent the supervisory role of the board, the proportion of institutional shareholding (Inst_Share) and the balance of equity (Share_Balance) (the sum of shares held by the second to fifth largest shareholders/shares held by the controlling shareholder) to represent the supervisory role of the equity structure, and whether the chairman and general manager roles are combined (Dual) to represent the decision-making power of the general manager. Based on these seven indicators, the corporate governance level index is constructed using principal component analysis (PCA). The first principal component from this analysis is used as a composite indicator reflecting the level of corporate governance, with higher scores indicating better governance.

The PCA method extracts the main information in the data through dimensionality reduction techniques when constructing corporate governance indices and assigns reasonable weights accordingly. The method first collects data from several indicators related to corporate governance and preprocesses them to ensure data completeness and accuracy. Then, PCA is utilized to downscale the data to extract a number of principal components, and the first few principal components with a cumulative contribution rate greater than or equal to 80% are usually selected as representatives. Next, the coefficients of each indicator

in the linear combination of each principal component are calculated, and the variance contribution ratio of the principal components is used to determine the weights of each principal component in constructing the corporate governance index. Finally, the final weight of each index, which is the weighted average of the coefficients of each index in the linear combination of each principal component, is calculated and normalized. Through this objective and reasonable method, PCA is able to determine the weights of the indicators in the corporate governance index, improve the accuracy and reliability of the index, and at the same time reduce the data dimensions, simplify the analysis process, and improve the computational efficiency.

(2)　Independent Variable: Digital Transformation Index (DT)

This variable is formed by analyzing the frequency of keywords related to "digital transformation" in the annual reports of all A-share listed companies on the Shanghai and Shenzhen stock exchanges. The underlying technologies include the four typical technologies of digital transformation, known as "ABCD" technologies (artificial intelligence (AI), blockchain (BC), cloud computing (CC), and Big Data (BD)), along with digital technology applications (DAs). Keywords reflecting the application of these technologies in practice were compiled to define the categories of underlying technology and digital technology application. Five dimensions were used to construct the degree of corporate digital transformation (see Table 1). Due to the typically "right-skewed" nature of this data, logarithmic transformation was applied to derive an overall indicator representing corporate digital transformation.

Table 1. Enterprise digital transformation index construction.

Underlying technology	Artificial intelligence (AI) technology	Machine learning, artificial intelligence, face recognition, business intelligence, identity verification, deep learning, biometrics, image understanding, semantic search, speech recognition, intelligent robots, intelligent data analytics, autonomous driving, natural language processing
	Big Data technology	Big Data, mixed reality, data visualization, data mining, text mining, virtual reality, heterogeneous data, augmented reality
	Cloud computing technology	EB-level storage, multi-party secure computing, brain-like computing, streaming computing, green computing, in-memory computing, cognitive computing, converged architectures, graph computing, Internet of Things, information–physical systems, billion-level concurrency, cloud computing
	Blockchain technology	Bitcoin, distributed computing, consensus mechanisms, federation chains, decentralization, digital currencies, smart contracts
Digital technology applications	Digital technology applications	NFC payment, third-party payment, e-commerce, industrial internet, internet finance, internet healthcare, fintech, open banking, quantitative finance, digital finance, digital marketing, Netflix, unmanned retailing, mobile internet, mobile internet, mobile payment, smart agriculture, smart wearable, smart grid, smart environmental protection, smart home, smart transport, smart customer service, smart energy, smart investment, intelligent culture and tourism, intelligent medical, intelligent marketing

(3)   Control Variables:

The model includes the following control variables: company size (SIZE, the natural logarithm of total assets at year-end), financial leverage (LEV, total liabilities at year-end/total assets at year-end), return on assets (ROA, pre-tax profit/average total assets), growth ability (GROWTH, (current main business income—previous main business income)/previous main business income), total asset turnover (TUNR, business income/total assets at year-end), proportion of independent directors (INDEP, proportion of independent directors in the listed company's board), size of the board (BOARD, logarithm of the number of board members plus one), proportion of shares held by the largest shareholder (TOP1, proportion of shares held by the largest shareholder to total shares), and whether audited by international "Big Four" accounting firms (BIG4, a dummy variable where 1 indicates audit by the "Big Four" and 0 otherwise).

(4)   Mediating Variables:

Innovation Capability (PANTENT): The sum of patent applications plus one, then log-transformed. Common indicators for measuring corporate innovation include R&D investment, new product value, and patent output. Due to the self-reported nature of R&D investment and new product value data, which may be less accurate, patent data collected and publicly released by the National Intellectual Property Administration is considered more authoritative, complete, and consistent. Invention patents, as opposed to utility model and design patents, better reflect a company's core technological capabilities and breakthrough innovation ability. Therefore, this study uses the natural log of the sum of patent applications plus one.

