Journal of Global Information Management
Volume 31 • Issue 6

Research on the Influence of Digital Transformation on Enterprise Internal Control Quality

Na Chen, Xi'an University of Technology, China
Shuili Yang, Xi'an University of Technology, China*
Lei Li, Xi'an University of Technology, China

ABSTRACT

Digital transformation has become a new engine driving the development of enterprises. Based on the data of Chinese A-share listed manufacturing enterprises from 2008 to 2020, this paper measured the intensity of enterprise digital transformation with the help of machine learning method, and empirically investigated the impact mechanism of digital transformation on the quality of enterprise's internal control. It is found that digital transformation can significantly improve the quality of internal control. Mechanism analysis shows that digital transformation has a positive impact on the quality of internal control mainly by reducing agency costs and increasing the shareholding ratio of institutional investors. The results of heterogeneity analysis indicate that the promotion effect of digital transformation on the quality of internal control is more significant in enterprises with small scale and strong manager's ability. Digitization improves the total factor productivity of enterprises by promoting the quality of internal control.

KEYWORDS

Digitization, Institutional Investors, Internal Control, Manager's Ability, Manufacturing Enterprises

INTRODUCTION

In recent years, the world economy has transformed into a mature digital economy led by data-driven innovation (Sultana et al., 2021). With the continuous emergence of "ABCD" technologies such as artificial intelligence, blockchain, cloud computing, and big data, digital technology is gradually becoming an important breakthrough point in the development and transformation of global enterprises (Nicoletti et al., 2020). According to the China Digital Economy Development Report (2022), the scale of China's digital economy has reached 45.5 trillion yuan in 2021, accounting for 39.8% of its gross domestic product, which has become an important support for high-quality development of the national economy. In 2020, the sudden COVID-19 epidemic had a major impact on China and even on the global economy and society. In the special stage of fighting the epidemic, digital technology

DOI: 10.4018/JGIM.321187 *Corresponding Author

played an irreplaceable role in epidemic prevention and the resumption of work and production of the real economy (Chadee et al., 2021). Under such policy-driven and practice-oriented changes, digital transformation (DITI) has become an important driving force for high-quality development of microeconomic entities (Ding et al., 2021).

With the rapid development of digital technology, it is not difficult to find that, under the new situation of the continuous impact of the COVID-19, the sharp increase of global economic and trade uncertainty, the contraction of global industrial chains and supply chains, the increasing downward pressure on the economy, and the acceleration of economic structural transformation, the world is experiencing unprecedented changes (Wang, 2020), and the development of manufacturing enterprises is also facing unprecedented challenges. In 2021, the added value of China's manufacturing industry was 31.38 trillion yuan, corresponding to an increase of 9.8% over the previous year. Against the backdrop of the impact on the global supply chain, Chinese manufacturing stood out and showed strong growth. However, with the rapid expansion of the scale, manufacturing enterprises' internal control failures, including financial fraud and economic violations, occurred frequently, such as Ruixing coffee's forged transaction volume of 2.2 billion yuan, Kangmei pharmaceutical's 30 billion cash "disappeared," Furen pharmaceutical's 1.7 billion cash book unable to pay dividends, and Kangdexin's 12.2 billion "flying away," which not only reflect the major problems in the accounting information disclosure of manufacturing enterprises in China, but also raise concerns about the quality of internal control of listed manufacturing companies. Internal control quality (ICQ) is the key and foundation to enhance the risk resistance and control ability of manufacturing enterprises, and it is also the decisive factor affecting the high-quality development of manufacturing enterprises. Under the new situation, faced with the impact of a new round of scientific and technological revolution represented by artificial intelligence technology and the influence of the global COVID-19, how to improve the ICQ of manufacturing enterprises has become an important issue the industry and academia have to solve urgently.

DITI has given enterprises new development momentum. Can this further affect enterprises' ICQ? If there is an impact, how does this impact affect the ICQ of the enterprise, and whether there are significant differences in different situations? These problems are not only related to the quality and efficiency of manufacturing enterprises' DITI, but also crucial to accurately identify the enabling effect of digital technology. Unfortunately, to date, most scholars have mainly analyzed the economic consequences of DITI from the aspects of business performance and innovation ability (Eller et al., 2020; Nwankpa & Datta, 2017), and few researchers have focused on whether enterprise DITI would have an impact on the ICQ. The research on the operation law between enterprise DITI and ICQ is not sufficient. Thus, in this research, the authors empirically tested the impact mechanism of DITI on ICQ based on the data of China's A-share manufacturing listed companies from 2008 to 2020, so as to provide new evidence for understanding the effect of enterprise DITI.

This study makes several theoretical contributions:

1. Based on the perspective of internal control, it enriches the research on the economic consequences of DITI. This paper provides an analysis of the impact mechanism of DITI on manufacturing enterprises' ICQ, proves that DITI can positively affect manufacturing enterprises' ICQ through empirical analysis, expands relevant research in the field of DITI, and provides theoretical basis for enterprises to improve digital investment.
2. This study provides empirical support for existing research on the relationship between DITI and ICQ and clarifies the channel mechanism of the impact of DITI on ICQ. At present, no studies are available on how the DITI affects ICQ. This work opens the "black box" of DITI affecting manufacturing enterprises' ICQ from the perspectives of agency cost and institutional investor shareholding, expands the research on the influencing factors of ICQ, and provides new evidence support for optimizing the internal governance mechanism of enterprises.

3. The authors provide practical reference for increasing the improvement of manufacturing enterprise governance environment and helping manufacturing enterprises develop with high quality, starting from the differentiated situation of DITI. The authors investigated the differentiated effect of DITI on ICQ caused by different enterprise scale and manager ability, and refined the research framework between DITI and ICQ, which offer insights for managers and policymakers in formulating appropriate implementation strategies for DITI.

The remainder of the paper is organized as follows: The second section outlines the existing literature; the third section illustrates theoretical analysis and research hypotheses ; the fourth section describes the research design; the fifth section provides the empirical results and discussion; the sixth section presents further analysis; the seventh section ends the study with conclusions and policy implications.

LITERATURE REVIEW

The literature review mainly includes two aspects, namely, the economic consequences of the DITI and the driving factors of companies' internal control.

Research on the Economic Consequences of Digital Transformation

Existing literature on the economic consequences of DITI can be summarized into an analysis of the positive effects and the negative effects.

The Positive Effects of Digital Transformation

A large number of scholars believe that enterprises can accelerate business model innovation (Bertani et al., 2021; Philippart, 2022), enhance sensitivity to market changes (Mikalef & Pateli, 2017) and the efficiency of financial markets (Agyapong, 2020), support product and service innovation (Li, Feng et al., 2022; Li, Zhou et al., 2022; Lin & Ma, 2022; Thomas & Carsten, 2020), expand employment opportunities for the youths (Azu et al., 2021), optimize risk management (Ma & Zhang, 2022) and supply chain management (Deng, 2022; Liu et al., 2022; Mak & Shen, 2021; Qin & Xiang, 2022; Seyedghorban et al., 2020; Yao et al., 2021; Ye et al., 2022) through the digitalization of key businesses, key links and key parts, which ultimately help enterprises improve their sustainable competitive advantage (Hanelt et al., 2021) and organizational performance (Abou-foul et al., 2021; Wang et al ., 2022).

