The Impact of Digital Transformation on Corporate ESG - Evidence Based on Chinese A-share Listed Companies

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Abstract. With the gradual development of the digital economy, improving ESG performance through digital transformation has become a new focus for enterprises. This paper focuses on the impact of enterprise digital transformation on ESG performance. Based on the panel data of China's A-share listed companies from 2013 to 2022, this paper empirically examines the impact of digital transformation on ESG performance by using A two-way fixed-effect model and adding time-fixed effects and individual-fixed effects. The study found that digital transformation can help improve ESG performance. Heterogeneity analysis show that the development of digital finance can significantly promote the development of enterprises in the eastern and central regions, while the impact on enterprises in the western region is not obvious. From the perspective of enterprise ownership, digital finance has a more significant improvement in the ESG performance of non-state-owned enterprises. This paper has the policy and practical significance for Chinese enterprises to carry out green transformation and realize the goal of "dual carbon" under the background of the digital economy. Companies can apply environmental protection, social responsibility, and corporate governance considerations to their operations by increasing investment in technology research and development.

Keywords: ESG digital transformation degree; Heterogeneity analysis; Two-way fixed effect model.

1. Introduction

Under the "two-carbon" policy, environment, society and governance have not only become the main foothold of policy realization but also the mainstream evaluation system of non-financial performance of enterprises. ESG is a general term for environmental, social, and corporate governance (Environment, social, and governance), which assesses the sustainability of an enterprise's operation and its impact on social values from the above three aspects. The ESG concept is highly compatible with China's "five-in-one" concept - "innovation, coordination, green, open and sharing", and the advantage of ESG performance has become a new competitive advantage for enterprises.

The fulfillment of ESG responsibility can show that enterprises are environmentally friendly, actively undertake social responsibility, and have a high level of internal governance of the investment choice, help enterprises to innovate green technology research and development investment, optimize energy-saving technology, develop energy-saving products, which is of great significance for China's environmental governance and green transformation of economic structure. Listed companies are important responsibility subjects for Chinese enterprises to practice the ESG concept, not only high energy consumption and energy enterprises, and the pursuit of the ESG concept has gradually become the mainstream consensus of society.

In addition, digitization is also one of the trends of social development. The digital transformation of enterprises is the process of integrating digital technology into the strategic decision-making, organizational structure, operating system and business process of enterprises, creating new business value models, and transforming into digital enterprises. In the "14th Five-Year Plan" released in 2021, the goal of "giving full play to the advantages of massive data and rich application scenarios, promoting the deep integration of digital technology and the real economy, enabling the transformation and upgrading of traditional industries, spawning new industries and new formats and

models, and strengthening the engine of economic development" was first proposed. Digital transformation is the key basis for enterprises to integrate and reconfigure information resources, so that enterprises can form efficient collaboration processes and flexible marketing models, mainly through improving production efficiency and reducing external transaction costs.

A large number of practices have shown that the improvement of the degree of digital transformation of enterprises can effectively promote the improvement of corporate environmental, social, and corporate governance performance, and goodESG performance means the improvement of the sustainable development ability of enterprises. First of all, the innovation and application of green technology can help enterprises improve efficiency and reduce costs, optimize resource allocation, and reduce negative externalities caused by the production process of enterprises. Second, the application of big data and blockchain technology has improved the transparency of internal information of enterprises, reduced the information asymmetry of stakeholders, and increased the pressure of external supervision. Third, digital transformation promotes the deep integration of upstream and downstream links of enterprises, improves the level of informatization, digitalization and intelligence, improves the efficiency of enterprise operation and management, helps enterprises build a value co-creation network with employees, customers, suppliers, and distributors, and promotes enterprises to efficiently fulfill their social responsibilities. Finally, the digital transformation of enterprises can improve the efficiency of corporate decision-making and operational management, and promote the ESG performance of enterprises by improving the sales profit margin.

Given this, this paper takes China's A-share listed companies from 2013 to 2022 as A sample and uses a two-way fixed effect model to study the relationship between ESG performance and digital transformation. The results of the benchmarking study

show that the digital transformation of enterprises has a positive effect on ESG performance. The results of heterogeneity analysis show that ESG performance has a more significant effect on the value enhancement of non-state-owned enterprises than that of state-owned enterprises. In addition, the paper divides the locations of companies into eastern, central, and western regions, and studies the impact of industrial structure on ESG performance in different regions. The results show that the degree of digital transformation has a significant promoting effect on enterprises in the eastern and central regions, but has no significant effect on enterprises in the western region. This phenomenon is closely related to the level of digital infrastructure and market development.

