

Research Article

Corporate Digital Transformation and Internal Control Effectiveness: The Moderating Role of Board IT Expertise

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Abstract

The digital transformation of corporations has changed the control environment by which organizations detect, measure, and deal with any operational and financial risks. This paper analyzes the effects of corporate digital transformation on internal control effectiveness, and the moderating effect of board IT expertise on the relationship using a panel of A-share listed Chinese firms over the period 2013-2022. Internal control effectiveness is defined using DIB internal control index, digital transformation using the frequency of digitalization-related disclosures in annual reports, while board IT expertise using the percentage of IT-experienced directors on the board. According to the results obtained using fixed-effect regression analysis, there is a positive and significant relation between digital transformation and internal control effectiveness, and that relationship is more intensified in the presence of IT knowledge among directors. However, the results remain robust to changes in specification and measurements. Digital transformation is therefore not a technological process but a governance one, where the board IT expertise complements the digital transformation process.

Keywords

Digital transformation, Internal control effectiveness, Board IT expertise, Corporate governance

1. Introduction

1.1. Research Background

As far as digital technologies have started diffusing into the operations of the firm and beyond to its very strategic processes, this has changed the way of managing information, coordinating activities, and controlling them. The integration of the data analysis, automation,

and information systems into operational processes of enterprises has greatly reduced the distance between the management of technology and its governance. On the market level of evidence, it can be said that besides changes in productivity, there will be also some consequences related to information environment and the quality of control mechanisms used by external stakeholders [1]. The internal control is one of the key components of this information environment – it is the mechanism through which the firm protects its assets, controls financial reporting, and reduces opportunities for managerial opportunism.

1.2. Research Gap

Prior literature has mainly focused on the impact of digital transformation on performance and innovations while neglecting the issue of control and governance. There are few works that study the implications of digital transformation for the internal control systems; however, the relationship between them is yet to be understood fully [2]. Another shortcoming of the literature is that while digital transformation has been regarded as a corporate phenomenon, the aspects of governance responsible for overseeing such projects have not received enough consideration. The board's competence in information technology (IT) has hardly ever been included in models of internal control, which opens up an opportunity for studying the dependence of the transformation impact on the quality of IT governance.

1.3. Research Questions and Contributions

The research investigates two interrelated research problems. The first one examines whether digital transformation enhances internal control effectiveness. The second problem studies whether board IT expertise affects the above relationship, improving the board's ability to understand, guide, and control digital transformation. The significance of the research can be seen from three perspectives. Firstly, from the theoretical perspective, the paper contributes to the research stream dedicated to the effects of digital transformation on governance, connecting this issue to the internal control research with the help of an information processing approach. Empirically, the research adds the concept of board IT expertise as a boundary condition, shifting from the direct effect perspective to the contingent effect one. Practically, the research provides recommendations for companies regarding the coordination of the process of digital transformation and board structure.

2. Literature Review and Hypotheses

2.1. Theoretical Foundation

Two perspectives serve as the foundation of the analysis. According to the theory of organizational information processing, performance relies on the balance between the information processing needs that exist for an organization and its capacity to satisfy those needs. Digital transformation helps address this need by facilitating more efficient information gathering, integration, and distribution, thus reducing the gap between the needs and capacity; yet, the magnitude of the benefit derived from such transformation depends on the way in which the information is acquired by those who provide guidance and oversight within the organization [3]. The upper echelons theory helps complete the picture by stating that the performance of organizations is based on the cognitive processes, knowledge, and expertise of their leaders. Individual traits of executives and directors determine the way strategic inputs are interpreted and decisions made, and the existing literature suggests that leadership traits are an important factor behind the success of digital projects [4].

2.2. Digital Transformation and Internal Control Effectiveness

Internal control may be improved by digital transformation through a number of means. First, automated transactions minimize the need for human interaction and eliminate mistakes and discrepancies from it, while integration of systems ensures continuous rather than episodic observation of operations and deviations. Information transparency diminishes the effects of the information asymmetry problems affecting the control environment and makes reporting more accurate and timely. Studies that are based on the various stages of transformation have shown that increased digitalization is related to higher quality of internal control and development in each of the elements of the control framework [5]. There is evidence to show that internal control quality acts as an intermediary mechanism through which transformation affects the performance of firms, which is further proof that transformation and internal control are closely related [6]. However, there is a caveat to it since the complexity of the systems created during transformation and higher risk of information security issues create conflicts that need to be overcome in order for control to be effective. This process appears to be related to certain leadership qualities [7].