The Negative Effects of Digital Transformation

Some scholars hold negative attitudes towards the impact of digital technology application on enterprise performance. Some believe that the implementation of digital management will have uncertain effects on enterprises. They consider potential threats and challenges, including that the digital divide makes enterprises' organizational structure and business processes more complex and increases the difficulty of collaboration (Grewal et al., 2019). This leads to a decrease in the concentration of innovative resources and elements (Zeng et al., 2018), which makes R&D efficiency very low (Jacobides et al., 2018) and the driving effect of digitalization on enterprise value very limited.

Research on the Driving Factors of Companies' Internal Control

Previous research on the driving factors of companies' internal control is mainly focused on the following three aspects: The influence of companies' own factors, the impact of internal governance mechanism, and the impact of external factors.

As to the first aspect (i.e., the influence of companies' own factors), Doyle et al. (2007) found that factors such as company size, financial status, and listing years have a negative impact on

companies' ICQ. Zhang et al. (2013) sustained that organizational structure, information technology, and management attention are the key factors affecting the effectiveness of enterprise internal control. Laux and Stocken's (2012) research showed that the effectiveness of internal control is related to the corporate governance mechanism, the financial risk of enterprises, and the compliance with laws and regulations.

As to the second aspect (i.e., the impact of internal governance mechanism), the chief executive officer (CEO) is a company's main strategic decision-maker; this has an important impact on the internal control of the company. Research shows that the CEO's tenure (Lin et al., 2014) and equity incentive (Balsam et al., 2014) both positively affect the internal control of the enterprise. However, Yazawa (2015) highlighted that the CEO's length of the tenure is not directly correlated to the ICQ. At the same time, the audit committee is an important institutional arrangement for an effective corporate governance structure. Indeed, the audit committee is responsible for guiding and supervising the company's internal control process and improving the quality of the company's financial reports (Ashraf et al., 2020). Previous studies showed that the size of the audit committee (Khoo et al., 2020), the independence of its members (Krishnan, 2005), accounting expertise (Lisic et al., 2019), information technology expertise (Haislip et al.,2016), long tenure, and close geographical distance between auditors and the company (Chen et al., 2016) are all significantly and positively related to enterprises' ICQ. In addition, the knowledge and experience on internal control defects chain directors obtained in other companies can better guide and supervise the internal control of their current company (Cheng et al., 2019), thus helping to avoid similar problems in the current company and improve the quality of internal control. Li et al. (2010) found that high-quality chief financial officers would improve ICQ.

As to the third aspect (i.e., the impact of external factors), Kanagaretnam et al. (2016) studied the impact of national culture on internal control. They found that individualism and power distance were positively related to major defects of internal control, while uncertainty avoidance was negatively related to them. Liu et al. (2012) found that, in an institutional environment with high information transparency, the more competitive the market is, the more capable the company is to actively improve internal control. Further, the nonstandard behavior of the company's management in internal control can be effectively suppressed. When the company's information transparency is low, the agency behavior of the company's management is in a relatively opaque state, and the management has a strong motivation to hide self-interest and conduct financial manipulation (Lobo et al., 2017). In this case, ICQ is low. Chu and Fang (2018) found that government audit can improve the effectiveness of internal control of central enterprises, but this effect is short-term. Chen et al. (2020) found that the attention of media and institutional investors can improve ICQ.

In prior studies, researchers actively explored the economic consequences of DITI and the driving factors of ICQ, but some shortcomings are still present. More specifically, there is limited knowledge about the effect of DITI on internal control and, more importantly, existing research lacks empirical analysis based on large samples. Besides, the majority of scholars conducted a wealth of research on the factors affecting ICQ, but they ignored the driving role of DITI in the process of enterprise internal control. Previous research did not fully address the question on how DITI affects internal control and did not provide supporting evidence in a statistical sense.

THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

Direct Action Mechanism

The important goal of internal control is to improve enterprises' organizational effectiveness, operating efficiency, and effect. ICQ is determined by the effective level of the construction of internal control system and the completion of internal control objectives, which reflect the control power and resist ability of micro enterprises. The implementation of DITI aims to give full play to the advantages of

information technology, optimize enterprise management methods, and promote the improvement of enterprise operation efficiency, which is consistent with the goal of enterprise internal control. From the perspective of element composition, internal control is an institutional system of enterprise control environment, risk assessment, management decision-making activities, information and communication, and internal supervision. Enterprise DITI can comprehensively promote the efficiency and agility of all links of internal control, and finally improve enterprise ICQ.

Specifically, from the perspective of enterprise internal environment control, the application of the new generation of information technology can convert the massive data accumulated in all links of enterprise production and operation into structured and standardized information available to enterprises. It can also accelerate the flow of enterprise internal information through continuous iterative innovation of technology, so as to form a governance environment conducive to learning orientation and organizational change, and promote the improvement of enterprise internal control level from the perspective of organizational structure.

From the perspective of enterprise risk assessment, enterprise digitization can strengthen the accurate prediction and scientific decision-making of the relationship between market supply and demand through the new generation of digital intelligent technologies such as big data screening and algorithm recommendation, dynamically realize the risk capture and identification in the interaction between the enterprise and the environment, track and evaluate the potential risks in time, and greatly improve the probability of avoiding market risks.

From the perspective of control management decision-making activities, the division of labor among various departments of the enterprise is different but interrelated. In order to complete the internal control objectives of the enterprise, all departments need to cooperate and promote each other. The imbalance of a certain link may cause overcapacity. Therefore, it is necessary to pay high control costs to coordinate and coordinate the activities of various departments, which also increases the difficulty of implementing the construction of internal control to a certain extent. The use of a financial information system, a decision support system, and other information systems can help enterprises realize massive data mining and effective information screening, so as to help enterprises make more scientific decision-making schemes. At the same time, digital technology can strengthen the cooperation and linkage of the activities of various departments of the enterprise through effective transmission of key information and real-time tracking of production process, reduce the coordination cost between departments, and promote the dynamic feedback and evaluation of management decision-making. This allows to improve the efficiency of enterprise management decision-making and realize the efficient management and operation of the organization (Fernandez & Nieto, 2006).

From the perspective of information and communication, digital technologies such as big data, cloud computing, and blockchain can not only improve the information acquisition ability of enterprises, but also improve the information integration and application ability. With the cross-border connection attribute of digital technology, enterprises can search all kinds of information resources online and improve the breadth and depth of data search, so as to help enterprises obtain more comprehensive and valuable information. At the same time, enterprises can carry out intensive management of fragmented information, promote the effective coordination of diversified information resources (Ortiz et al., 2019), and then serve the enterprise's production decision-making, process tracking, and process optimization. As a result, companies can realize the effective connection between "supply and demand," ensure the real-time and transparency of important activities (e.g., enterprise R&D, production, and financial control) and make the information communication in all links of enterprises smoother. Thus, they can reduce the difficulty of implementing internal control construction and optimize the internal control process.

From the perspective of internal supervision, digital technology is a new supervision tool and governance means, which can effectively reduce the degree of information asymmetry. On the one hand, the application of digital technology can improve the enterprise's own information disclosure system, improve the quality of information disclosure, and make the enterprise's information disclosure

more transparent, open, and timely (Zhao et al., 2020). On the other hand, enterprise DITI helps to form a digital governance system based on data mining, analysis, and application, and promotes the accuracy and scientization of enterprise supervision and governance mechanism (Zhao et al., 2020). In this regard, the authors put forward the following assumption:

Hypothesis One: DITI can improve ICQ.

Indirect Mechanism: The Dual Path of Internal Governance and External Supervision

The main mechanism of enterprise DITI on enterprise ICQ lies in the reduction of agency cost and the attraction to institutional investors. It promotes enterprise ICQ by giving full play to the internal governance effect and external supervision effect.

