

Study on the Impact of Digital Transformation on Corporate Sustainability Performance - A Perspective on the Mediating Role of Technological Innovation

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Abstract: Relying on empirical analysis using data from Shanghai and Shenzhen A-share listed firms between 2014 and 2021, this research confirms that digital transformation has a significant enhancing effect on corporate sustainability performance, with technological innovation acting as a crucial mediating factor. Moreover, the study incorporates control variables including firm size, growth, leverage, corporate governance structure, and board characteristics, while further exploring how the impact of digital transformation varies across firms with different ownership types (e.g., state-owned versus private firms) and varying levels of managerial capability. These findings offer valuable insights for policymakers, supporting evidence-based policymaking to accelerate the digital transformation of Chinese enterprises and promote high-quality economic development.

Keywords: Digital transformation, Corporate sustainability, Technological innovation, Robustness testing, Heterogeneity effects

1. Introduction

Sustainability performance has drawn growing attention as a vital metric for assessing enterprises' overall development, spanning economic, environmental, and social aspects. In recent years, China's digital economy has expanded rapidly. By 2023, its scale is projected to exceed 50 trillion yuan, approaching the contribution of the secondary sector and becoming a major force in driving national modernization.

Within this context, digital technologies, particularly in areas such as 'Big Intelligence, Mobile, and Cloud,' have emerged as central engines of corporate transformation, enabling enterprises to enhance resource integration, management efficiency, and value creation through digital transformation. However, with digital transformation deepening, how firms can harness digital technology to advance sustainable development—and the exact mechanisms underlying this process—remains an important question requiring further examination. Therefore, understanding how digital transformation promotes sustainable corporate growth through the mediating effect of technological innovation holds substantial theoretical and practical relevance.

This study aims to empirically reveal how digital transformation enhances corporate sustainability performance via technological innovation. It also accounts for factors such as enterprise size, growth, gearing ratio, corporate governance structure, and board characteristics as control variables.

Specifically, this paper makes two key contributions. First, it investigates how digital transformation strengthens corporate sustainable performance by enhancing technological innovation capability, with technological innovation acting as a mediator. Second, from the perspectives of property rights and managerial competence, it further explores the heterogeneous characteristics of digital transformation's effect on sustainable performance.

2. Literature Review

2.1. Digital Transformation Literature Research

A considerable body of research has examined the impact of digital transformation on multiple aspects of enterprise sustainable development, particularly focusing on improvements in high-quality development and enterprise value. Regarding how digital transformation drives high-quality development, existing academic views remain somewhat divided. Some studies suggest that digital transformation enhances development quality by reshaping operational models and increasing management efficiency, with evidence indicating a clear linear positive relationship [1].

With respect to innovation, existing research indicates that digital transformation substantially enhances firms' innovation capacity. For example, through a multivariate statistical analysis of 938 enterprises, some scholars have found that digital transformation serves as a key driver in strengthening the level of enterprise innovation and enhancing market competitiveness [2]. In addition, studies on SMEs point out that digital transformation can enhance their innovation efficiency and resilience in dynamic market environments by improving the resilience of business organizations [3].

Regarding research on enterprise value, scholars generally agree on the positive effects of digital transformation on enterprise value. Some empirical studies have found that digital transformation positively contributes to the long-term value of enterprises by improving resource allocation efficiency and optimizing decision-making processes [4].

2.2. Sustainable Development Performance literature Research

Sustainability performance has been the focus of research in both academia and practice in recent years, especially on how to enhance the sustainability of enterprises through internal and external factors. In existing studies, scholars have explored a variety of factors that affect corporate sustainability performance, mainly including the competence of the executive team and IT capabilities. Regarding the influence of the executive team, some scholars believe that the strategic decisions and development direction of an enterprise are highly dependent on the cognitive level of the executives, especially the dual cognition of the executives in the field of environmental protection and sustainable development [5]. In addition, there are also studies that show that the impact of IT capability on sustainability performance cannot be ignored. Some scholars, through their research on the automobile manufacturing industry, found that the improvement of IT capabilities can effectively enhance the agility of business processes in the process of digital transformation, which in turn improves the corporate sustainability outcomes [6].

2.3. The Relationship Between Digital Transformation And Enterprise Sustainable Development Performance

Regarding digital transformation, the majority of existing research concentrates primarily on financial performance [7] or environmental performance [8], and fewer studies have explored the deep-seated mechanism between the two from the perspective of enterprise sustainable development performance. Therefore, by constructing a more long-term evaluation system of enterprise sustainability

performance, as well as specifically analyzing the impact of digital transformation in promoting this performance, and the role of the degree of technological innovation in influencing it, is still a topic worthy of in-depth research.