Degree of Information Asymmetry (ABSDA): Following Hutton et al. (2009) [47], this study uses the absolute value of residuals calculated by the modified Jones model, with larger values indicating higher levels of information asymmetry.

Table 2 gives a list of variable definitions.

Table 2. Definition of variables.

Stats	Definition
CGL	Principal component analysis reflects the level of corporate governance during the year
DT	Logarithmic processing of keyword frequency in annual reports of listed companies
SIZE	The natural logarithm of annual total assets
LEV	Total liabilities at year-end divided by total assets at year-end
ROA	Net profit divided by the average balance of total assets
GROWTH	Income from main operations for the current period and income from main operations for the previous period
TUNR	Operating income/total assets closing balance
INDEP	Proportion of independent directors on the board of directors of listed companies
BOARD	Number of members of the Board of Directors plus one to take the logarithm
TOP1	Percentage of total shares held by the largest shareholder
BIG4	One if audited by an international "Big 4" accounting firm, 0 otherwise.
PANTENT	The sum of the number of patents filed plus one is taken as a natural logarithm.
ABSDA	The ratio of net receivables to total assetAbsolute value of residuals calculated by the modified Jones model

4.3. Model Setting

Based on the variable design described above, the following regression model is constructed to examine the impact of digital transformation on the level of corporate governance.

$$CGL_{it} = \beta_0 + \beta_1 DT_{it} + \sum \beta_k Controls_{it} + \sum Industry + \sum Year + \varepsilon_{it}$$

where subscript *i* denotes the firm, *t* denotes the year, β_i is the regression coefficient of the corresponding variable, $\sum Industry$ denotes the industry dummy, $\sum Year$ denotes the year dummy, and ε_{it} is the residual term.

5. Empirical Test and Results Analysis

5.1. Descriptive Statistics

Table 3 presents the descriptive statistics for the sample variables. For the entire sample, the maximum and minimum values of corporate governance level are 2.319 and −2.093, respectively, indicating significant differences in corporate governance levels among companies. The mean and median values of the digital transformation degree are 1.197 and 0.693, respectively. This suggests a considerable variance in the pace of digital transformation among listed companies, with some enterprises having embarked on digital transformation while others have not adopted such strategies. Most enterprises are at an early stage of digital transformation. Other variables, such as company size (SIZE), with a mean of 22.193 and a standard deviation of 1.279, align with the general scale distribution of listed companies. The mean leverage ratio (LEV) of 0.435 and a standard deviation of 0.203 indicate high financial leverage. The return on assets (ROA) has a mean of 0.059 and a standard deviation of 0.064, highlighting significant differences among companies. The growth capability (GROWTH) has a mean of 0.180 and a standard deviation of 0.392, indicating rapid annual growth. The degree of information asymmetry (ABSDA) has a mean of 0.054 and a standard deviation of 0.051, showing a considerable dispersion. The mean value for innovation capability (PANTENT) is 2.449 with a standard deviation of 1.761, indicating a wide gap in the number of patent applications among listed companies. Resulting in a final dataset of 31,222 observations.

Table 3. Descriptive statistics.

	N	Min	Sd	Min	P50	Max
CGL	31,222	−0.088	0.980	−2.093	−0.237	2.319
DT	31,222	1.197	1.350	0.000	0.693	4.920
SIZE	31,222	22.193	1.279	19.931	22.006	26.166
LEV	31,222	0.435	0.203	0.057	0.431	0.887
ROA	31,222	0.059	0.064	−0.175	0.055	0.258
GROWTH	31,222	0.180	0.392	−0.530	0.118	2.402
TUNR	31,222	0.631	0.433	0.078	0.532	2.577
INDEP	31,222	0.374	0.053	0.308	0.333	0.571
BOARD	31,222	2.250	0.178	1.792	2.303	2.773
TOP1	31,222	34.463	14.885	8.567	32.234	74.180
BIG4	31,222	0.059	0.236	0.000	0.000	1.000
ABSDA	31,222	0.054	0.051	0.001	0.039	0.259
PANTENT	31,222	2.449	1.761	0.000	2.565	6.719

5.2. Correlation Analysis

Table 4 lists the Pearson correlation coefficients among variables, where the correlation coefficient between corporate governance level (CGL) and digital transformation index (DT) is 0.147, significant at the 1% level, preliminarily supporting the study's hypothesis.

Table 4. Pearson's correlation.