According to the principal-agent theory, information asymmetry between management at all levels and between management and shareholders is the main incentive for the company's management to implement nonstandard behaviors contrary to internal control (Lobo et al., 2017). Information runs through all internal control activities of the enterprise. It is the key and foundation to ensure the implementation of various control activities, which is very important to improve ICQ. For enterprises to implement DITI, on the one hand, the new generation of information technology can promote the information transmission between shareholders and managers, enterprises, and the outside world through better information mining and integration functions, break the information barrier between management, and reduce the blindness and uncertainty in the activities of the management's internal control, so as to effectively reduce the impact of internal agency problems on the level of internal control. On the other hand, enterprises can build a digital governance system with the help of intelligent algorithms, big data, and other technical means to promote a more sound enterprise information disclosure mechanism. Relying on the enterprise's digital information platform, shareholders can timely and efficiently obtain the internal control information of the management, timely understand the operation status of the enterprise, form effective supervision over the management, and minimize the speculation of the enterprise in internal control activities such as budget and resource allocation. This will alleviate the principal-agent contradiction, urge the management to standardize the enterprise internal control system, and reasonably improve their own internal control level. In this regard, the authors put forward the following assumption:

Hypothesis Two: Agency cost plays an intermediary role in improving ICQ in DITI.

Under the condition of better processing and output of effective information, enterprises' DITI can "push" information to market subjects, and institutional investors can undoubtedly grasp more information than before, thus reducing the degree of information asymmetry between the two sides. More importantly, enterprises' DITI is becoming the focus of social construction and development in the new era and new stage. It can make use of its own technological advantages to realize information analysis, direction grasp, and process optimization of enterprises' various activities, greatly improve enterprises' information processing capacity (Wu et al., 2021), optimize the allocation of enterprise resources, increase enterprises' innovation ability and performance, and enable enterprises to reach the boundary of maximum capital use efficiency under the constraint of limited resources. At the same time, enterprises' DITI releases positive signals to the outside world by means of annual report information disclosure and actual production technology transformation investment. Institutional investors tend to have higher expectations for enterprises undergoing DITI. Indeed, they expect a better rate of return on investment, which has an important function of guiding investors' limited attention and attracting a large number of institutional investors' attention and participation. Institutional investors have professional and strong investment analysis ability and long-term value investment concept. In

order to achieve the goal of maximizing long-term investment income, a higher shareholding ratio will make institutional investors more motivated to collect and analyze relevant information of listed companies and supervise the misconduct of insiders (Li et al., 2018).

On the one hand, in order to maximize their own interests, institutional investors actively participate in enterprise decision-making by giving full play to their resources and professional advantages; they understand the internal governance of enterprises, supervise enterprises to build a transparent internal control system, independently disclose internal control evaluation reports, and track the operation of listed companies (Harford et al., 2018). In this way, they promote the effective operation of enterprise internal control.

On the other hand, institutional investors can use their information advantages to timely transmit the "signal" of good or bad business operation to the capital market. At the same time, when there are defects in the enterprise's internal control, institutional investors can use the way of "voting with their feet" to put pressure on the management, urge the enterprise to strengthen the construction of internal control, reduce the defects of internal control, continuously improve the company's operating efficiency, and reduce self-interest behavior. In this way, institutional investors promote the improvement of ICQ. In this regard, the authors put forward the following assumption:

Hypothesis Three: Institutional investors' shareholding plays an intermediary role in improving ICQ in DITI.

RESEARCH DESIGN

Sample Selection and Data Source

In this study, the authors selected China's A-share manufacturing listed companies from 2008 to 2020 as the initial research sample, and excluded the samples of financial industry, Special Treatment or Particular Transfer, missing data, and abnormal financial data. After the above processing, the authors obtained a total of 19791 annual observation values of enterprises. The authros drew the main data for this paper from CSMAR database, the internal control index from Shenzhen DIB internal control and risk management database, the DITI data by sorting out the relevant materials of the annual reports of listed companies. The authors used Stata16.0 to process related data.

Variable Selection and Definition

Dependent Variables

Internal Control Quality: We adopted the natural logarithm after adding 1 to Dibo internal control index of Chinese listed companies to measure the level of enterprise internal control.

Independent Variables

Digital Transformation: In this paper, the authors argue that, as a major strategy for enterprises' high-quality development in the new era, their DITI is easier to be reflected in their annual reports. Indeed, focused and coherent annual reports can convey the enterprise's strategy, vision, business philosophy, and relevant development path. Therefore, the authors used text analysis based on Python to identify enterprises' degree of transformation. More specifically, they analyzed the annual reports of listed enterprises by calculating the relevant word frequency related to "enterprise digital transformation" (Wu et al., 2021).

As to the classification of keywords, first of all, enterprises will focus on relying on "digital technology driven" to transform and improve the digitalization of the original technology system and production system in the process of enterprise DITI, which depends on the layout and development of key core technologies. Among them, "ABCD" technologies (e.g., artificial intelligence, blockchain,

cloud computing, and big data) constitute the core architecture of enterprise DITI (Qi & Xiao, 2020), which focuses on "the application of underlying technology." Furthermore, DITI is more focused on how to "land," emphasizing the integration of digital technology and complex behavior scenarios. This level focuses on "practical application of technology." In this regard, the authors divided DITI into two levels, namely, "bottom technology application" and "technology practice application."

As to the determination of the characteristic words of enterprise DITI, the authors propose a subitem discussion based on the academic field and the industrial field. On the reference of academic literature, the authors referred to the theme of DITI (Wu et al., 2021; Yuan et al., 2021; Zhao et al., 2020), and sorted out specific keywords related to DITI. The authors further expanded the featured lexicon of DITI on the basis of important policy documents and research reports, such as the report on the trend of DITI in 2020 and the government implementation plan for "using data to empower intelligence on the cloud" to facilitate new economic development. According to the above analysis, the authors carried out the structural classification (i.e., the two levels of "bottom technology application" and "technology practice application") and formed a featured lexicon (Table 1).

In terms of specific measurement, firstly, based on the Python crawler function, the authors collected and sorted out the annual reports of A-share listed companies of China from CNINFO. Subsequently, they extracted all text content through the Java pdfbox library and used it as a data pool for subsequent feature word screening. Secondly, according to the keywords in Table 1, the researchers used Python to search, match, and count the word frequency of the corresponding keywords in the annual report. Then, the authors eliminated the negative words such as "no" and "none" before the keywords and also the keywords "digital transformation" that were not relevant to the company. Finally, the authors logarithmized the aforementioned keyword statistics, that is, they measured the relative level of firms' DITI by the logarithm of the total number of occurrences of keywords plus one.

Table 1. Construction of corporate digital transformation indexes

Index	Dimension		Key feature terms
Digitalization	Bottom technology application	Artificial intelligence technology	Artificial intelligence, intelligent robot, business intelligence, image understanding, face recognition, voice recognition, investment decision support system, intelligent data division analysis, machine learning, authentication automatic driving, depth learning, semantic search, natural language processing.
		Blockchain technology	Blockchain, digital currency, distributed computing, privacy technology, smart financial contract.
		Cloud computing technology	Cloud computing, Internet of things, billion level concurrency, graph computing, cognitive computing, stream computing, memory computing, multi-party security computing, brain like computing, green computing, color computing, fusion architecture, EB level storage, information physical system.
		Big data technology	Big data, augmented reality, data mining, text mining, heterogeneous data, credit reporting, data visualization, mixed reality, virtual reality.
	Technology practice application	Digital scene application	Mobile Internet, Industrial Iinternet, Internet medical, E-commerce, mobile payment, third party payment, NFC payment, Smart energy, B2B, B2C, C2B, C2C, O2O, Internet connection, intelligent factory, intelligent logistics, intelligent manufacturing, intelligent warehousing, intelligent equipment, intelligent production, digital marketing, unmanned retail, Internet gold finance, digital finance, fintech, financial technology, quantitative finance, open banking.