3. Theoretical analyses and research hypotheses

3.1. Digital transformation and enterprise sustainable development performance

Throughout digital transformation, companies not only improve operational effectiveness but also achieve more accurate resource allocation by adopting cutting-edge technologies like AI, big data, cloud platforms, and blockchain, thereby fostering long-term sustainability enhancement. For example, the wide application of digital technology enables enterprises to achieve real-time information sharing and collaboration in the supply chain, thereby optimizing production and sales planning, reducing redundancy and inventory, and lowering operating costs [9]. In addition, digital technology plays an important role in enhancing production efficiency, and through automated and intelligent production processes, enterprises are not only able to reduce labor costs, but also significantly increase productivity and ensure more efficient use of resources, thereby achieving sustained economic returns [10]. The application of digital technology further speeds up product and service innovation within enterprises, helping enterprises to open up new business areas and market space, further enhancing their long-term competitiveness and economic returns [11].

In addition to promoting economic benefits, digital transformation also brings significant social benefits to enterprises. Through digital technology, enterprises are able to connect more closely with consumers and gain insights into their needs so as to continuously optimize service quality and enhance customer satisfaction and loyalty, which helps them maintain a stable market position in the long term [12]. Digitalization also enhances information transparency, enabling stakeholders to participate more effectively in corporate management decisions, increasing corporate social responsibility and thus promoting sustainable social development [13].

In addition, digital technology plays an important role in enhancing employee management and incentives. Through data-driven transparent management, enterprises are able to achieve a fairer reward and punishment system, and enhance employee satisfaction and loyalty, which helps to maintain the long-term stable operation of enterprises [14].

Therefore, based on the above analysis, digital transformation not only promotes the efficiency of the enterprise in the short term, but also lays a solid foundation for the long-term sustainable development of the enterprise. As a result, this paper puts forward the following hypothesis:

H1: Digital transformation helps to improve enterprise sustainable development performance.

3.2. Analysis of mediating mechanisms

Firstly, digital transformation provides a more efficient innovation support platform for enterprises by improving the efficiency of data circulation and the degree of information sharing [15]. Digital technology can help enterprises integrate resources, break traditional technical barriers, and accelerate the process of technological research and development, thus providing enterprises with sustained innovation power.

Secondly, digital transformation plays a key role in optimizing resource allocation, and through data analysis and intelligent decision-making, enterprises can accurately identify the opportunities and directions of technological innovation, reduce the risks and costs of technological research and development, and thus improve the efficiency and effectiveness of technological innovation. Digital technology can also promote cross-field and cross-regional cooperation, breaking the time and space limitations of technological innovation, thus providing a broader space for technological development.

Through technological innovation, enterprises can continuously optimize their production methods and operation modes, thus enhancing their long-term sustainable development performance. Technological innovation can not only enhance firms' production efficiency while lowering operational expenses, but also optimize resource distribution and strengthen overall managerial effectiveness. Under the impetus of digital transformation, enterprises' investment in technological innovation has been enhanced, which further improves their performance in the economic, environmental and social aspects of sustainable development. By promoting technological innovation through digital transformation, enterprises are able to maximize the use of resources, reduce waste, enhance production efficiency, and ultimately form a long-term stable virtuous cycle, helping them to achieve greater success in their long-term sustainable development goals.

Based on this, the study puts forward the following hypothesis:

H2: Digital transformation facilitates technological innovation, which in turn contributes to the long-term sustainable development performance of enterprises.

4. Model Construction

4.1. Sample Selection and Data Source

Considering data availability, this study selects listed firms from Shanghai and Shenzhen A-shares between 2014 and 2021 as its sample, and applies the following data processing steps: (1) deleting ST firms from the sample; (2) removing observations from the financial sector; (3) discarding firms with critical variable omissions; (4) so as to reduce the impact of outliers, this paper carries out the shrinking of 1% on all the continuous variables, ensuring data robustness and reliability. All initial data originate from credible sources including CSMAR, WIND, and CCER databases, supplemented by information extracted from corporate annual reports to guarantee data quality and the reliability of research findings.