	CGL	DT	SIZE	LEV	ROA	GROWTH	TUNR	INDEP	BOARD	TOP1	BIG4	ABSDA	PANTENT
CGL	1.000												
DT	0.147 ***	1.000											
SIZE	−0.449 ***	0.064 ***	1.000										
LEV	−0.309 ***	−0.108 ***	0.478 ***	1.000									
ROA	−0.045 ***	−0.025 ***	0.049 ***	−0.263 ***	1.000								
GROWTH	0.027 ***	0.019 ***	0.048 ***	0.038 ***	0.288 ***	1.000							
TUNR	−0.104 ***	0.009 *	0.031 ***	0.158 ***	0.148 ***	0.080 ***	1.000						
INDEP	0.490 ***	0.090 ***	0.009	−0.025 ***	−0.025 ***	0.003	−0.031 ***	1.000					
BOARD	−0.666 ***	−0.114 ***	0.251 ***	0.162 ***	0.040 ***	−0.008	0.037 ***	−0.517 ***	1.000				
TOP1	−0.264 ***	−0.125 ***	0.192 ***	0.068 ***	0.125 ***	0.018 ***	0.076 ***	0.033 ***	0.031 ***	1.000			
BIG4	−0.185 ***	−0.012 **	0.345 ***	0.102 ***	0.046 ***	−0.012 **	0.035 ***	0.028 ***	0.098 ***	0.132 ***	1.000		
ABSDA	0.024 ***	−0.029 ***	−0.054 ***	0.107 ***	−0.070 ***	0.119 ***	0.030 ***	0.017 ***	−0.053 ***	−0.025 ***	−0.048 ***	1.000	
PANTENT	0.007	0.224 ***	0.296 ***	0.013 **	0.048 ***	0.012 **	0.043 ***	0.044 ***	0.003	−0.017 ***	0.085 ***	−0.113 ***	1.000

*, ** and ***, respectively, indicate that the index is significant at the significance levels of 10%, 5% and 1%.

5.3. Baseline Regression Results

Table 5 provides an in-depth assessment of the impact of digital transformation on corporate governance practices. The findings in the table indicate that there is a significant positive and statistically significant relationship between the advancement of digital transformation and the improvement of corporate governance standards across time. In detail, this analysis initially examines the direct impact of digital transformation on the current level of corporate governance without considering external factors such as industry-specific nuances and yearly changes. In this case, the calculated coefficient for digital transformation is 0.041, which is highly significant at the 1% level. This means that, on average, for every unit increase in digital transformation efforts, there is a corresponding increase in corporate governance effectiveness of 0.041 units, highlighting the substantial beneficial impact of digitization.

Table 5. Estimated results of the impact of digital transformation on corporate governance.

CGL	(1) T Phase	(2) T Phase	(3) T + 1 Phase	(4) T + 2 Phase
DT	0.041 ***	0.024 ***	0.026 ***	0.031 ***
	(15.626)	(6.804)	(5.987)	(6.482)
SIZE	−0.201 ***	−0.199 ***	−0.202 ***	−0.191 ***
	(−63.152)	(−56.362)	(−46.342)	(−39.467)
LEV	−0.399 ***	−0.348 ***	−0.337 ***	−0.334 ***
	(−19.328)	(−15.752)	(−12.482)	(−11.303)
ROA	−0.153 **	0.026	−0.053	−0.067
	(−2.512)	(0.427)	(−0.671)	(−0.743)
GROWTH	0.118 ***	0.113 ***	0.124 ***	0.123 ***
	(13.232)	(12.856)	(10.823)	(10.070)
TUNR	−0.104 ***	−0.122 ***	−0.137 ***	−0.145 ***
	(−14.157)	(−13.865)	(−12.937)	(−12.615)
INDEP	4.913 ***	4.926 ***	3.773 ***	3.394 ***
	(67.863)	(69.403)	(41.378)	(33.741)
BOARD	−2.370 ***	−2.278 ***	−2.007 ***	−1.857 ***
	(−107.326)	(−102.012)	(−73.739)	(−62.032)
TOP1	−0.012 ***	−0.012 ***	−0.013 ***	−0.013 ***
	(−52.878)	(−50.001)	(−44.215)	(−43.383)
BIG4	−0.092 ***	−0.078 ***	−0.064 ***	−0.055 ***
	(−6.906)	(−5.834)	(−3.729)	(−2.923)
Constant	8.488 ***	7.998 ***	7.833 ***	7.262 ***
	(104.359)	(90.603)	(72.722)	(60.719)
Industry	No	Yes	Yes	Yes
Year	No	Yes	Yes	Yes
N	31,222	31,222	26,418	23,082
adj. R^2	0.630	0.648	0.559	0.523

** and *** respectively, indicate that the index is significant at the significance levels of 5%, and 1%.

In order to gain a fuller understanding of this relationship over time, this study extends the window of analysis to subsequent periods, i.e., T + 1 and T + 2. Here, "T" represents the baseline or current time period of the survey, while "T + 1" and "T + 2" stand for the immediately following year and the next following year, respectively. By examining these future time periods, the study seeks to assess whether the positive impact of digital transformation on corporate governance will persist or diminish over time. Notably, the results for the T + 1 and T + 2 periods are consistent with the results of the baseline analysis, and the consistency of these results across time periods, including T, T + 1, and T + 2, underscores the enduring value of digital initiatives in enhancing governance structures and practices. Decisions on "T" are typically based on data availability and research questions designed to capture a representative snapshot of current practices while allowing for meaningful comparisons of subsequent periods for meaningful comparisons.

