Digital Transformation and Corporate Social Responsibility: Empirical Evidence from Chinese Listed Companies

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Abstract. Digital transformation is an inevitable choice for the transformation and development of contemporary enterprises. This paper takes the A-share listed companies in Shanghai and Shenzhen stock markets from 2011 to 2021 as research samples. Using text mining methods, it constructs indicators of digital transformation for enterprises and systematically examines the specific effects of digital transformation on corporate social responsibility. The study finds that digital transformation significantly improves corporate social responsibility with heterogeneity. After a series of robustness tests, this conclusion remains strong. The research results of this paper enrich the study of the economic consequences of digital transformation for physical enterprises and the factors influencing corporate social responsibility, providing important insights and reference value for promoting the digital transformation of physical enterprises and constructing a new pattern of the digital economy.

Keywords: Digital transformation; corporate social responsibility; Text mining.

1. Introduction

In the context of Chinese-style modernization, modern enterprises actively strive to fulfill social responsibility and achieve the integration of corporate value and social value, which is a strategic action in pursuit of high-quality corporate development (Chi, 2023). In June 2021, the Securities and Futures Commission revised the disclosure guidelines for annual and semi-annual reports, encouraging companies to include information on "carbon emission reduction measures and their effects" and "poverty eradication and rural revitalization achievements" in their regular reports. Corporate social responsibility (CSR) is a public responsibility towards multiple stakeholders based on the dual economic and social attributes of enterprises, aiming to create comprehensive and shared values that cover economic, social, and environmental aspects for the economic and social stakeholders of the enterprises (Xiao et al., 2018; Li et al., 2011). CSR performance has received extensive attention from academia and industry, with existing studies mainly focusing on the motives and economic consequences of CSR performance. In terms of motivation, factors such as corporate financial strength (Chen & Wang, 2021), public opinion pressure under media attention (Xu & Huang, 2015), and capital market opening (Zhang & Liu, 2023) influence CSR. In terms of economic consequences, fulfilling social responsibility is believed to provide enterprises with competitive advantages, accelerate technological innovation (Xiao et al., 2022), alleviate financing constraints (Qian et al., 2017), and improve investment efficiency (Zhong & Xu, 2017).

In the current context, the digital economy, driven by digital technology, is rapidly expanding and has become a driving force behind China's high-quality economic development (Li & Huang, 2022). With the advent of the digital economy era, technologies such as artificial intelligence, blockchain, cloud computing, big data, and the Internet of Things are being extensively applied in the real economy. To stay competitive in the industrial and supply chain, more and more enterprises are embracing the digital economy and utilizing big data to promote their digital transformation (Zhang et al., 2023; Chen & Hao, 2022). Digital transformation is both a necessity and a demand. It brings innovative momentum to enterprises (Han et al., 2019), effectively addresses financing constraints, promotes innovation (Duan et al., 2023), and improves operational performance (He & Liu, 2019; Yang & Liu, 2018), thereby driving business value and enhancing total factor productivity of enterprises (Tu & Yan, 2022).

The existing literature in this field primarily examines the impact of digital transformation, digital economy, and digital finance on corporate social responsibility (CSR). Liu et al. (2022) highlight the significant contribution of digital finance in promoting CSR by alleviating external financing constraints faced by firms. Qi and Xu (2023) argue that the digital context has transformed the theoretical basis of CSR, and the convergence, openness, interactivity, and symbiosis in organizational production methods within the digital economy make enterprises more "endogenous" and "autonomous" in fulfilling their social responsibility. However, some scholars view the digital economy as a "double-edged sword" that gives rise to new challenges. For instance, Xiao and Yang (2020) find that platform-based enterprises in the platform economy, as a specific form of the digital economy, often exhibit a lack of social responsibility and alienation. Against this backdrop, as the digital economy becomes increasingly vital for national and regional high-quality development, it becomes essential to understand how digital transformation influences CSR. Thus, the author aims to explore the question of whether digital transformation can indeed enhance CSR performance, the mechanisms underlying this effect, and whether the effect varies across different time periods and spatial contexts.