4.2. Model design

This paper focuses on how digital transformation influences enterprises' sustainable development outcomes, in order to validate the hypothesis, the following model is developed in this study

$$SGR_{i,t} = c_0 + \alpha_0 DCG_{i,t} + \beta_0 \sum control_{i,t} + \sum year + \sum Industry + \varepsilon_{i,t}$$

In this equation, i identifies the enterprise, and t indicates the year. On the left side, SGR measures the firm's sustainable development performance, while the right side contains the constant term c_0 , alongside the regression coefficients α_0 and β_0 . The variable DCG reflects the extent of digital transformation, CONTROL represents the control variables, and ε represents the residual term. The core analytical focus of this model lies in the coefficient α_0 , which captures the effect of digital transformation (DCG) on corporate sustainability performance (SGR). A significantly positive α_0 would signify that digital transformation meaningfully enhances firms' sustainable development performance, demonstrating that digital transformation acts as a key driver for improving long-term sustainability outcomes.

Table 1: Variable Definition

Variable Type	Variable Name	Variable Symbol	Variable Calculation
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Table 1: (continued).

Explained Variables	Sustainability Performance	SGR	Corporate Sustainability = Net Sales Margin * Earnings Retention Ratio * (1 + Equity Ratio) / (1 / Total Asset Turnover - Net Sales Margin * Earnings Retention Ratio * (1 + Equity Ratio))
Core Explanatory Variables	Digital Transformation	DCG	Measured by the frequency of the corresponding keywords in the annual reports published by listed companies
Mediating variables	Technology Innovation	Inpatent	Ln (number of patents granted for inventions + 1)
Control variable	Enterprise Scale	Size	Ln (total assets of enterprises at the end of the year)
	Enterprise Growth	Growth	(Current period's operating income - previous period's operating income) / previous period's operating income
	Dual Career	DUAL	If the chairman and general manager are held by the same person, the value will be 1, otherwise it will be 0.
	Internal Governance Level	CorpGov	Using principal component analysis, analyse and construct the comprehensive evaluation index of corporate governance quality
	Assets and Liabilities Ratio	LEV	Total liabilities/total assets

5. Empirical analysis

5.1. Descriptive statistics

The following table displays the descriptive statistics for key variables. Firstly, the average sustainability performance (SGR) of firms stands at 0.280, with values ranging from -0.510 to 3.030, and a standard deviation of 0.350, indicating considerable variability in firms' sustainability performance. In particular, the median of 0.200 is lower than the mean, suggesting that the sustainability performance of most enterprises is relatively weak. Secondly, digital transformation (DCG) records an average value of 1.620, with a median of 1.390, lower than the mean, and a standard deviation of 1.450, with a minimum value of 0 and a maximum value of 5.040 showing that there is a great difference in the degree of implementation of digital transformation among enterprises. Regarding technological innovation (Inpatent), firms hold an average of 2.770 patents, the median equals the mean, while the standard deviation reaches 1.480, with a minimum of 0 and a maximum of 6.810, indicating that half of the enterprises in the sample are more active in terms of technological innovation, but there are also some enterprises that are more conservative or lack of investment in this area. The mean value of GROWTH is 0.210, the standard deviation is 0.560, the minimum value is -0.900, and the maximum value is 3.650, suggesting that some firms in the sample may be in the decline stage, while others have high growth potential. Finally, the level of corporate governance (CorpGov) has a mean of 0.370, a standard deviation of 0.980, a minimum value of -1.390, and a maximum value of 2.890, suggesting that there is a wide variation in corporate governance among the sample firms.

Table 2: descriptive statistics

Variable	N	Mean	SD	Min	p50	Max
SGR	7252	0.280	0.350	-0.510	0.200	3.030
DCG	7252	1.620	1.450	0	1.390	5.040
DUAL	7252	0.360	0.480	0	0	1
Inpatient	7252	2.770	1.480	0	2.770	6.810
GROWTH	7252	0.210	0.560	-0.900	0.140	3.650
LnSize	7252	21.89	1.080	20.05	21.73	25.22
LEV	7252	0.350	0.180	0.0500	0.340	0.790
CorpGov	7252	0.370	0.980	-1.390	0.190	2.890

5.2. Benchmark regression analysis

The regression findings reveal a strong positive association between digital transformation (DCG) and corporate sustainability performance (SGR), with a coefficient of 0.0184, reaching the 1% significance threshold. This indicates that the implementation of digital transformation can significantly improve the sustainability performance of enterprises, aligning with conclusions drawn in prior studies, which further validates the key role of digital technology in promoting the sustainable development of enterprises, and H1 is verified.

5.3. Robustness test

Transforming explanatory variables measurement method can overcome the possible adverse effects of measurement bias of the independent variables on the empirical results. This study quantifies keyword frequencies across four key areas: digital technology utilization, online business models, intelligent manufacturing, and contemporary information systems. These frequencies serve as indicators to capture the extent of digital transformation within each dimension [16]. Based on this, the collected word frequency data undergoes standardization, after which the entropy method assigns weights to each dimension. Ultimately, a comprehensive index (DIGI_text) is constructed, which acts as a proxy variable representing the firm's level of digital transformation.