H1. The degree of corporate digital transformation is positively associated with internal control effectiveness.

2.3. The Moderating Role of Board IT Expertise

The board takes full responsibility for the management of risk and control, but the successful performance of the above task in a digital environment requires the ability of the board to understand the problems associated with technology. Individuals on the board with IT experience are well-placed to assess risks inherent in digital projects, to allocate resources

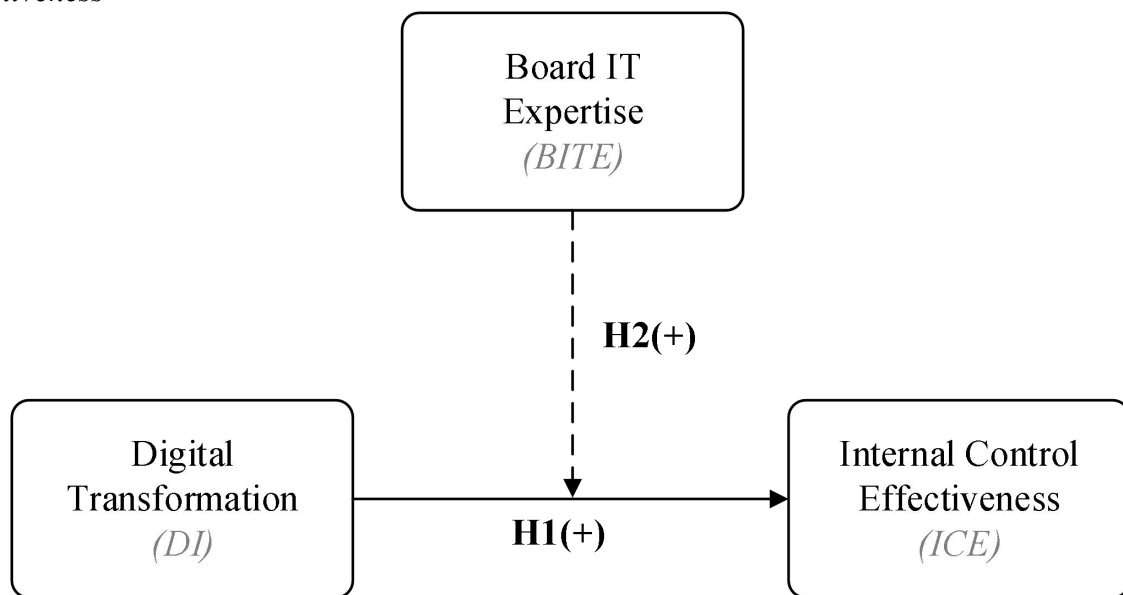
adequately and to monitor the development of systems such that digital transformation results in better control rather than increased risk. Research has proven that IT expertise at the board level positively influences the effectiveness of the control system primarily because of increased control activities and improved information and communication components of the system [8]. It is also evident that the IT governance structures at the board level significantly affect organizational performance as a result of technology competencies developed [9]. This idea can also be found in assurance contexts when technology-savvy oversight creates a connection between the effects of digital transformation and the quality of the output of monitoring [10]. The board members' IT expertise makes it more probable that the information processing capacity brought about by transformation will be taken into account and used for control purposes.

H2. Board IT expertise positively moderates the relationship between digital transformation and internal control effectiveness.

The hypothesized relationships are summarized in the research model shown in Figure 1.

Figure 1

Research model of digital transformation, board IT expertise, and internal control effectiveness



3. Research Design

3.1. Sample Selection and Data Sources

Sample Selection

The samples include Chinese A-share companies that are traded on the stock market of Shanghai and Shenzhen from 2013 to 2022. The financial firms have been excluded owing to

their special regulation and control features. Also, the samples include firm-year observations that are not classified as ST or *ST and that do not have insolvent balance sheet and missing values in the key variables. Financial information, governance information, and internal control information have been collected from the CSMAR and Wind databases. The information about digital transformation has been gathered from the management discussion and analysis part of annual reports. All continuous variables have been trimmed at 1% and 99% level to avoid any outlier effects. The number of firm-year observations in the sample is 21,436.