This paper aims to make several potential contributions. Firstly, it contributes to the existing literature on corporate social responsibility (CSR) by examining the social spillover effects of digital transformation within the framework of CSR. By considering both corporate digital transformation and CSR together, the paper offers insights into how digital transformation influences CSR outcomes, thus expanding the scope of CSR research. Secondly, through empirical analysis using a sample of A-share listed companies in Shanghai and Shenzhen from 2011 to 2021, the paper provides empirical evidence on the positive impact of digital transformation on CSR, as well as its underlying mechanisms and heterogeneity. This empirical analysis not only confirms the enhancement effect of digital transformation on CSR but also sheds light on the varying effects across different contexts. These findings can assist enterprises in adopting differentiated and dynamic strategies in their digital transformation efforts, enabling them to strike a balance between economic performance and social responsibility. Overall, this paper contributes to the understanding of the relationship between digital transformation and CSR, providing practical implications for businesses aiming to leverage digital transformation to enhance their CSR performance.

2. Literature review and theoretical mechanisms

The promotion of corporate social responsibility (CSR) through digital transformation can be attributed to various factors. Firstly, digital technology integration in areas such as internal control, financial management, and information disclosure empowers enterprises to fulfill their social responsibility obligations in multiple aspects (Affirmation et al., 2022). It enables the reduction of principal-agent costs (Xu & Zhang, 2022) and curbs irrational behavior among executives (Qi et al., 2020), thus enhancing corporate social responsibility based on long-term development and internal and external evaluations. Additionally, digital transformation plays a crucial role in promoting technological and green innovation (Xu et al., 2019). It leads to improved total factor productivity, reduced resource waste, decreased pollutant emissions, and facilitates energy-saving and consumption reduction, consequently promoting corporate environmental responsibility (Zhao, 2022).Overall, digital transformation strengthens internal control disclosure, weakens surplus management, and fosters technological and green innovation, all of which contribute to enhancing corporate social responsibility.

From an external perspective, digital transformation brings about several changes that facilitate the fulfillment of corporate social responsibility (CSR). Firstly, digital transformation enables enterprises to quickly identify, capture, and analyze the diverse value demands and social issues of various stakeholders, aligning them with their own resources and development advantages (Affirmation et al., 2022). This promotes the fulfillment of CSR as enterprises become more closely connected with consumers, who play a decisive role in determining their success or failure (Wang et

al., 2020; Chen et al., 2020). Enterprises are thus more motivated to meet CSR expectations driven by consumer influence.

Secondly, digital technology fosters openness and virtualization, transforming the connections between enterprises and other businesses (Wu et al., 2021). This shared network platform enhances external information transparency, encouraging enterprises to improve their social responsibility performance to attract partners (Xiao et al., 2021).

Furthermore, digital transformation promotes the service-oriented transformation of enterprises, leading to increased service consciousness and a greater focus on product quality, brand image, and external reputation (Zhao, 2022). Service transformation prompts enterprises to provide relevant services alongside their products, enhancing their commitment to quality management, integrity, and reciprocity. It also reinforces their after-sales service consciousness, leading to a stronger emphasis on external word-of-mouth, brand image, and reputation. Consequently, enterprises actively listen to customer feedback to improve customer satisfaction (Zhang and Li, 2019) and engage in social activities such as public welfare donations, charity work, and poverty alleviation to establish a positive brand image.

In summary, the service-oriented transformation and enhanced external reputation contribute to a shift in corporate governance philosophy from a traditional "shareholder-centered" approach to a "corporate social responsibility philosophy." This transformation prompts enterprises to take on greater social responsibility.

3. Indicator construction and model design

3.1 Indicator construction

3.1.1. Selection of dependent variable

The dependent variable in this paper is corporate social responsibility (CSR), which is measured using the third-party CSR rating index adopted by Zhen et al. (2021). The CSR rating index is based on the CSR score provided by Hexun.com for listed companies. Hexun.com's CSR evaluation dimensions encompass five major areas: shareholder responsibility, employee responsibility, supplier and consumer responsibility, environmental responsibility, and social responsibility (Xiao et al., 2022). This comprehensive evaluation system allows for an objective assessment of CSR performance across different dimensions.

The use of Hexun.com's CSR rating index offers several advantages. Firstly, its evaluation system is diverse, meticulously designed, and comprehensive, allowing for an objective evaluation of CSR performance in various dimensions (Affirmation et al., 2022). This approach avoids the endogeneity issues that may arise when using financial dimensions to measure stakeholder performance and overemphasizing single dimensions, such as charitable donations alone (Xiao et al., 2021).