The regression analysis confirms that DIGI_text significantly enhances corporate sustainability performance (SGR), with a regression coefficient of 0.404, reaching the 5% significance threshold. This outcome demonstrates that using word frequency-based indicators to measure digital transformation aligns well with the findings from the benchmark regression. It further reinforces the conclusion that digital transformation's positive influence on corporate sustainability performance holds strong robustness.

Table 3: Benchmark regression analysis and robustness tests

	(1) SGR	(2) SGR
DCG	0.0184*** (0.00338)	
DIGI_text		0.404** (0.168)
DUAL	-0.0198** (0.00968)	-0.0193** (0.00970)
GROWTH _w	0.0681*** (0.00665)	0.0690*** (0.00666)

Table 3: (continued).

LnSizew	-0.00998** (0.00469)	-0.00691 (0.00465)
LEVw	0.637*** (0.0262)	0.633*** (0.0263)
CorpGovw	0.00941* (0.00520)	0.0102* (0.00521)
_cons	0.247** (0.114)	0.193* (0.113)
Industry	Yes	Yes
Year	Yes	Yes
<i>N</i>	7252	7252
<i>R</i> ²	0.206	0.204
adj. <i>R</i> ²	0.197	0.195

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Further analyses

6.1. Intermediation mechanism test

Table 4: Intermediation mechanism test

	(1) Inpatent	(2) SGR
DCG	0.0971*** (0.0142)	0.0171*** (0.00339)
Inpatent		0.0134*** (0.00280)
_cons	-12.82*** (0.478)	0.419*** (0.119)
control variables	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
<i>N</i>	7252	7252
<i>R</i> ²	0.266	0.209
adj. <i>R</i> ²	0.258	0.200

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In the mediation analysis section, this research explores the intermediary role of technological innovation, captured by the Inpatent variable, in linking digital transformation (DCG) to corporate sustainability performance (SGR). Specifically, two regression models are developed: Model (1) examines how digital transformation influences technological innovation, and Model (2) assesses the effect of technological innovation on corporate sustainability performance, while simultaneously accounting for the direct influence of digital transformation.

First, the results of model (1) reveal that digital transformation has a notable positive influence on technological innovation, reflected by a regression coefficient of 0.0971, which passes the 1%

significance level. This finding suggests that digital transformation effectively stimulates technological innovation.

Subsequently, model (2) investigates the link between technological innovation and corporate sustainability performance (SGR), showing a regression coefficient of 0.0134, also statistically significant at the 1% level. This confirms that technological innovation acts as a crucial driver for corporate sustainability, contributing positively to enhancing firms' long-term sustainable development and performance.

Moreover, the findings from model (2) further confirm that digital transformation (DCG) positively influences corporate sustainability performance (SGR), with a regression coefficient of 0.0171, which is also significant at the 1% significance level. This indicates that digital transformation not only has a direct impact on corporate sustainability performance, but also indirectly promotes corporate performance through the mediating variable of technological innovation, proving H2.

6.2. Heterogeneity analysis

Table 5: heterogeneity test

	(1) SGR	(2) SGR	(3) SGR	(4) SGR
DCG	0.0208** (0.00858)	0.0168*** (0.00383)	0.0111** (0.00547)	0.0269*** (0.00414)
DUAL	-0.0118 (0.0318)	-0.0280*** (0.0104)	-0.0216 (0.0155)	-0.0125 (0.0119)
GROWTH _w	0.0605*** (0.0156)	0.0703*** (0.00769)	0.0721*** (0.00889)	0.0453*** (0.0102)
LnSizew	-0.0313*** (0.00957)	-0.00413 (0.00589)	-0.00781 (0.00767)	-0.0119** (0.00577)
LEV _w	0.793*** (0.0628)	0.603*** (0.0303)	0.631*** (0.0415)	0.689*** (0.0331)
CorpGovw	0.0258 (0.0212)	0.00946 (0.00594)	0.0249*** (0.00820)	-0.0102 (0.00653)
_cons	0.552** (0.230)	0.174 (0.140)	0.231 (0.173)	0.142 (0.177)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
N	1501	5501	3215	4037
R2	0.228	0.215	0.220	0.267
adj. R2	0.194	0.204	0.200	0.255

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

As part of the heterogeneity analysis, this study investigates whether the effect of digital transformation on corporate sustainability performance varies depending on firms' ownership structure. For this purpose, the sample is classified into two distinct categories: state-owned enterprises (Soe=1) and non-state-owned enterprises (Soe=0), and conducts regression analyses separately.