Intermediary Variables

Agency Cost and Institutional Investor Shareholding: The total asset turnover rate is used to measure the agency cost of enterprises, that is, the higher the total asset turnover rate, the lower the agency cost. Based on Zhen et al.'s (2021) method, the authors measured the shareholding ratio of institutional investors by the sum of the proportion of six types of institutional investors: Securities companies, securities investment funds, social security funds, Qualified Foreign Institutional Investors, trust companies, and insurance companies.

Control Variables

The control variables the authors selected mainly include those at firm level and corporate governance level. Table 2 lists the definitions and descriptions of all variables.

Table 2. Name and definition of variables

Variable and variable names	Variable definition
Dependent variables	
ICQ	Log (internal control index of Chinese Listed Companies+1).
Independent variables	
DITI	Log (the total word frequency based on crawler data collection and sorting+1).
Intermediary variables	
Agency cost (TTA)	Operating income/total assets.
Institutional investor shareholding (HOLD)	The sum of the proportion of six types of institutional investors: Securities companies, securities investment funds, social security funds, Qualified Foreign Institutional Investors, trust companies, and insurance companies.
Control variables	
Company size (SIZE)	Log (total assets at the year end).
Asset liability ratio (LEV)	Total liabilities/total assets.
Enterprise profitability (ROE)	Return on net assets.
Cash holding level (CASH)	Cash and its cash equivalents/total assets.
Shareholding ratio of the largest shareholder (TOP1)	Shareholding ratio of the largest shareholder.
Company listing age (LISTAGE)	Difference between the current year and the year of listing.
The nature of property right (SOE)	State-owned enterprises=1, otherwise=0.
Book to market ratio (BM)	Owner's equity of the end of year/market value.
Proportion of independent directors (INDEP)	Number of independent directors/number of board of directors.
Dual (DUAL)	One for the chairman and general manager=1, otherwise =0.
Whether auditors are from the four major international firms (BIG4)	If the auditors are from the top four international firms=1, otherwise=0.
YEAR	Year dummy variable.
INDUSTRY	Industry dummy variable.

Model Formulation

According to Wen and Ye (2014), the authors used the stepwise regression method to test the direct effect of DITI on ICQ and the intermediary effect of agency cost and shareholding of institutional investors. Equations (1)—(3) show the specific model:

$$ICQ_{i,t} = \alpha_0 + \alpha_1 DITI_{i,t} + \alpha_2 Controls + YEAR + INDUSTRY + \varepsilon_{i,t} \quad (1)$$

$$MED_{i,t} = \beta_0 + \beta_1 DITI_{i,t} + \beta_2 Controls + YEAR + INDUSTRY + \varepsilon_{i,t} \quad (2)$$

$$ICQ_{i,t} = \gamma_0 + \gamma_1 DITI_{i,t} + \gamma_2 MED_{i,t} + \gamma_3 Controls + YEAR + INDUSTRY + \varepsilon_{i,t} \quad (3)$$

where α_1 represents the total effect of DITI on enterprise ICQ, β_1 represents the impact of DITI on the intermediary variable (i.e., agency cost and shareholding ratio of institutional investors), and γ_2 represents the influence of intermediary variable (i.e., agency cost and shareholding ratio of institutional investors) on enterprise ICQ. According to Wen and Ye's (2014) method, whether the mediating effect is significant mainly depends on whether β1 and γ_2 are significant. The total effect is $\alpha 1 = \gamma_1 + \beta_1 \times \gamma_2$; the degree of the mediating effect is measured by $\beta 1 \times \gamma_2 / \alpha_1$.

E$_M$PIRICAL RESULTS AND DISCUSSION

Descriptive Statistics of Variables

Table 3 shows the descriptive statistical results of all variables. From the perspective of the ICQ index, the mean value is 6.206, the standard deviation is 1.315, and the median is 6.504,

Table 3. Descriptive statistical analysis of variables

Variables	N	Mean	p50	sd	Min	Max
ICQ	19791	6.206	6.504	1.315	0.000	6.902
DITI	19791	1.171	0.693	1.243	0.000	5.517
HOLD	19791	6.292	2.116	9.560	0.000	54.195
TTA	19791	0.684	0.592	0.468	0.001	11.841
SIZE	19791	21.929	21.792	1.194	17.388	27.547
LEV	19791	0.414	0.405	0.203	0.007	1.758
ROE	19791	0.037	0.066	1.382	-174.895	21.348
CASH	19791	0.048	0.046	0.075	-0.762	1.127
INDEP	19791	0.373	0.333	0.054	0.091	0.750
DUAL	19791	0.287	0.000	0.452	0.000	1.000
LISTAGE	19791	2.100	2.197	0.743	0.000	3.434
TOP1	19791	0.338	0.317	0.143	0.029	0.900
SOE	19791	0.315	0.000	0.464	0.000	1.000
BM	19791	0.879	0.614	1.360	0.008	143.803
BIG4	19791	0.044	0.000	0.205	0.000	1.000

which reflects the low level of ICQ of manufacturing enterprises in China, with great differences among enterprises. The mean value of DITI degree is 1.171 and its standard deviation is 1.243, indicating a large gap in the implementation of DITI among different enterprises. The average and median shareholding ratio of institutional investors (HOLD) are 6.292% and 2.116%, respectively, reflecting the high shareholding ratio of a few institutional investors. The average agency cost (TTA) is 0.684 and the standard deviation is 0.468, indicating some differences in agency costs among different enterprises.

Analysis of Benchmark Regression Results

Table 4 shows the basic regression results between DITI and ICQ of manufacturing enterprises. Column (1) is the result of estimation using ordinary least squares method with only the explanatory variable DITI. The results show that DITI has a significant positive impact on ICQ; column (2) includes year and industry fixed effects, and the estimated coefficient of DITI passes the test at the significant level of 1%. Compared with column (1), R^2 in column (2) is greatly improved, indicating that the interpretation degree of the equation is further enhanced. Column (3) includes further control variables and the empirical results are consistent with expectations. The regression coefficient of DITI is 0.050 and passes the test at the 1% significant level; this shows that, after controlling various heterogeneous conditions, DITI has a significant positive impact on ICQ. Hypothesis one is verified.

Conduction Mechanism Test

The authors carried out the transmission mechanism test by stepwise regression; columns (1)—(3) in Table 5 are the test results of the intermediary model using agency cost. Column (1) of Table 5 shows that the coefficient of DITI is 0.050, which passes the 1% significance level test. Column (2) evidences that the coefficient of DITI is 0.009, which is significantly positively correlated at the level of 1%, indicating that the higher the degree of DITI, the higher the total asset turnover, that is, the lower the agency cost of the enterprise. Column (3) reports the common impact of DITI and agency cost on enterprise ICQ. The coefficients of DITI and TTA are positive, and both pass the test at the 1% significance level, indicating that DITI can indirectly promote the improvement of enterprise ICQ by reducing enterprise agency cost, and there are some intermediary effects. Hypothesis two is confirmed. Columns (4)—(6) are the test results of the intermediary model using the shareholding of institutional investors. The result of column (4) is the same as that of column (1). The results of column (5) show that the coefficient of DITI is 0.485, which is tested at the significant level of 1%, indicating that DITI can actively promote the increase of shareholding proportion of institutional investors. The results of column (6) show that the regression coefficient between HOLD and ICQ is 0.002, which is significantly positively correlated at the level of 5%. At the same time, the direct effect of DITI on ICQ (β=0.050, P<0.01) is also significant, indicating that DITI can indirectly promote the improvement of ICQ of manufacturing enterprises by increasing the shareholding ratio of institutional investors, and there are some intermediary effects. Hypothesis three is verified.