By employing the third-party CSR rating index from Hexun.com, this paper provides a robust and comprehensive measurement of CSR performance, enabling a thorough examination of the impact of digital transformation on CSR across multiple dimensions.

3.1.2. Selection of independent variables

In this paper, the level of digital transformation of enterprises is measured using text analysis and text mining techniques based on the study conducted by Wu et al. (2021). The measurement is based on the frequency or occurrence of keywords related to "digitalization" in the annual reports of Chinese listed companies.

Annual reports are considered a valuable source of information that reflects the strategic focus, business philosophy, and development path of enterprises, making them an appropriate medium to gauge the level of digital transformation. By analyzing the word usage in annual reports, we can gain insights into the strategies and approaches adopted by companies towards digital transformation.

To measure the degree of digital transformation, this paper follows a specific approach. Firstly, a Python crawler function is utilized to gather and organize the annual reports of A-share listed companies in the Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE). Subsequently, the text contents of the reports are extracted using the Java PDFbox library. Next, specific characteristic words related to "underlying technology application" (such as artificial intelligence, big data, cloud computing, and blockchain) and "technology practice application" (including digital technology) are extracted from the annual reports of listed companies. High-frequency words associated with digital transformation are identified and extracted from these reports.

Finally, the Jieba function is employed to tokenize the words from all the samples, creating a data pool. The collected feature word spectrum is then searched, matched, and counted to generate a summed word spectrum. The natural logarithm of the summed word spectrum plus one is taken as an indicator of the digital transformation level of listed companies, denoted as "digt1." A higher value of digt1 signifies a higher degree of digital transformation in the entity enterprises.

By employing this methodology, the paper aims to capture and quantify the extent of digital transformation in Chinese listed companies, providing valuable insights into the level of digitalization and its relationship with other variables of interest.

3.1.3. Control variables selection

To address the interference of endogeneity problems caused by omitted variables, this paper introduces the following control variables (Zit) with reference to the existing literature (Wang et al., 2023; Peng et al., 2018). Specifically, firm age (age), measured as the logarithm of the firm's years of establishment; firm growth capacity (growth), measured as the growth rate of the firm's total assets; firm duality rate (dual), measured as the concurrent appointment of the firm's chairman and general manager; board size (board), measured as the logarithm of the firm's board size; and equity concentration (top10). Measured by the shareholding ratio of the top 10 shareholders.

3.2 Model design

$$CSR_{it} = \alpha_0 + \alpha_1 dig_{it} + \alpha_2 Z_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

CSRit is the social responsibility of firm i in period t and digit is the degree of digital transformation of firm i in period t. Meanwhile, the model indicates time fixed effects in order to avoid individual heterogeneity in the within-group regression, thus adding individual fixed effects that indicate that firm i does not change over time. Further, the random error terms in this paper are clustered to the firm level to address the systematic heteroskedasticity of the model.

3.3 Data sources and descriptive statistics

This paper selects listed companies in Shanghai and Shenzhen A-shares from 2011-2021 as the research object and screens them according to the following steps: (1) Exclude financial listed companies; (2) Exclude samples with missing financial data or insolvency; (3) Exclude samples that are marked ST or *ST in the current year. Firm-level cluster regressions are performed on the samples to eliminate the interference of differences between data groups and to reasonably control the effect of heteroskedasticity. The financial data used in the study were derived from the CSMAR database.

4. Empirical Analysis

4.1 Baseline regression

The baseline regression model in this paper examines the average effect of digital transformation on corporate social responsibility (CSR). Building upon the approach proposed by Bai et al. (2022), this study extends the analysis by employing a panel quantile regression model to investigate potential variations in the effects of digital transformation on CSR at different quantile points. The findings are presented in columns (3) to (5) of Table 1.

The overall results indicate that digital transformation has a significant positive impact on CSR, with statistical significance observed at the 1% level. However, there is also evidence of heterogeneity in the effects. Specifically, at the 0.75 quantile, digital transformation shows a negative impact on CSR, although this effect is not statistically significant. One possible explanation for this finding is that digital transformation heavily relies on the extensive development of network infrastructure and power infrastructure, which can result in substantial energy consumption (Hu, 2023). Moreover, studies have indicated that China's grid infrastructure expansion to support the demands of digital transformation requires the consumption of greenhouse gas (GHG)-intensive materials such as steel and electrical equipment (Wei et al., 2021).