5.4. Heterogeneity Analysis

Table 6 examines heterogeneity based on property rights, dividing the sample into state-owned and non-state-owned enterprises. The impact of digital transformation on corporate governance is significantly positive in the non-state-owned enterprises group, with an estimated coefficient of 0.013, but not significant in the state-owned enterprises group, indicating a more pronounced governance effect of digital transformation in non-state-owned enterprises.

Table 6. Heterogeneity of property rights.

CGL	(1) State-Owned Business	(2) Non-State Enterprise
DT	0.002	0.013 ***
	(0.465)	(3.056)
SIZE	−0.082 ***	−0.225 ***
	(−26.785)	(−41.790)
LEV	0.019	−0.316 ***
	(1.035)	(−9.988)
ROA	−0.740 ***	−0.005
	(−12.498)	(−0.061)
GROWTH	0.037 ***	0.092 ***
	(4.284)	(7.663)
TUNR	−0.057 ***	−0.102 ***
	(−7.828)	(−7.674)
INDEP	4.522 ***	5.108 ***
	(72.747)	(46.617)
BOARD	−2.102 ***	−2.053 ***
	(−109.867)	(−56.936)
TOP1	−0.011 ***	−0.010 ***
	(−52.365)	(−27.035)
BIG4	−0.037 ***	−0.274 ***
	(−3.460)	(−11.100)
Constant	5.116 ***	7.944 ***
	(69.810)	(53.187)
Industry	Yes	Yes
Year	Yes	Yes
N	12,159	19,063
adj. R^2	0.775	0.568

***, respectively, indicate that the index is significant at the significance levels of 1%.

This may be due to the fact that non-state-owned may be more flexible and able to adapt and respond more quickly to the changes brought about by digital transformation, resulting in significant improvements in corporate governance. State-owned, on the other hand, may be subject to more policy, regulatory, and institutional constraints, resulting in the effects of digital transformation being less pronounced in terms of corporate governance than in non-state-owned. This finding is important for a deeper understanding of the relationship between digital transformation and corporate governance.

Table 7 explores regional heterogeneity, dividing the sample into eastern, central, and western regions. The specific divisions are based on the following: Eastern region: 11 provincial-level administrative regions, including Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. These regions are generally characterized by coastal advantages, a strong economic base, and a high level of technology. Central region: including Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan, a total of eight provincial-level administrative regions. These areas are located in the interior of China, where the economic base is relatively weak but the development potential is huge. Western region: 12 provincial-level administrative regions including Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia,

Xinjiang, Guangxi, and Inner Mongolia. The results show significant positive impacts of digital transformation on corporate governance in eastern and central enterprise groups, with coefficients of 0.017 and 0.046, respectively, but not significant in the western region, indicating that the digital transformation governance effect varies across regions.

Table 7. Regional heterogeneity.

CGL	(1) East	(2) Centre	(3) West
DT	0.017 ***	0.046 ***	0.016 *
	(4.210)	(5.163)	(1.658)
SIZE	−0.218 ***	−0.168 ***	−0.140 ***
	(−50.150)	(−18.918)	(−17.325)
LEV	−0.314 ***	−0.520 ***	−0.178 ***
	(−11.328)	(−10.084)	(−3.416)
ROA	0.005	−0.066	−0.178
	(0.071)	(−0.450)	(−1.218)
GROWTH	0.107 ***	0.126 ***	0.125 ***
	(9.742)	(6.039)	(6.605)
TUNR	−0.119 ***	−0.188 ***	−0.165 ***
	(−10.741)	(−9.667)	(−7.726)
INDEP	5.152 ***	4.791 ***	4.222 ***
	(56.444)	(29.660)	(27.838)
BOARD	−2.227 ***	−2.106 ***	−2.462 ***
	(−76.670)	(−42.261)	(−51.573)
TOP1	−0.012 ***	−0.012 ***	−0.012 ***
	(−40.011)	(−23.046)	(−19.817)
BIG4	−0.068 ***	−0.199 ***	−0.105 ***
	(−4.342)	(−5.865)	(−2.870)
Constant	8.241 ***	7.050 ***	7.445 ***
	(71.078)	(35.107)	(41.123)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	21,729	5173	4320
adj. R^2	0.648	0.669	0.669

* and ***, respectively, indicate that the index is significant at the significance levels of 10% and 1%.