Endogenous Treatment and Robustness Test

The previous analysis may raise endogenous problems. On the one hand, the improvement of digitization will promote ICQ. On the other hand, enterprises with better ICQ may also have higher demand to promote high-level digitization. The authors used the following methods to solve the above endogenous problems:

1. **Lag Test:** The authors reintroduced the explanatory variable DITI into the model calculation after one lag period. The results in column (1) of Table 6 show that the estimated coefficient of DITI is 0.043, which is significantly positively correlated at the 1% level.

Table 4. Benchmark regression results

	(1)	(2)	(3)
	ICQ	**ICQ**	**ICQ**
DITI	0.041***	0.107***	0.050***
	(5.32)	(11.27)	(5.84)
SIZE			0.267***
			(20.04)
LEV			-1.262***
			(-15.53)
ROE			0.052**
			(2.50)
CASH			1.171***
			(6.51)
INDEP			0.050
			(0.30)
DUAL			0.003
			(0.16)
LISTAGE			-0.274***
			(-16.95)
TOP1			0.169***
			(2.81)
SOE			0.055**
			(2.19)
BM			-0.061***
			(-5.33)
BIG4			-0.117***
			(-2.93)
CONSTANT	6.111***	6.345***	1.769***
	(426.56)	(185.86)	(6.76)
YEAR	NO	YES	YES
INDUSTRY	NO	YES	YES
N	19791	19791	19791
A-R^2	0.001	0.017	0.111

Note: t-values based on robust standard errors are in parentheses; *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

2. **Propensity Score Matching Method:** Aiming at the problem of sample selectivity error, using the propensity score matching method, taking the control variable in model (1) as the pairing variable, the authors matched the enterprises with and without DITI by 1:1 nearest neighbor. The ATT value after matching is 0.083, which passes the test at the 5% significant level. On this basis, the researchers used the samples after matching screening for regression again. The results are in column (2) of Table 6; the DITI coefficient is 0.050, which passes the 1% significance level test.

Table 5. Test of intermediary effect based on agency cost and shareholding of institutional investors

	(1)	(2)	(3)	(4)	(5)	(6)
	ICQ	TTA	ICQ	ICQ	HOLD	ICQ
DITI	0.050***	0.009***	0.049***	0.050***	0.485***	0.050***
	(5.84)	(2.97)	(5.65)	(5.84)	(7.42)	(5.76)
TTA			0.173***			
			(5.77)			
HOLD						0.002**
						(2.34)
SIZE	0.267***	0.010*	0.266***	0.267***	2.967***	0.263***
	(20.04)	(1.76)	(20.07)	(20.04)	(11.40)	(19.03)
LEV	-1.262***	0.378***	-1.322***	-1.262***	-4.924***	-1.255***
	(-15.53)	(14.79)	(-16.02)	(-15.53)	(-5.22)	(-15.47)
ROE	0.052**	0.010	0.051**	0.052**	0.058	0.052**
	(2.50)	(1.21)	(2.55)	(2.50)	(0.79)	(2.51)
CASH	1.171***	0.954***	0.995***	1.171***	15.780***	1.146***
	(6.51)	(13.58)	(5.38)	(6.51)	(13.92)	(6.28)
INDEP	0.050	-0.210***	0.090	0.050	1.045	0.048
	(0.30)	(-3.91)	(0.54)	(0.30)	(0.87)	(0.29)
DUAL	0.003	-0.026***	0.007	0.003	0.676***	0.002
	(0.16)	(-3.85)	(0.36)	(0.16)	(4.57)	(0.11)
LISTAGE	-0.274***	-0.013***	-0.279***	-0.274***	-1.687***	-0.271***
	(-16.95)	(-2.79)	(-17.24)	(-16.95)	(-17.91)	(-16.57)
TOP1	0.169***	0.244***	0.122**	0.169***	-4.691***	0.176***
	(2.81)	(11.55)	(2.02)	(2.81)	(-9.36)	(2.92)
SOE	0.055**	0.029***	0.052**	0.055**	-0.455**	0.056**
	(2.19)	(3.37)	(2.07)	(2.19)	(-2.23)	(2.21)
BM	-0.061***	-0.018**	-0.058***	-0.061***	-1.217	-0.060***
	(-5.33)	(-2.10)	(-5.65)	(-5.33)	(-1.57)	(-5.56)
BIG4	-0.117***	0.055***	-0.128***	-0.117***	0.151	-0.117***
	(-2.93)	(3.52)	(-3.21)	(-2.93)	(0.40)	(-2.94)
CONSTANT	1.769***	0.496***	1.685***	1.769***	-44.777***	1.834***
	(6.76)	(4.28)	(6.47)	(6.76)	(-8.90)	(6.84)
YEAR	YES	YES	YES	YES	YES	YES
INDUSTRY	YES	YES	YES	YES	YES	YES
N	19791	19791	19791	19791	19791	19791
A-R^2	0.111	0.085	0.115	0.111	0.171	0.111

Note: t-values based on robust standard errors are in parentheses; *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

3. **Excluding the Impact of Annual Events in the Industry:** The authors controlled the fixed effect of industry annual multiplication on the basis of industry and year. Column (3) shows that the estimated coefficient of DITI is 0.051, which is significant at the level of 1%.

In addition, the authors also tested the robustness through the following methods:

1. **Replacing the Model:** Based on the panel quantile regression model, the authors investigated the marginal effect of DITI on ICQ at 0.5 quantile. The results are shown in column (4) of Table 6. The regression coefficient passed the test at the 1% significance level, which is not substantially different from the previous results.
2. **Resetting the Sample Interval:** The authors deleted the samples from the first three years and brought the sample data from 2011 to 2020 into the model again for robustness test. The results are shown in column (5) of Table 6. The regression results are basically consistent with the previous results, which proves that the research conclusion of this study is reliable.

FURTHER ANALYSIS

Regulation Effect of Enterprise Scale

The application degree and development level of information technology in large and small enterprises will be at different levels as a result of their different capital, technology, and other resources. Generally speaking, large-scale manufacturing enterprises have better information infrastructure, higher level of information integration and utilization, and limited room to improve ICQ. On the contrary, for smaller enterprises, it is difficult to obtain information, so enterprises have a stronger motivation to improve the corporate governance environment by implementing DITI. Column (1) of Table 7 shows the adjustment results of enterprise scale. The multiplier coefficient of DITI and enterprise size (SIZE) is -0.02 and passes the test at the 1% significant level; it shows that the smaller the enterprise size, the stronger the enterprise's motivation to implement DITI, the greater the space to play, and the more significant the impact on the enterprise's ICQ.