These findings suggest that while digital transformation generally contributes positively to CSR, there may be environmental concerns associated with the energy consumption and material requirements during the infrastructure development process. The quantile regression analysis provides insights into the variations in the effects of digital transformation at different levels of the CSR distribution, highlighting the need for further examination of the underlying mechanisms and contextual factors that shape these relationships.

Table 1. Baseline regression.

	Fixed effects		Q=0.25	Q=0.5	Q=0.75
	(1)	(2)	(3)	(4)	(5)
digt1	0.0050***	0.0037***	0.0021***	0.0021***	-0.0007
	(0.0010)	(0.0011)	(0.0004)	(0.0004)	(0.0005)
age		-0.0071	-0.0086***	0.0022*	-0.0072***
		(0.0100)	(0.0014)	(0.0013)	(0.0022)
roa		-0.0027	0.4777***	0.4169***	0.2720***
		(0.0042)	(0.0543)	(0.0290)	(0.0205)
growth		-0.0001***	-0.0004	-0.0001	-0.0000
		(0.0000)	(0.0004)	(0.0002)	(0.0001)
board		0.0392***	0.0537***	0.0687***	0.1147***
		(0.0081)	(0.0040)	(0.0036)	(0.0055)
top3		0.0005***	0.0009***	0.0007***	0.0010***
		(0.0001)	(0.0000)	(0.0000)	(0.0000)
indtor		0.0385	0.0623***	0.1086***	0.1874***
		(0.0236)	(0.0140)	(0.0110)	(0.0201)
fixratio		-0.1009***	-0.0822***	-0.0776***	-0.0950***
		(0.0098)	(0.0050)	(0.0041)	(0.0048)
duality		0.0002	0.0011	-0.0040***	-0.0129***
		(0.0021)	(0.0012)	(0.0010)	(0.0013)
_cons	0.2346***	0.1651***	0.0241*	-0.0032	-0.0431**
	(0.0015)	(0.0380)	(0.0129)	(0.0111)	(0.0182)
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
N	31686	29239	29693	29693	29693
adj. R^2	0.4622	0.4764	0.4764	0.4764	0.4764

Notes: ***, **, * indicate significance at the level of 1%, 5%, and 10%.Parenthetically presented is the clustered robust standard error.

4.2 Robustness analysis

4.2.1. Changing the measurement of enterprise digitalization

In the benchmark regression section, this paper adopts the measurement of enterprise digital transformation by Wu et al. (2021). In the robustness test, the degree of digital transformation of enterprises is measured again by drawing on Yuan Chun et al. (2021). The specific results are shown

in columns (1) and (2) of Table 2. The results show that digital transformation can still significantly contribute to the fulfillment of CSR.

4.2.2. Changing the way CSR is measured

In the robustness test section, this paper employs corporate ESG data provided by Hexun.com to further validate the findings. This ESG data has the advantages of high update frequency (quarterly updates), broad coverage (encompassing all A-share listed companies), and high data availability (Wang et al., 2022). The CSI ESG index system assigns companies ratings ranging from C to AAA based on index scores, with each rating assigned a numerical value from 1 to 9 for empirical analysis convenience.

Columns (3) and (4) present the results of the correlation analysis between ESG and the degree of digital transformation. The findings demonstrate a positive and significant correlation between ESG and digital transformation. Moreover, in columns (5) and (6), the regression models are re-estimated using alternative measures for digital transformation and CSR indicators, respectively. The results remain significant, indicating that different measures employed for digital transformation and CSR do not alter the core findings of the paper. This further strengthens the credibility of the facilitative effect of digital transformation on CSR.

By incorporating the robustness analysis using ESG data and alternative indicators, the study enhances the reliability and robustness of the observed positive relationship between digital transformation and CSR. These findings highlight the consistent and positive impact of digital transformation on corporate social responsibility across different measurement approaches, supporting the notion that digital transformation plays a facilitating role in promoting CSR.

4.2.3. Different models

In order to address potential issues such as autocorrelation and heteroskedasticity and account for the intrinsic correlation among different firms, the standard errors are adjusted using double clustering in individual and time. This adjustment helps improve the statistical inference and mitigate the impact of these issues on the results. Column (7) of Table 5 presents the results incorporating the double clustering adjustment, and the coefficient of digital transformation remains significantly positive, consistent with the benchmark findings.