This may be due to the fact that enterprises in the eastern and central regions are relatively economically developed and may have easier access to the resources and technical support needed for digital transformation, leading to significant improvements in corporate governance. In contrast, in the western region, where the economy is relatively backward, firms may face more resource and technological constraints, resulting in a less pronounced effect of digital transformation on corporate governance than in the eastern and central regions. This finding has important implications for a deeper understanding of the relationship between digital transformation and corporate governance and for the formulation of targeted regional policies.

According to the cash flow portfolio model proposed by Dickinson (2011) [48], and with reference to the common practice of domestic research, this paper divides the life cycle of a company as shown in Table 8 below. On the basis of the rationalization of the division through the above-mentioned methods, indicators for the division of the life cycle of enterprises have been formed, which are recorded as the growth period (growth period), the maturity period (ripening period), and the decline period (recession period).

Table 8. Enterprise life cycle segmentation.

Cash	Growth		Ripening		Recession			
	Inception	Growth	Ripening	Recession	Recession	Recession	Phase Out	Phase Out
Net cash flow from operations	-	+	+	-	+	+	-	-
Net cash flows from investments	-	-	-	-	+	+	+	+
Net financing cash flow	+	+	-	-	+	-	+	-

The regression results in Table 9 show that the impact of digital transformation on corporate governance is significantly positive at the 1% level of significance in the maturity and decline periods with coefficients of 0.027 and 0.040, respectively. It is significantly positive at the 10% level of significance in the growth period with coefficients of 0.009, which suggests that its impact varies across life cycle stages. This may be due to the fact that in the growth period, due to the challenges of resource allocation constraints, immature management systems, and insufficient talent reserves, firms in this stage tend to invest more energy in market development and product development, and the enhancement effect of digital transformation on corporate governance may be limited in comparison with that of firms in the maturity and decline periods.

Table 9. Life cycle heterogeneity.

CGL	(1) Growth Period	(2) Ripening Period	(3) Recession Period
DT	0.009 *	0.027 ***	0.040 ***
	(1.686)	(4.459)	(5.237)
SIZE	−0.211 ***	−0.205 ***	−0.180 ***
	(−38.428)	(−35.869)	(−22.495)
LEV	−0.261 ***	−0.516 ***	−0.362 ***
	(−7.147)	(−14.059)	(−8.452)
ROA	0.303 ***	−0.373 ***	0.200 *
	(2.944)	(−3.642)	(1.692)
GROWTH	0.095 ***	0.129 ***	0.068 ***
	(7.611)	(7.421)	(3.835)
TUNR	−0.101 ***	−0.164 ***	−0.056 ***
	(−7.374)	(−11.031)	(−3.109)
INDEP	5.016 ***	4.875 ***	4.886 ***
	(48.012)	(40.583)	(31.027)
BOARD	−2.314 ***	−2.256 ***	−2.221 ***
	(−70.555)	(−60.231)	(−43.096)
TOP1	−0.012 ***	−0.012 ***	−0.012 ***
	(−31.761)	(−30.264)	(−22.891)
BIG4	−0.005	−0.088 ***	−0.178 ***
	(−0.255)	(−4.518)	(−5.030)
Constant	8.314 ***	8.153 ***	7.297 ***
	(61.408)	(56.234)	(36.897)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	13,241	11,731	6250
adj. R^2	0.656	0.656	0.630

* and ***, respectively, indicate that the index is significant at the significance levels of 10% and 1%.

The study may have been limited by the selection of the sample, which failed to provide comprehensive coverage of enterprises of various types, sizes, and regions, resulting in the generalizability of the findings being somewhat affected. Future research could

expand the sample to increase diversity and representativeness in order to improve the generalizability of the findings.

5.5. Mediation Effect Analysis

Table 10 analyzes the mediation effect of innovation capability, showing that digital transformation enhances innovation capability, thereby improving corporate governance levels. Hypothesis 2 was verified. The regression result for the impact of digital transformation on innovation capability is significantly positive at the 1% level. Further analysis, including the Sobel test, validates the mediation effect of innovation capability in the impact of digital transformation on corporate governance.

Table 10. Intermediation effects—innovation capacity.

	(1)	(2)	(3)
	CGL	PANTENT	CGL
DT	0.024 ***	0.137 ***	0.023 ***
	(6.804)	(18.861)	(6.447)
PANTENT			0.009 ***
			(3.294)
SIZE	−0.199 ***	0.600 ***	−0.204 ***
	(−56.362)	(72.452)	(−52.957)
LEV	−0.348 ***	−0.382 ***	−0.345 ***
	(−15.752)	(−7.973)	(−15.573)
ROA	0.026	0.712 ***	0.020
	(0.427)	(5.373)	(0.326)
GROWTH	0.113 ***	−0.060 ***	0.114 ***
	(12.856)	(−2.870)	(12.918)
TUNR	−0.122 ***	0.281 ***	−0.124 ***
	(−13.865)	(12.811)	(−14.058)
INDEP	4.926 ***	−0.039	4.926 ***
	(69.403)	(−0.239)	(69.408)
BOARD	−2.278 ***	0.014	−2.278 ***
	(−102.012)	(0.269)	(−102.059)
TOP1	−0.012 ***	−0.001 ***	−0.012 ***
	(−50.001)	(−2.706)	(−49.951)
BIG4	−0.078 ***	−0.078 **	−0.078 ***
	(−5.834)	(−2.124)	(−5.783)
Constant	7.998 ***	−12.570 ***	8.107 ***
	(90.603)	(−59.413)	(85.760)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	31,222	31,222	31,222
adj. R^2	0.648	0.502	0.648