Table 6. Endogenetic treatment and robustness test

	(1)	(2)	(3)	(4)	(5)
	ICQ	**ICQ**	**ICQ**	**ICQ**	**ICQ**
L.DITI	0.043***				
	(4.63)				
DITI		0.050***	0.051***	0.005***	0.049***
		(3.78)	(5.88)	(6.55)	(5.44)
CONSTANT	1.623***	1.433***	1.830***	6.041***	0.776**
	(6.15)	(3.43)	(7.08)	(325.62)	(2.44)
Controls	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES
INDUSTRY	YES	YES	YES	YES	YES
INDUSTRY×YEAR	NO	NO	YES	NO	NO
N	19785	7709	19791	19791	17180
A-R^2	0.114	0.114	0.112	0.133	0.113

Note: t-values based on robust standard errors are in parentheses; *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Regulatory Effect of Managers' Ability

When the ability of enterprise managers is strong, their advantages in information acquisition and integration are more obvious, and the efficiency of using assets is relatively high. In order to maintain their good reputation, they have stronger motivation to implement DITI and promote the improvement of ICQ. On the contrary, when the ability of managers is weak, the management is more likely to have differences, and it is difficult to form a unified opinion on the implementation of DITI. Therefore, the motivation of enterprises to implement DITI to improve the effectiveness of internal control is weak. Referring to Demerjian et al.'s (2012) practice, the DEA Tobit two-stage model is used to measure the manager's ability level (MA).

Column (2) of Table 7 shows the adjustment results of managers' ability. The multiplication coefficient of DITI and manager ability (MA) is 0.132 and passes the test at the 5% significant level. This shows that the stronger the ability of enterprise managers, the more obvious the motivation of enterprises to implement DITI, the greater the space to play, and the more significant the impact on enterprises' ICQ.

Economic Consequences of Digital Transformation to Improve the Quality of Internal Control

Total factor productivity of enterprises is not only affected by technological progress, but also closely related to factors such as resource allocation ability and management level. As an important part of

Table 7. Further analysis results

	(1)	(2)	(3)	(4)	(5)
	ICQ	**ICQ**	**TFP**	**ICQ**	**TFP**
DITI	0.491***	0.036***	0.046***	0.050***	0.044***
	(3.74)	(4.48)	(12.43)	(5.78)	(12.09)
SIZE	0.293***				
	(18.23)				
DITI×SIZE	-0.020***				
	(-3.39)				
MA		0.105			
		(0.94)			
MA×DITI		0.132**			
		(2.03)			
ICQ					0.042***
					(7.95)
CONSTANT	1.228***	4.242***	-6.486***	1.762***	-6.659***
	(3.82)	(15.45)	(-58.62)	(6.74)	(-59.00)
Controls	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES
INDUSTRY	YES	YES	YES	YES	YES
N	19791	14151	18589	19791	18587
A-R^2	0.112	0.057	0.746	0.112	0.748

Note: t-values based on robust standard errors are in parentheses; *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

corporate governance mechanism, internal control is an important path for enterprises to improve the efficiency of resource allocation. According to the principal-agent theory, high-quality internal control can improve the quality of enterprise accounting information, alleviate the information asymmetry between shareholders and management, management and the outside world, so as to reduce the agency risk and promote the management to optimize the allocation of resources. At the same time, high-quality internal control can improve the information transparency of enterprises, attract investors' attention to enterprises, so that enterprises can obtain more resources at a lower cost, and finally help enterprises achieve high-quality development. Therefore, in this study the authors further tested the intermediary effect of ICQ between enterprise DITI and total factor productivity. Referring to Hu et al.'s (2020) research, the authors used the LP method to measure the total factor productivity (TFP) of enterprises. According to the abovementioned general test procedure of intermediary effect, on the basis of significantly improving ICQ by enterprise DITI, the authors further integrated enterprise DITI and ICQ into the regression model of the impact on enterprise TFP. Columns (3)—(5) of Table 7 show the test results of intermediary effect. In column (3), the coefficient of enterprise DITI is 0.046 and passes the 1% significance level test; it shows that DITI can promote the improvement of enterprise TFP. In column (5), the regression coefficients of enterprise DITI and ICQ on enterprise TFP are 0.044 and 0.042, respectively, and both have passed the significance test at the level of 1%, indicating that the quality of internal control has a partial intermediary effect between enterprise DITI and enterprise TFP. It further shows that enterprise digitization can improve enterprises' TFP by strengthening ICQ, and finally help enterprises achieve high-quality development.

CONCLUSION AND IMPLICATIONS

Conclusion

The DITI of enterprises is not only the micro focus of realizing the deep integration of digital economy and real economy, but also a major strategic measure to help the high-quality development of manufacturing enterprises. In this paper, the authors discussed the impact mechanism of DITI on the ICQ of manufacturing enterprises, and empirically analyzed the indirect path effect of agency cost and institutional investor shareholding between DITI and the ICQ of manufacturing enterprises, as well as the degree of impact under different situations. The results showed that:

1. DITI can directly promote manufacturing enterprises' ICQ.
2. The mechanism analysis indicates that DITI can have a positive impact on manufacturing enterprises' ICQ by reducing enterprise agency costs and attracting the attention of institutional investors. Agency costs and institutional investors' shareholding play a partial intermediary effect in the role path of DITI in promoting the improvement manufacturing enterprises' ICQ.
3. The moderating effect analysis indicates that the promotion effect of DITI on ICQ is more obvious in manufacturing enterprises with small scale and strong manager ability.
4. The TFP of manufacturing enterprises has been significantly improved after the improvement of ICQ.

Practical Implications

According to the above conclusions, the authors put forward the following countermeasures and suggestions. First, enterprises should actively promote DITI. Manufacturing enterprises can actively strengthen the construction of digital infrastructure, build an enabling platform for digital technology, and strengthen data integration and sharing with the help of their own resource advantages. Besides, companies can accelerate the construction of their data governance system to realize dynamic data collection, transmission, aggregation, and application. They can establish a situation awareness platform to realize the automatic awareness, real-time tracking, and adaptive optimization decision-

making of the whole process and all elements of the enterprise, and fully release the dividend of digital technology on the internal control of the enterprise.

Second, in terms of internal control, enterprises should not only optimize the internal governance of the company, but also pay attention to the possible impact of external driving forces (e.g., institutional investors) on the enterprise. In terms of corporate governance, enterprises should actively promote organizational change to match the organizational structure with the enterprise digital strategy, create a good learning atmosphere and encourage all staff to participate in digital change, and improve the mechanism of enterprise information disclosure and governance. In terms of external drive, companies should pay attention to the introduction of strategic partners, give full play to the information and professional advantages of institutional investors, and optimize resource allocation. Only through the coordinated promotion of internal and external forces can internal control really play a role in preventing enterprise risks and improving enterprise operation efficiency, and finally help enterprises achieve their strategic objectives.

Third, smaller manufacturing enterprises and stronger managers face greater competitive pressure and stronger internal control needs. The government should break through the existing institutional constraints, implement classified supervision, and promote DITI according to the organizational characteristics and strategic tasks of different types of manufacturing enterprises, so as to accurately use digital technology for enterprises and promote ICQ. Finally, this will help manufacturing enterprises achieve high-quality development and create favorable conditions.

ACKNOWLEDGMENT

This work was financed by the key project of the National Social Science Foundation of China [grant number 21AJY020].