3.2. Variable Definitions

The dependent variable, internal control effectiveness, is operationalized using the natural logarithm of one plus the DIB internal control index, which is a well-known measure of the effectiveness of a firm's control system design and operations; the addition of one serves the purpose of taking into account the fact that the index becomes zero if the firm reports deficiencies in internal controls. The explanatory variable, digital transformation, is operationalized using the natural logarithm of one plus the frequency of digitalization terms reported in the annual report of the firm, following the text-based method prevalent in this literature. The moderating variable, board IT expertise, is calculated using the ratio of IT experts among directors of the firm to the total number of directors. In addition to year and industry fixed effects, a set of controls, namely, firm size, leverage, profitability, growth, board size, independence of the board, CEO duality, and ownership structure, are controlled for in all models.

Table 1

Variable definitions

Type	Symbol	Name	Measurement
Dependent	ICE	Internal control effectiveness	Natural logarithm of (1 + DIB internal control index)
Independent	DT	Digital transformation	Natural logarithm of (1 + frequency of digitalization-related terms in the annual report)
Moderating	BITE	Board IT expertise	Number of directors with IT backgrounds / board size
Control	Size	Firm size	Natural logarithm of total assets
Control	Lev	Leverage	Total liabilities / total assets
Control	ROA	Profitability	Net income / total assets

Control	Growth	Growth	Growth rate of operating revenue
Control	Bsize	Board size	Natural logarithm of the number of directors
Control	Indep	Board independence	Number of independent directors / board size
Control	Dual	CEO duality	1 if the CEO also chairs the board, 0 otherwise
Control	SOE	Ownership type	1 if state-owned, 0 otherwise

3.3. Model Specification

Two regressions are performed. H1 is tested using regression (1), where internal control effectiveness is regressed on digital transformation and control variables. In order to test H2, regression (2) is performed, where board IT expertise and its interaction with digital transformation are included in the model; the constituent variables are mean-centered to simplify interpretation and minimize collinearity issues. Both regressions use cluster-robust standard errors for each firm and fixed effects for both year and industry. A statistically significant and positive coefficient on digital transformation in regression (1) indicates support for H1, whereas a positive and significant interaction term in regression (2) suggests support for H2. Multicollinearity problems are assessed using pairwise correlations and variance inflation factors prior to estimating the regressions; the significant interaction term in regression (2) is also analyzed using simple-slope analysis. The results' robustness is further examined through several robustness tests.

4. Empirical Results

4.1. Descriptive Statistics

Statistics for the main variables used in the paper are provided in Table 2. The average for internal control effectiveness is 6.44 with standard deviation equal to 0.53, and the existence of some small values is due to the fact that there are companies with known control deficiencies. The digital transformation score is 1.62, and it shows significant variation among companies since not all of them adopt new technology equally fast. Expertise of board in IT is 0.041 on average, which means that such directors are still rare.

Table 2

Descriptive statistics

Variable	N	Mean	SD	Min	Median	Max
ICE	21,436	6.44	0.53	0.00	6.55	6.88

DT	21,436	1.62	1.39	0.00	1.39	5.36
BITE	21,436	0.041	0.076	0.000	0.000	0.444
Size	21,436	22.28	1.31	19.68	22.10	26.15
Lev	21,436	0.424	0.203	0.051	0.417	0.892
ROA	21,436	0.039	0.061	-0.253	0.037	0.208
Growth	21,436	0.168	0.372	-0.541	0.113	2.147
Bsize	21,436	2.12	0.20	1.61	2.20	2.71
Indep	21,436	0.376	0.054	0.333	0.364	0.571
Dual	21,436	0.284	0.451	0.000	0.000	1.000
SOE	21,436	0.351	0.477	0.000	0.000	1.000

Correlation coefficients between each of the main independent variables are provided in Table 3. There is a positive correlation between digital transformation and internal control effectiveness, which provides initial evidence to support hypothesis 1. Correlations between each of the explanatory variables are small in size, and variance inflation factor calculations in the diagnostics, which are not shown, do not exceed any thresholds.