** and ***, respectively, indicate that the index is significant at the significance levels of 5% and 1%.

The study shows that digital transformation improves corporate governance by enhancing innovation capability, which plays an important mediating role in the process. This finding reveals the intrinsic linkages and transmission mechanisms between digital transformation, innovation capacity, and corporate governance. For policymakers, they should encourage firms to engage in digital transformation and innovation to enhance overall corporate governance and market competitiveness. For corporate managers, they should focus on the facilitating effect of digital transformation on innovation capability and further optimize corporate governance structure and improve governance efficiency by enhancing innovation capability.

Table 11 examines the mediation effect of information asymmetry, indicating that digital transformation reduces information asymmetry, thereby enhancing corporate governance levels. Hypothesis 3 was verified. The regression result for the impact of digital

transformation on information asymmetry is significantly negative at the 1% level, demonstrating that digital transformation lowers information asymmetry levels. Further analysis confirms the mediation effect of information asymmetry.

Table 11. Intermediation effects—information asymmetry.

	(1)	(2)	(3)
	CGL	ABSDA	CGL
DT	0.024 ***	−0.001 **	0.024 ***
	(6.804)	(−2.450)	(6.775)
ABSDA			−0.142 **
			(−2.358)
SIZE	−0.199 ***	−0.004 ***	−0.200 ***
	(−56.362)	(−12.224)	(−56.295)
LEV	−0.348 ***	0.025 ***	−0.345 ***
	(−15.752)	(12.159)	(−15.552)
ROA	0.026	−0.061 ***	0.018
	(0.427)	(−7.761)	(0.284)
GROWTH	0.113 ***	0.017 ***	0.116 ***
	(12.856)	(16.022)	(13.037)
TUNR	−0.122 ***	0.004 ***	−0.121 ***
	(−13.865)	(4.215)	(−13.795)
INDEP	4.926 ***	−0.003	4.925 ***
	(69.403)	(−0.473)	(69.407)
BOARD	−2.278 ***	−0.014 ***	−2.280 ***
	(−102.012)	(−6.501)	(−102.026)
TOP1	−0.012 ***	−0.000 ***	−0.012 ***
	(−50.001)	(−2.746)	(−50.033)
BIG4	−0.078 ***	−0.004 ***	−0.079 ***
	(−5.834)	(−3.386)	(−5.875)
Constant	7.998 ***	0.180 ***	8.023 ***
	(90.603)	(20.892)	(89.924)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	31,222	31,222	31,222
adj. R^2	0.648	0.080	0.648

** and ***, respectively, indicate that the index is significant at the significance levels of 5%, and 1%.

The study shows that digital transformation enhances corporate governance by reducing the level of information asymmetry and that information asymmetry plays an important mediating role in this process. This finding reveals the intrinsic links and transmission mechanisms between digital transformation, information asymmetry, and corporate governance. For policymakers, they should encourage firms to undergo digital transformation to reduce the level of information asymmetry and enhance corporate governance and market competitiveness. For corporate managers, they should focus on the role of digital transformation in reducing information asymmetry and further optimize corporate governance structure and improve governance efficiency by reducing information asymmetry.

5.6. Robustness Analysis

1. Use of Cluster-Robust Standard Errors

This study considers an individual-level analysis, employing cluster-robust standard errors at the company level.

According to the regression results shown in Table 12, the main findings of this study are consistent with previous studies. This suggests that the effects of digital transformation on corporate governance, innovation capacity, or information asymmetry are significant and consistent, both at the individual level and at the firm level of analysis. This consistency

enhances the reliability and robustness of the findings, suggesting that the effects of digital transformation are replicable at different levels and across different data sets.

Table 12. Robustness test—cluster-robust standard errors.

	CGL
DT	0.024 ***
	(3.312)
SIZE	−0.199 ***
	(−24.918)
LEV	−0.348 ***
	(−7.387)
ROA	0.026
	(0.239)
GROWTH	0.113 ***
	(11.520)
TUNR	−0.122 ***
	(−6.123)
INDEP	4.926 ***
	(32.348)
BOARD	−2.278 ***
	(−44.202)
TOP1	−0.012 ***
	(−20.965)
BIG4	−0.078 ***
	(−2.590)
Constant	7.998 ***
	(38.841)
Industry	Yes
Year	Yes
N	31,222
adj. R^2	0.648

*** respectively, indicate that the index is significant at the significance levels of 1%.

The variable DT (digital transformation) has a significant positive coefficient of 0.024 ***, indicating the robust positive impact of digital transformation on corporate governance level (CGL).