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

Abou-foul, M., Ruiz-Alba, J. L., & Soares, A. (2021). The impact of digitalization and servitization on the financial performance of a firm: An empirical analysis. *Production Planning and Control*, *32*(12), 975–989. do i:10.1080/09537287.2020.1780508

Agyapong, D. (2020). Implications of digital economy for financial institutions in Ghana: An exploratory inquiry. *Transnational Corporations Review*, *13*(1), 51–61. doi:10.1080/19186444.2020.1787304

Ashraf, M., Michas, P. N., & Russomanno, D. (2020). The impact of audit committee information technology expertise on the reliability and timeliness of financial reporting. *The Accounting Review*, *95*(5), 23–56. doi:10.2308/accr-52622

Azu, N. P., Jelivov, G., Aras, O. N., & Isik, A. (2021). Influence of digital economy on youth unemployment in West Africa. *Transnational Corporations Review*, *13*(1), 32–42. doi:10.1080/19186444.2020.1849936

Balsam, S., Jiang, W., & Lu, B. (2014). Equity incentives and internal control weaknesses. *Contemporary Accounting Research*, *31*(1), 178–201. doi:10.1111/1911-3846.12018

Bertani, F., Ponta, L., Raberto, M., Teglio, A., & Cincotti, S. (2021). The complexity of the intangible digital economy: An agent-based model. *Journal of Business Research*, *129*(5), 527–540. doi:10.1016/j. jbusres.2020.03.041

Chadee, D., Ren, S., & Tang, G. (2021). Is digital technology the magic bullet for performing work at home? Lessons learned for post COVID-19 recovery in hospitality management. *International Journal of Hospitality Management*, *92*, 102718. doi:10.1016/j.ijhm.2020.102718 PMID:33071425

Chen, Y., Gul, F. A., Truong, C., & Veeraraghavan, M. (2016). Auditor client specific knowledge and internal control weakness: Some evidence on the role of auditor tenure and geographic distance. *Journal of Contemporary Accounting and Economics, 12*(2), 121-140. doi:. 2016.03.00110.1016/j.jcae

Chen, Z. J., Dong, M. T., Ma, P. C., & Min, Y. J. (2020). Media and institutional investors pay attention to the interaction of internal control-empirical data from state-owned enterprises. *Finance and Trade Research*, *31*(9), 99–110. doi:10.19337/j.cnki.34-1093/f.2020.09.009

Cheng, S., Felix, R., & Indjejikian, R. (2019). Spillover effects of internal control weakness disclosures: The role of audit committees and board connections. *Contemporary Accounting Research*, *36*(2), 934–957. doi:10.1111/1911-3846.12448

Chu, J., & Fang, J. X. (2018). Can government audit improve the effectiveness of internal control of central enterprises? *Accounting and Economic Research*, *32*(5), 18–39. doi:10.16314/j.cnki.31-2074/f.2018.05.002

Demerjian, P. R., Lev, B., & Mcvay, S. (2012). Quantifying managerial ability: A new measure and validity tests. *Management Science*, *58*(7), 1229–1248. doi:10.1287/mnsc.1110.1487

Deng, K. (2022). Research on evaluation of intelligent manufacturing capability and layout superiority of supply chains by big data analysis. *Journal of Global Information Management*, *30*(7), 1–20. doi:10.4018/JGIM.294903

Ding, Y., Zhang, H., & Tang, S. (2021). How does the digital economy affect the domestic value-added rate of Chinese exports? *Journal of Global Information Management*, *29*(5), 71–85. doi:10.4018/JGIM.20210901.oa5

Doyle, J., Ge, W., & McVay, S. (2007). Determinants of weaknesses in internal control over financial reporting. *Journal of Accounting and Economics*, *44*(1-2), 193–223. doi:10.1016/j.jacceco.2006.10.003

Eller, R., Alford, P., Kallmünzer, A., & Peters, M. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. *Journal of Business Research*, *112*(C), 119–127. doi:10.1016/j. jbusres.2020.03.004

Fernandez, Z., & Nieto, M. J. (2006). The Internet: Competitive strategy and boundaries of the firm. *International Journal of Technology Management, 1*, 182-195. doi:. 00923410.1504/ijtm.2006

Grewal, L., Stephen, A. T., & Coleman, N. V. (2019). When posting about products on social media backfires:The negative effects of consumer identity signaling on product interest. *Journal of Marketing*, *1*(2), 1–14. doi:10.1177/0022243718821960

Haislip, J. Z., Peters, G. F., & Richardson, V. J. (2016). The effect of auditor IT expertise on internal controls. *International Journal of Accounting Information Systems*, *20*, 1–15. doi:10.1016/j.accinf.2016.01.001

Hanelt, A., Bohnsack, R., Marz, D., & Marante, C. A. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. *Journal of Management Studies*, *58*(5), 1159–1197. doi:10.1111/joms.12639

Harford, J., Kecskes, A., & Mansi, S. (2018). Do long-term investors improve corporate decision making? *Journal of Corporate Finance*, *50*, 424–452. doi:10.1016/j.jcorpfin.2017.09.022

Hu, H. F., Dou, B., & Wang A. P. (2020). Enterprise financialization and production efficiency. *World Economy, 1*, 70-96. doi:CNKI:SUN:SJJJ.0.2020-01-006

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal*, *39*(8), 2255–2276. doi:10.1002/smj.2904

Kanagaretnam, K., Lobo, G. J., Ma, C., & Zhou, J. (2016). National culture and internal control material weaknesses around the world. *Social Science Electronic Publishing*, *31*(1), 28–50. doi:10.1177/0148558X14560897

Khoo, E. S., Lim, Y., & Monroe, G. S. (2020). Audit committee members' reputation incentives and their effectiveness in monitoring the financial reporting process. *Abacus*, *56*(3), 348–406. doi:10.1111/abac.12201

Krishnan, J. (2005). Audit committee quality and internal control: An empirical analysis. *The Accounting Review*, *80*(2), 649–675. doi:10.2308/accr.2005.80.2.649

Laux, V., & Stocken, P. C. (2012). Managerial reporting, overoptimism, and litigation risk. *Journal of Accounting and Economics*, *53*(3), 577–591. doi:10.1016/j.jacceco.2012.02.001

Li, C., Feng, W., Han, S., Gupta, S., & Kamble, S. (2022). Digital adaptive governance, digital transformation, and service quality in logistics enterprises. *Journal of Global Information Management*, *30*(1), 1–26. doi:10.4018/JGIM.309377

Li, C., Sun, L., & Ettredge, M. (2010). Financial executive qualifications, financial executive turnover, and adverse SOX 404 opinions. *Journal of Accounting and Economics*, *50*(1), 93–110. doi:10.1016/j.jacceco.2010.01.003

Li, C. T., Liu, B. B., Zhou, P., & Zhang, X. (2018). Stone of other mountains: QFII and information disclosure of listed companies. *Financial Research*, (12), 138-156. doi:CNKI:SUN:JRYJ.0.2018-12-009

Li, L., Zhou, W., Weig, L., & Yang, S. (2022). How can digital collaboration capability boost service innovation? Evidence from the information technology industry. *Technological Forecasting and Social Change*, *182*, 121830. doi:10.1016/j.techfore.2022.121830

Lin, B., & Ma, R. (2022). How Does Internet Development Affect Green Technology Innovation in China? *Journal of Global Information Management*, *30*(1), 1–21. doi:10.4018/JGIM.309081

Lin, Y., Wang, Y., Chiou, J., & Huang, H. (2014). CEO characteristics and internal control quality. *Corporate Governance*, *22*(1), 24–42. doi:10.1111/corg.12042

Lisic, L. L., Myers, L. A., Seidel, T. A., & Zhou, J. (2019). Does audit committee accounting expertise help to promote audit quality? Evidence from auditor reporting of internal control weaknesses. *Contemporary Accounting Research*, *36*(4), 2521–2553. doi:10.1111/1911-3846.12517