2. Literature review

2.1 Digital transformation

The digital transformation of enterprises is the transformation of the deep integration of digital information technology and enterprise development, which will lead to changes in organizational structure and enterprise value. Fitzgeral (2013) believes that digital transformation is the use of a new generation of digital technologies to achieve major business transformation such as simplifying operation models, creating new business models, and improving user experience. Existing literature has drawn conclusions on the impact of digital transformation on enterprises in two aspects: On the one hand, digital transformation can help improve the core competence of enterprises (Benner and Waldfogel, 2023). Verhoef (2021) believes that digitalization is the collection, processing, analysis, and transformation of data into usable information through digital technology, which helps to make decisions, develop new digital business models, and help enterprises create value and improve performance. According to the research of Zhao et al. (2021), the implementation of digital transformation is conducive to improving the innovation ability and operation efficiency of enterprises, improving the allocation of labor resources, and accelerating the integration of modern

manufacturing and service industries. Reduce operating costs and improve overall production efficiency. In addition, digital transformation improves the quality, authenticity and timeliness of ESG information disclosure, which helps stakeholders to grasp corporate information in a timely and comprehensive manner and alleviate corporate financing constraints (Qi Yudong et al., 2023). On the other hand, digital technology also has its problems and shortcomings. Digital technology will bring more management expenses, labor costs and other negative impacts (Ren Zhicheng and Dai Xiang, 2015). Second, Dodgson and other scholars believe that digital transformation will also bring about digital divide, increase the difficulty of collaboration, and is not conducive to gathering innovation resources (Zeng Fue et al., 2018).

2.2 ESG performance

ESG performance is a comprehensive performance of environmental, social

responsibility and corporate governance, and the impact of ESG rating on corporate performance is also divided into two aspects: on the one hand, the investment operation system of enterprises with better ESG performance is more legal and compliant, the management of enterprises with environmental risk management has strong environmental awareness (Li Jinglin et al., 2021). Enterprises with better ESG performance release good signals in the labor market and have better human capital. According to the efficiency wage theory, enterprises with good ESG performance can stimulate the enthusiasm and creativity of employees. Enterprises with good ESG performance tend to have stronger market influence, which is conducive to promoting win-win cooperation among stakeholders such as employees, managers and customers, forming unique market competitiveness and enhancing enterprise value. (Wang Linlin et al., 2022). Bai Xiong et al. (2022) found that good ESG performance of listed companies can alleviate corporate financing constraints and enhance corporate value. On the other hand, Bhandari et al. (2017) believe that enterprises' investment in environmental protection will occupy a large amount of funds and is not directly related to the main business of enterprises. Sanches (2017) and other scholars found a negative correlation between ESG and financial performance through empirical studies. It can be seen that the current domestic and foreign scholars have not reached a unified conclusion on the impact of ESG performance and enterprise performance and the degree of digital transformation.

In summary, we propose the research hypothesis of this paper, that is, H0: the degree of digital transformation of enterprises has a positive impact on ESG performance.

3. Sample Selection and Data Sources

This paper studies the impact of digital transformation on ESG performance of Chinese A-share listed companies from 2013 to 2022. To avoid the interference ofother factors, this paper first eliminated the samples of listed companies in the financial industry, and then eliminated the ST and *ST samples to avoid the influence of abnormal samples, and finally obtained 35923 company-year observations. Considering the influence of extreme values, 1% tailing treatment is carried out for continuous variables. The digital transformation of enterprises and the financial data of listed companies used in this paper are all from the Guotai 'a Database (CSMAR), and the ESG performance data is from the China Securities rating system. The statistical software used in this paper is Stata17.0.

3.1 Definition of main variables

3.2.1 Explanatory variables

Drawing on existing research practices (Wu Fei et al., 2021), this paper constructs an indicator of the degree of enterprise digital transformation through the word frequency of digital transformation keywords. Compared with the use of virtual variables whether digital transformation is carried out,

the frequency of digital transformation can better indicate the degree of transformation of an enterprise, covering the current business situation and future development direction of an enterprise. The underlying technical architecture of enterprise digital transformation is divided into artificial intelligence technology, blockchain technology, big data technology, cloud computing technology, and digital application, and the word frequency number of five types of characteristic words in the enterprise annual report is matched and processed logarithmically.

3.2.2 Explained variables.

This paper selects the ESG rating of listed companies disclosed by the ESGrating system of China Securities as the ESG rating data of this paper. China Securities ESG rating is divided into nine levels, from low to high respectively C, CC, CCC, B, BB, BBB, A, AA, and AAA,nine levels are assigned, A level is 3, B level is 2, C level is 1.

3.2 Control variable

1.Enterprise Size (Size): the natural logarithm of the company's total assets. Using firm size as a control variable can eliminate the effect of extra income caused by scale.

2. Financial leverage (Lev): The ratio of liabilities to assets. The asset-liability ratio is good for enterprises to improve performance within a reasonable range, but too high will increase the repayment risk and financial cost of enterprises, which is unfavorable to enterprise performance. Controlling the asset-liability ratio can eliminate the influence of unreasonable capital structure.

3. Enterprise performance (ROA): reflects the production and operation efficiency and effect of an enterprise in a certain period. In this paper, ROA is selected as an indicator to measure enterprise performance.