Table 3

Pearson correlation matrix for the main variables

	ICE	DT	BITE	Size	Lev
ICE	1.000				
DT	0.074	1.000			
BITE	0.041	0.128	1.000		
Size	0.196	0.083	0.032	1.000	
Lev	-0.153	-0.026	-0.019	0.412	1.000

4.2. Baseline Regression

The basic results are shown in column (1) of Table 4. The coefficient on digital transformation is 0.0187 and statistically significant at the 1% level, which shows that companies that are further along in their digital transformation process have greater internal control efficiency. The effect is economically small – a one standard deviation rise in digital

transformation leads to an improvement of 0.026 in log-index, which is a considerable but far from large improvement compared to its variability. All other coefficients are as expected – larger companies and those with higher profits have better internal control efficiency.

4.3. Moderating Effect Test

The moderating model is provided in column (2) of Table 4. The coefficient of the interaction term between digital transformation and board IT expertise is 0.0413 and is statistically significant at the 5% level, suggesting that the effect of transformation on internal control quality is magnified when boards have more IT expertise. As revealed through simple slopes testing, the interaction effect is stronger at high values of board IT expertise than at low values, as seen from Figure 2. These findings support H2 and suggest that board-level technological expertise moderates the control effect of transformation. The added explanatory value of the interaction effect is small in this case, which can be attributed to the fact that the number of IT literate directors is very small.

Table 4

Regression results for internal control effectiveness

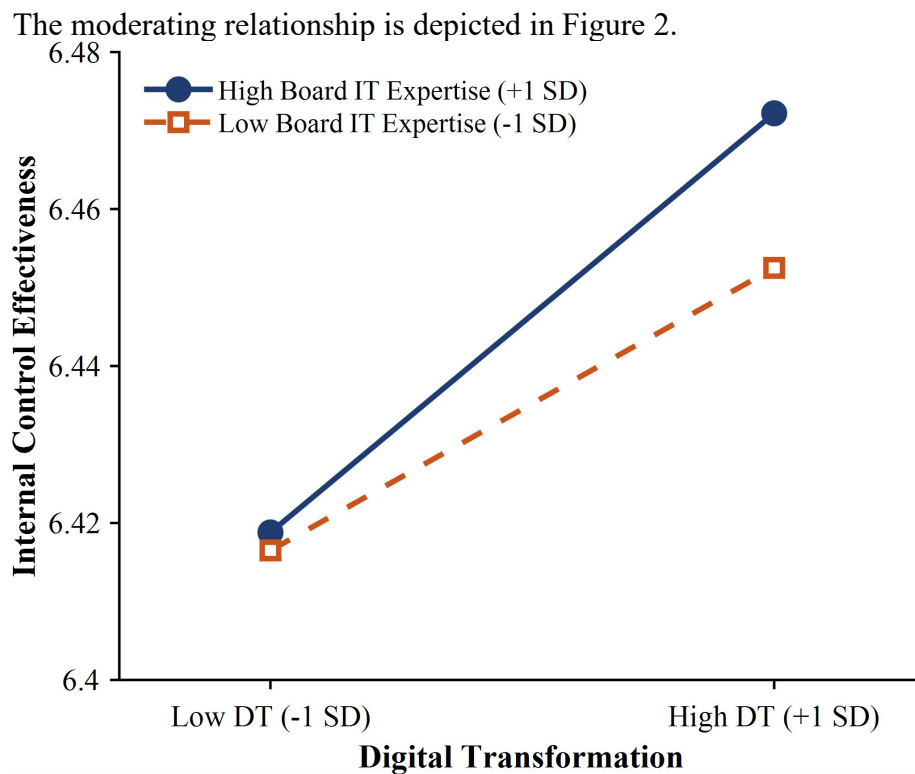
Variable	(1) Baseline	(2) Moderating
DT	0.0187*** (4.62)	0.0161*** (3.94)
BITE		0.0724** (2.31)
DT x BITE		0.0413** (2.18)
Size	0.0632*** (7.15)	0.0619*** (7.02)
Lev	-0.1174*** (-5.38)	-0.1158*** (-5.31)
ROA	0.2853*** (6.04)	0.2817*** (5.96)
Growth	0.0091* (1.79)	0.0088* (1.74)
Bsize	0.0207 (1.12)	0.0198 (1.07)
Indep	0.0416 (0.94)	0.0402 (0.91)
Dual	-0.0083 (-1.05)	-0.0079 (-1.00)
SOE	0.0254** (2.27)	0.0249** (2.23)
Constant	5.031*** (24.6)	5.047*** (24.8)
Year FE	Yes	Yes