Liu, K. P., Chiu, W., Chu, J., & Zheng, L. J. (2022). The Impact of Digitalization on Supply Chain Integration and Performance: A Comparison Between Large Enterprises and SMEs. *Journal of Global Information Management*, *30*(1), 1–20. doi:10.4018/JGIM.315301

Liu, T. L., Luo, L., He, W. F., & Chen, H. W. (2012). Property right nature, institutional environment, and internal control. *Accounting Research, 3*, 52-61. . 2012.03.00810.3969/j.issn.1003-2886

Lobo, G., Wang, C., Yu, X., & Zhao, Y. P. (2017). Material weakness in internal controls and stock price crash risk. *Journal of Accounting, Auditing & Finance*, *35*(1), 1–33. doi:10.1177/0148558X1002500101

Ma, X., & Zhang, Y. (2022). Digital innovation risk management model of discrete manufacturing enterprise based on big data analysis. *Journal of Global Information Management*, *30*(7), 1–14. doi:10.4018/JGIM.286761

Mak, H., & Shen, Z. M. (2021). When triple-A supply chains meet digitalization: The case of JD.com's C2M model. *Production and Operations Management*, *30*(3), 656–665. doi:10.1111/poms.13307

Mikalef, P., & Pateli, A. (2017). Information technology-enabled dynamic capabilities and their indirect effect on competitive performance: Findings from PLS-SEM and fsQCA. *Journal of Business Research*, *70*(1), 1–16. doi:10.1016/j.jbusres.2016.09.004

Nicoletti, G., Rueden, C. V., & Andrews, D. (2020). Digital technology diffusion: A matter of capabilities, incentives or both? *European Economic Review, 128(C),*103513. doi:. 10351310.1016/j.euroecorev.2020

Nwankpa, J. K., & Datta, P. (2017). Balancing exploration and exploitation of IT resources: The influence of digital business intensity on perceived organizational performance. *European Journal of Information Systems*, *26*(5), 469–488. doi:10.1057/s41303-017-0049-y

Ortiz, J., Ren, H., Li, K., & Zhang, A. (2019). Construction of open innovation ecology on the Internet: A case study of Xiaomi (China) using institutional logic. *Sustainability*, *11*(11), 1–17. doi:10.3390/su11113225

Philippart, M. H. (2022). Success factors to deliver organizational digital transformation: A framework for transformation leadership. *Journal of Global Information Management*, *30*(8), 1–17. doi:10.4018/JGIM.304068

Qi, Y. D., & Xiao, X. (2020). Enterprise management reform in the digital economy era. *Managing the World*, *36*(6), 135-152+250. 10.19744/j.cnki.11-1235/f.2020.0091

Qin, Y., & Xiang, L. (2022). Quality Improvement of Agricultural Products Supply Chain Under Social Preference and CSR by Big Data Analysis. *Journal of Global Information Management*, *30*(7), 1–26. doi:10.4018/JGIM.291513

Seyedghorban, Z., Tahernejad, H., Meriton, R., & Graham, G. (2020). Supply chain digitalization: Past, present, and future. *Production Planning & Control, 31*(2-3), 96-114. doi:. 2019.163146110.1080/09537287

Sultana, S., Akter, S., Kyriazis, E., & Wamba, S. F. (2021). Architecting and developing big data-driven innovation (DDI) in the digital economy. *Journal of Global Information Management*, *29*(3), 165–187. doi:10.4018/JGIM.2021050107

Thomas, R., & Carsten, L. P. (2020). Digitization capability and the digitalization of business models in business-to-business firms: Past, present, and future. *Industrial Marketing Management*, *86*, 180–190. doi:10.1016/j.indmarman.2019.11.019

Wang, H., Zheng, L. J., Xu, X., & Hung, T. H. (2022). Impact of financial digitalization on organizational performance: A look at the dark side. *Journal of Global Information Management*, *30*(1), 1–35. doi:10.4018/JGIM.315307

Wang, Y. M. (2020). Great changes in a century, high-quality development, and building a new development pattern. *Management World*, *36*(12), 1–13. doi:10.19744/j.cnki.11-1235/f.2020.0179

Wen, Z. L., & Ye, B. J. (2014). Intermediary effect analysis: Method and model development. *Progress in Psychological Science*, *5*, 731–745. doi:10.3724/SP.J.1042.2014.00731

Wu, F., Hu, H. Z., Lin, H. Y., & Ren, X. Y. (2021). Enterprise digital transformation and capital market performance-empirical evidence from stock liquidity. *Management World*, *37*(7), 130–144. doi:10.19744/j.cnki.11-1235/f.2021.0097

Yao, Y., Duan, Y., & Huo, J. (2021). On empirically estimating bullwhip effects: Measurement, aggregation, and impact. *Journal of Operations Management*, *67*(1), 5–30. doi:10.1002/joom.1090

Yazawa, K. (2015). The incentive factors for the (non-)disclosure of material weakness in internal control over financial reporting: Evidence from J-SOX mandated audits. *International Journal of Auditing*, *8*(2), 19–23. doi:10.1111/ijau.12035

Ye, F., Liu, K., Li, L., Lai, K., Zhan, Y., & Kumar, A. (2022). Digital supply chain management in the COVID-19 crisis: An asset orchestration perspective. *International Journal of Production Economics*, *245*, 108396. doi:10.1016/j.ijpe.2021.108396 PMID:34931109

Yuan, C., Xiao, T. S., Geng, C. X., & Sheng, Y. (2021). Enjoy a high reputation digital transformation and enterprise division of labor: Specialization or vertical integration. *China Industrial Economy*, *9*, 137–155. doi:10.19581/j.cnki.ciejournal.2021.09.007

Zeng, F., Zheng, X., & Li, X. (2018). Research on the relationship between IT capability and enterprise sustainable development performance. *Scientific Research Management*, *39*(4), 92–101. doi:10.19571/j.cnki.1000-2995.2018.04.010

Zhang, J. D., Ji, D. B., & Sun, Y. B. (2013). Empirical study on influencing factors of enterprise internal control effectiveness. *Management World, 8*, 179-180. doi:. 2013.08.02210.19744/j.cnki.11-1235/f

Zhao, C., Cao, W., Yao, Z. Y., & Wang, Z. Q. (2020). Will Internet plus help reduce cost stickiness of enterprises? *Financial Research*, *46*(4), 33–47. doi:10.16538/j.cnki.jfe.2020.04.003

Zhao, C., Chen, S. H., & Cao, W. (2020). "Internet plus" information disclosure: Substantive statement or strategic speculation-evidence based on the risk of stock price collapse. *China Industrial Economy*, *3*, 174–192. doi:10.19581/j.cnki.ciejournal.2020.03.020

Zhen, H. X., Ling, F., & Jing, Y. X. (2021). "Participating in governance" or "choosing governance:" Test based on the endogenous relationship between institutional investors and accounting conservatism. *System Engineering Theory and Practice*, *41*(9), 2198–2217. doi:10.12011/SETP2020-1602

Na Chen is a doctoral candidate of the School of Economics and Management, Xi'an University of Technology. She is also an associate professor and master's supervisor of the Business School, Gansu University of Political Science and Law. Her research interests focus on corporate governance and innovation management.

Shuili Yang is currently a professor and doctoral tutor with the School of Economics and Management, Xi'an University of Technology. His research interests primarily involve corporate governance, operations management, and innovation management.

Lei Li is currently a doctoral candidate in the School of Economics and Management, Xi'an University of Technology. His research interests include digital economy and corporate governance.