Additionally, to address possible measurement errors in the raw data, a data tailoring approach is applied. Specifically, the largest and smallest 5% of sample data for both digital transformation and CSR are removed. The re-estimated model results are reported in column (8) of Table 2. Even after the tailoring process, the coefficient of digital transformation continues to exhibit a significantly positive effect across the entire range. These results further reinforce the reliability and robustness of the benchmark model.

By applying double clustering adjustment and implementing data tailoring, this paper takes measures to enhance the accuracy and validity of the results, reinforcing the consistent and positive impact of digital transformation on CSR. These additional analyses contribute to the overall reliability and robustness of the findings.

Table 2. Robustness tests.

	(1) csr	(2) csr	(3) ESG	(4) ESG	(5) ESG	(6) ESG	(7) csr	(8) csr_w
digt2	0.0044***	0.0037**			0.1037***	0.0846***		
	(0.0014)	(0.0016)			(0.0036)	(0.0035)		
digt1			0.0078***	0.0074***			0.0037**	
			(0.0018)	(0.0019)			(0.0016)	
digt1_w								0.0035***
								(0.0010)
age		-0.0043		0.0142		0.2564***	-0.0071	-0.0083
		(0.0102)		(0.0168)		(0.0068)	(0.0178)	(0.0092)
roa		-0.0025		-0.0011		0.0177	-0.0027	-0.0029
		(0.0042)		(0.0130)		(0.0240)	(0.0070)	(0.0061)
growth		-0.0001***		-0.0001		-0.0005**	-0.0001*	-0.0001*
		(0.0000)		(0.0001)		(0.0002)	(0.0000)	(0.0000)
board		0.0356***		0.0560***		0.0666***	0.0392**	0.0347***
		(0.0082)		(0.0128)		(0.0133)	(0.0133)	(0.0077)
top3		0.0005***		0.0006***		0.0006***	0.0005**	0.0005***
		(0.0001)		(0.0002)		(0.0002)	(0.0002)	(0.0001)
indtor		0.0375		0.1021***		0.4518***	0.0385	0.0326
		(0.0239)		(0.0366)		(0.0467)	(0.0399)	(0.0225)
fixratio		-0.1021***		0.0051		-0.0691***	-0.1009***	-0.0893***
		(0.0098)		(0.0181)		(0.0194)	(0.0161)	(0.0092)
duality		-0.0002		-0.0050		0.0158***	0.0002	0.0001
		(0.0021)		(0.0038)		(0.0059)	(0.0023)	(0.0017)
_cons	0.2363***	0.1645***	3.3331***	3.1108***	3.2519***	2.2065***	0.1651**	0.1762***
	(0.0015)	(0.0387)	(0.0029)	(0.0630)	(0.0039)	(0.0452)	(0.0651)	(0.0358)
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
N	31065	28656	11871	11509	11568	11233	29239	29239
adj. R^2	0.4579	0.4719	0.8245	0.8267	0.1152	0.2203	0.4747	0.4872

5. Conclusion and Implication

In summary, this paper provides valuable insights into the impact of digital transformation on corporate social responsibility (CSR). The findings suggest that digital transformation significantly improves CSR performance, although there is some heterogeneity. The robustness tests confirm the positive relationship between digital transformation and CSR using different measures, enhancing the credibility of the findings. Furthermore, after adjusting for standard errors and applying data tailoring, the positive effect of digital transformation on CSR remains significant.

These findings have important implications for enterprises. In today's society, the importance of CSR is increasing, and businesses are expected to go beyond economic goals and actively fulfill social responsibilities. The study highlights the role of digital transformation in enhancing CSR performance. Digital transformation not only improves efficiency and quality but also contributes to CSR. Therefore, enterprises should recognize the significance of digital transformation in fulfilling social responsibilities.

For businesses with a low level of digitalization, the study emphasizes the need to invest in digital transformation and develop a strategic approach. By embracing digital transformation, companies can achieve a significant improvement in their CSR performance. In the competitive business environment, fulfilling social responsibilities through digital transformation becomes essential for sustainable success.

Overall, this research contributes to the understanding of the relationship between digital transformation and CSR and provides practical guidance for enterprises to leverage digitalization for enhanced social responsibility.

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