Industry FE	Yes	Yes
N	21,436	21,436
Adjusted R-squared	0.312	0.318

Notes. t-statistics based on firm-clustered robust standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Figure 2

Moderating effect of board IT expertise on the relationship between digital transformation and internal control effectiveness



4.4. Robustness Checks

A number of tests are employed to verify the stability of the estimates, and their outcomes are reported in Table 5. Using the disclosure of the presence of an internal control deficiency as an alternative dependent variable leads to a flip in the signs of the estimates as anticipated, whereby digital transformation and the interaction between digital transformation and IT knowledge among board members have been found to be linked with a reduced likelihood of disclosing such internal control deficiencies, as evidenced in column (1) of Table 5. Using another text-based proxy for digital transformation normalized for the overall disclosure length does not change the results substantially in column (2). Estimation using the post-2015 subsample of the data and one-period lag of digital transformation in columns (3)

and (4), respectively, lead to similar conclusions about the relationships studied.

Table 5

Robustness checks

Variable	(1) ICW indicator	(2) Alternative DT	(3) Post-2015 subsample	(4) One-period lag
DT	-0.0092** (-2.34)	0.0203*** (4.18)	0.0179*** (4.05)	0.0166*** (3.71)
BITE	-0.0388* (-1.79)	0.0761** (2.19)	0.0702** (2.14)	0.0689** (2.08)
DT x BITE	-0.0205* (-1.88)	0.0448** (2.05)	0.0391** (2.02)	0.0377* (1.95)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
N	21,436	21,436	16,842	18,109
(Pseudo) R-squared	0.146	0.316	0.309	0.311

Notes. t-statistics based on firm-clustered robust standard errors are in parentheses. Column (1) employs a binary indicator equal to 1 when an internal control weakness is disclosed, so a negative coefficient denotes an improvement in control; the reported fit statistic for this column is a pseudo R-squared. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

5. Conclusions and Implications

5.1. Research Conclusions

In this paper, the interconnection of digital transformation in corporations and its influence on the efficiency of internal control and the moderating effect of the IT knowledge of the board members have been considered. The results suggest a positive relationship between the two phenomena, which is even more intensified in the case where there is a higher share of directors knowledgeable about IT issues. The obtained findings are robust from a statistical perspective but moderate in economic terms, meaning that digital transformation has a positive effect on internal control but is not a decisive factor.

5.2. Contributions and Implications

This study contributes to existing research on governance implications of digital

transformation by relating it to the field of internal controls and by showing that the association is conditional instead of universal. Introducing board IT knowledge as a moderator addresses the underestimation of technology governance at the highest level of the organization and relates the internal controls research with that of director knowledge. In practice, this research indicates that companies that intend to digitalize themselves need to align their digitalization plans with the knowledge of their boards because the advantages of transformation in terms of control will be achieved only when the directors will be capable of overseeing the technology risks. Hiring board members with IT background and improving technology governance at the board level are two practical ways to achieve that.

5.3. Limitations and Future Research

Some caveats apply to the results. The data come from publicly listed companies in China, and the specific nature of institutions in this particular environment makes it difficult to generalize these results across other countries. The textual measurement of digital transformation reflects the extent of emphasis rather than the actual ability, while the indicator for IT skill of the board members uses the observable background characteristics of the board members, which might be an imperfect proxy for the real technological skill of the board members. There are several ways that digital transformation can influence control systems that remain to be explored in future research.

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Data availability

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Declarations

Conflict of interest

The authors declare that there is no conflict of interest.

Ethics approval



Not applicable.

Consent to participate

Not applicable.

Consent for publication

All authors have given their consent.

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