2. Exclusion of Special Event Samples

The financial crisis of 2008–2009 and the COVID-19 pandemic since 2020 have profoundly impacted the capital market landscape and the digital transformation processes of companies, subsequently affecting the enhancement of corporate governance levels. The digital trend remains unchanged despite these changes. Digital transformation has transitioned from a "nice-to-have" to a "must-have" for companies striving to survive in adverse conditions. Excluding samples from the financial crisis and the pandemic periods and re-running the model, Table 13 shows that the conclusions remain unaffected.

Taken together, the findings emphasize that the importance and positive impact of digital transformation on firms remain unchanged despite external shocks such as the financial crisis and the new crown epidemic. Meanwhile, by excluding data from special periods and revalidating them, the study further confirms the robustness and reliability of its findings. This finding provides strong support for businesses and managers, suggesting that it is wise to continue investing in digital transformation in uncertain environments.

After excluding the periods of the financial crisis and COVID-19 pandemic, the significant positive impact of digital transformation (DT) on corporate governance level (CGL) persists, with a coefficient of 0.025 ***.

3. Replacement of Explanatory Variable

Instead of the digital transformation index used previously, a dummy variable indicating whether a firm underwent digital transformation in a given year (DT_Dummy)

was used for a robustness check. The results in Table 14 demonstrate that the coefficient of DT_Dummy is significantly positive at the 5% level. This indicates that the significant positive effect of digital transformation on corporate governance levels remains valid even when the explanatory variable is changed.

Table 13. Robustness test—excluding samples.

	(1)
	CGL
DT	0.025 ***
	(5.820)
SIZE	−0.193 ***
	(−45.661)
LEV	−0.420 ***
	(−15.942)
ROA	0.058
	(0.763)
GROWTH	0.132 ***
	(12.792)
TUNR	−0.136 ***
	(−12.985)
INDEP	4.894 ***
	(57.766)
BOARD	−2.251 ***
	(−84.432)
TOP1	−0.012 ***
	(−42.245)
BIG4	−0.075 ***
	(−4.802)
Constant	7.838 ***
	(74.590)
Industry	Yes
Year	Yes
N	22,405
adj. R^2	0.645

***, respectively, indicate that the index is significant at the significance levels of 1%.

Table 14. Replacement of explanatory variable.

	(1)
	CGL
DT_Dummy	0.030 **
	(2.129)
SIZE	−0.197 ***
	(−24.731)
LEV	−0.353 ***
	(−7.472)
ROA	0.019
	(0.175)
GROWTH	0.114 ***
	(11.596)
TUNR	−0.119 ***
	(−5.964)
INDEP	4.934 ***
	(32.285)

Table 14. *Cont.*

	(1)
	CGL
BOARD	−2.278 ***
	(−44.208)
TOP1	−0.012 ***
	(−21.080)
BIG4	−0.081 ***
	(−2.671)
Constant	7.946 ***
	(38.743)
Industry	Yes
Year	Yes
N	31,222
adj. R^2	0.648

** and ***, respectively, indicate that the index is significant at the significance levels of 5%, and 1%.

To summarize. The positive impact of digital transformation on corporate governance is further confirmed to be robust and significant by replacing the explanatory variables and conducting robustness tests. This finding enhances the credibility of the previous conclusions and provides firms and managers with stronger evidence to support their decision to undertake digital transformation.

DT_Dummy's significant positive coefficient reaffirms the robust positive impact of digital transformation on corporate governance.

5.7. Endogeneity Test

Considering the potential endogeneity problem, where companies with higher levels of corporate governance may be more motivated to undertake digital transformation than those with lower levels, an instrumental variable approach was employed. The lagged value of digital transformation was used as an instrumental variable in a two-stage least squares regression, meeting the requirements of relevance and exogeneity. The regression results reported in Table 15 indicate that the chosen instrumental variable is viable. The coefficients for digital transformation are significantly positive at the 1% level, thus confirming the hypothesis that digital transformation significantly and positively impacts corporate governance levels.

Table 15. Endogeneity test.