Findings from model (1) indicate that digital transformation (DCG) exerts a statistically significant positive influence on the sustainability performance (SGR) of state-owned enterprises (Soe=1), with

a regression coefficient of 0.0208, reaching the 5% significance threshold. On the one hand, this is related to the financial and policy support background of SOEs, which facilitates easily access to resources during digital transformation initiatives, which in turn enhances their long-term sustainability performance. On the other hand, SOEs have a complete organizational structure, which is conducive to cooperation and collaborative digitalization between departments.

However, in model (2), digital transformation's impact on sustainability performance is even stronger among non-state-owned firms ($Soe=0$), with a regression coefficient of 0.0168 and significant at the 1% significance level. Although SOEs benefit more from the process of digital transformation, the regression coefficient of non-SOEs is larger and more significant. Firstly, under the competitive market environment, non-state-owned firms demonstrate greater agility in leveraging digital transformation to enhance sustainability outcomes, which can better contribute to the realization of sustainable development of enterprises.

Second, this paper also compares the effect of digital transformation (DCG) on corporate sustainability performance (SGR) by grouping firms according to their high and low managerial authority (MA). Managerial power is measured by principal component analysis (PCA), after screening, five indicators, including the combination of the positions of general manager and chairman of the board of directors, the size of the board of directors, whether the CEO is still the CEO after the IPO, the tenure of managers, and the ratio of the proportion of shares held by the first-largest shareholder to the sum of the second-largest to the tenth-largest shareholders, are selected as the basic variables for calculating managerial power in the PCA method. When the managerial power of listed companies is higher than the median is assigned a value of 1, otherwise it is 0 [17].

From model (3), for firms with high managerial power ($MA=1$), the effect of digital transformation (DCG) on firms' sustainability performance is significant, with a regression coefficient of 0.0111, which is significant at the 5% significance level. Firms with high managerial capabilities usually have strong strategic vision and management capabilities, and thus are good at utilizing digital transformation to improve operational efficiency and innovation capabilities, thus effectively promoting long-term sustainable development of the firm.

In contrast, in model (4), the positive impact of digital transformation is more significant in firms with low managerial capability ($MA=0$), with a regression coefficient of 0.0269 and significant at the 1% significance level. Although firms with low managerial capabilities may have certain deficiencies in strategy formulation and execution, they tend to rely more on technological innovation and the introduction of external resources in the digital transformation process. As a result, digital transformation has a more prominent role in improving the sustainability performance of these firms, which is associated with their high dependence on new technologies and strong external learning capabilities.

7. Conclusion

This research draws on data from A-share listed firms in Shanghai and Shenzhen between 2014 and 2021 to investigate the relationship between digital transformation and corporate sustainability performance, along with its underlying mechanisms. Empirical results confirm that digital transformation contributes positively to corporate sustainability outcomes, while also revealing that technological innovation serves as a key mediating channel. Furthermore, the analysis highlights that the effect of digital transformation differs depending on firm characteristics. Specifically, non-state-owned firms and those with relatively weaker managerial capabilities benefit more significantly from digital transformation. Based on these insights, the following managerial recommendations are proposed:

At the governmental level, strengthening policy support and increasing financial investment in digital transformation are essential. This approach would not only advance corporate sustainable

development, but also accelerate the broader industry transformation and modernization process. Based on the research outcomes, notable disparities exist in how different firms undergo digital transformation. Therefore, policymakers should design tailored support policies aligned with the specific characteristics and needs of individual enterprises. For example, for small-scale enterprises, it can implement the policy of ‘specialty and newness’ to promote their development in the direction of greater efficiency and professionalism; while for state-owned enterprises, it can take advantage of its policy to further accelerate the digitalization process and optimize the allocation of resources. Meanwhile, the government should also learn from the all-encompassing spirit of non-public enterprises seeking innovative breakthroughs in the wave of digitization, so as to enhance overall market competitiveness.

At the enterprise level, digital transformation should become a core strategy for promoting sustainable development. Enterprises need to formulate a long-term digitalization strategy based on their actual situation, integrate advanced digital technologies and innovative talents, and cultivate a digitalization culture so that it becomes part of their daily operations. Meanwhile, enterprises with low managerial capability should actively meet the challenges of digital transformation and accelerate the transformation process through external resources and technological innovation. For enterprises with high managerial capabilities, they can focus on the combination of management capabilities and technological innovation, and leverage their leadership strengths to better integrate digital technologies with their corporate development strategies.

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