	(1)	**(2)**
	CGL	CGL
L.DT	0.022 ***	
	(5.814)	
DT		0.028 ***
		(5.825)
SIZE	−0.185 ***	−0.186 ***
	(−49.080)	(−49.126)
LEV	−0.279 ***	−0.277 ***
	(−11.691)	(−11.635)
ROA	−0.106	−0.112 *
	(−1.608)	(−1.705)
GROWTH	0.137 ***	0.135 ***
	(14.109)	(13.915)
TUNR	−0.128 ***	−0.129 ***
	(−13.813)	(−13.923)
INDEP	4.882 ***	4.878 ***
	(65.431)	(65.517)

Table 15. *Cont.*

	(1)	**(2)**
BOARD	−2.292 ***	−2.292 ***
	(−97.019)	(−97.237)
TOP1	−0.013 ***	−0.013 ***
	(−52.490)	(−52.487)
BIG4	−0.088 ***	−0.087 ***
	(−6.420)	(−6.363)
Constant	7.727 ***	7.762 ***
	(82.851)	(82.036)
Industry	Yes	Yes
Year	Yes	Yes
N	26,418	26,418
adj. R^2	0.657	0.657

* and ***, respectively, indicate that the index is significant at the significance levels of 10% and 1%.

The significant positive impact of digital transformation on corporate governance is further confirmed by considering potential endogeneity issues and conducting regression analysis using an instrumental variables approach. This finding enhances our understanding of the relationship between digital transformation and corporate governance and provides firms and managers with strong evidence to support their digital transformation decisions.

6. Threats to Research Validity

Text analysis may have limitations in measuring the digital transformation of companies. It relies on textual content in annual reports, which may not fully capture the breadth and depth of firms' digital transformation efforts, thus introducing a degree of inaccuracy. In addition, the sample of this study focuses primarily on listed companies in the Shanghai and Shenzhen A-share markets, which may limit the generalizability of the findings to other types of firms or markets. There is also the possibility of omitted variable bias, as this study may not have considered other factors that affect the relationship between digital transformation and corporate governance.

In conducting this research, several potential threats to validity should be acknowledged. First, the use of text analytics to measure digital transformation may introduce some level of inaccuracy, as it relies on the textual content of annual reports, which may not fully capture the extent and depth of a company's digital transformation efforts. Second, the sample selection, focusing on listed companies on the Shanghai and Shenzhen A-share markets, may limit the generalizability of the findings to other types of enterprises or markets. Third, the possibility of omitted variable bias exists, as there may be other factors influencing the relationship between digital transformation and corporate governance that were not considered in this study. To mitigate these threats, future research could employ a combination of quantitative and qualitative indicators to measure digital transformation, expand the sample to include a broader range of enterprises, and consider additional variables that may affect the relationship being investigated.

7. Research Conclusions and Implications

This paper investigates the impact of digital transformation on corporate governance levels by analyzing listed companies on the Shanghai and Shenzhen A-share markets from 2007 to 2021, from both theoretical and empirical perspectives. The main findings highlight the positive correlation between digital transformation and corporate governance. Specifically, digital transformation significantly improves the level of corporate governance, as evidenced by robustness checks and endogeneity tests.

Further analysis reveals that the promotion effect of digital transformation on corporate governance is more pronounced in non-state-owned enterprises, enterprises in the central and eastern regions, and those in the maturity and decline stages of their lifecycle.

Additionally, digital transformation enhances corporate governance by improving firms' innovation capabilities and reducing the degree of information asymmetry.

Compared to existing studies, our findings complement the literature by specifically exploring the role of digital transformation in improving corporate governance, particularly in non-state-owned enterprises and firms from the Central and Eastern regions. Moreover, by revealing the mechanisms underlying digital transformation's enhancement of firms' innovation capabilities and reduction of information asymmetry, this study provides new insights into how digital transformation impacts corporate governance.

By delineating the relationship between corporate digital transformation and governance, this paper offers policy insights for driving enterprises' digital changes and high-quality development. To enhance the specificity and operability of the policy recommendations, the following refined suggestions are proposed from both the enterprise and governmental perspectives:

Enterprises should actively pursue digital transformation, using it as an opportunity to cultivate new momentum for better transitioning from old to new dynamics and constructing a new development pattern. To enhance their core competitiveness, firms should specifically focus on leveraging digital technologies to optimize business processes, enhance product and service quality, and improve operational efficiency. This can be achieved by adopting open and shared business models, investing in digital talents and technologies, and fostering a culture of innovation and continuous learning. By doing so, enterprises can deeply integrate the real and digital economies and better achieve high-quality development.

Government and relevant departments should formulate specific institutional policies and support measures to accelerate enterprises' digital transformation and empower high-quality development through digital transformation. This can be achieved by establishing clear guidelines and standards for digital transformation, providing financial support and tax incentives for enterprises investing in digital technologies, and fostering collaboration between industry, academia, and government to promote innovation and knowledge sharing. Additionally, accelerating the establishment of data and information sharing mechanisms can reduce the degree of information asymmetry, and encouraging enterprises to apply digital decision-making systems can foster an atmosphere of scientific and intelligent decision-making. By implementing these specific measures, the government can collaboratively build and advance the digital transformation wave across society.

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