4. Tobin-Q: The ratio of acompany's market capitalization to its book assets represents the value of the enterprise.

5. Cash flow (Cash): Take the natural logarithm of the annual cash flow of a business.

6. Insholding: The proportion of institutional investor ownership to the total share capital of the company.

7. Ownership concentration (Top1): the proportion of equity held by the largest shareholder of an enterprise. The relative concentration of equity may promote the motivation of major shareholders to supervise the management, which will have an impact on corporate performance. Taking ownership concentration as a control variable, the influence of ownership concentration on firm performance is eliminated.

8. Proportion of independent directors (Indratio): Independent directors improve the credibility of the company's public disclosure information, which can make the company's stock price better convey the performance signal of the enterprise. This article is measured by the total number of independent directors/boards.

9. Years of establishment (Age): For 1+ years of establishment, take the natural logarithm. The age of establishment reflects the market position and experience of the enterprise to a certain extent, which may have an impact on the performance of the enterprise.

10. Book-to-market ratio (BM): calculated by the ratio of the total owner's equity to the outstanding market value at the end of the year.

4. Empirical result

4.1 Model setting

This paper adopts panel data regression, controls year and time, and individual fixed effects, and establishes the regression model as follows:

$ESG_{i,t+1} = \beta 0 + \beta 1\ Dgt_{i,t} + \beta 2 Size_{i,t} + \beta 3\ Lev_{i,t} + \beta 4\ Roa_{i,t} + \beta 5\ TobinQ_{i,t} + \beta 6\ cash_{i,t} + \beta 7\ Insholding_{i,t} + \beta 8\ ToP1_{i,t} + \beta 9\ Indration_{i,t} + \beta 10 Age_{i,t} + \beta 11\ BM_{i,t} + \beta 12\ year_{i,t} + \beta 13\ Firm_{i,t} + \varepsilon_{i,t}$

The model is used to investigate the impact of the degree of digital transformation of enterprises in the current period on the ESG performance of enterprises in the future. Where i represents the enterprise, t represents the Year, Year represents the fixed effect of the year, Firm represents the fixed effect of the individual company, ESG represents the ESG performance of the enterprise, Dgt represents the level of digital transformation, ε represents the random disturbance term, and β is the corresponding regression coefficient. The regression coefficient β 1 is expected to be significantly positive, that is, the higher the degree of enterprise digital transformation, the better the enterprise ESG performance, that is, the hypothesis test in this paper is valid.

4.2 Baseline regression result

In this paper, the bidirectional fixed effect model is used to test the significance, and the time-fixed effect and the individual fixed effect are added. Table 3 shows the impact of the degree of digital transformation on ESG performance in the next period. Without adding control variables, the regression coefficient of enterprise digital transformation (Dgt) is 0.0025 and significantly positive at a 1% level, indicating that enterprise digital transformation significantly promotes enterprise ESG performance. After adding control variables, the impact of the digital transformation index on the ESG performance of enterprises is also significantly tested, confirming the research hypothesis . The significance and symbols of other control variables are consistent with existing literature, in which financial leverage, firm performance, cash flow, and book- to-market ratio have a significant negative impact on firm ESG performance. Company size, Tobin's Q value, institutional investors' shareholding ratio, ownership concentration, independent directors' proportion, and the age of establishment of enterprises have a significant positive impact on ESG performance.

Table 1 The impact of enterprise digital transformation on ESG performance

Variables	ESG (1)	(2)
Dgt	0.0025***	0.0025***
Size	(0.0008) 0.0973***	(0.0008) 0.1044***
Lev	-0.2048*** (0.0323)	-0.2538*** (0.0354)
Roa	-0.0044 (0.0434)	0.1732*** (0.0657)
TobinQ	0.0088*** (0.0088)	0.0162*** (0.0039)
Cash	-0.0039 (0.0034)	-0.0074** (0.0036)
Insholding	0.0691* (0.0370)	0.0487 (0.0376)
Top1	0.0021*** (0.0006)	0.0022*** (0.0006)
Indratio	0.1430** (0.0595)	0.1505** (0.0604)
BM	-0.0786*** (0.0237)	-0.0514** (0.0250)
Time-fixed effect	Yes	Yes
Individual-fixed effect	Yes	Yes
Observations	23221	23221
Adj.R^2	0.0552	0.0552

Note: *, **, and *** indicate significance levels of 10%, 5%, and 1% respectively.

4.3 Heterogeneity analysis

In the heterogeneity analysis, this paper focuses on how the degree of nationalization of company shares and the east-west location ofthe company's location in China affect the digital transformation and ESG performance of enterprises. According to the data, the regression coefficient of state-owned

enterprises is 0.0016 and that of non-state-owned enterprises is 0.0049. Compared with state-owned enterprises, ESG performance has a more obvious improvement in the value of non- state-owned enterprises. Perhaps because state-owned enterprises have a certain connection with the government, compared with non-state-owned enterprises, it is easier to obtain government financial support and loans from financial institutions, and financing difficulty and constraints are less. However, non-state-owned enterprises can only improve enterprise value through good ESG performance, release positive signals to the market, obtain more financing opportunities, and reduce financing constraints, to promote the benign development of enterprises.

Besides, this paper divides the location of the company into east, middle, and west for regression analysis. The results in Table 4 show that the development level of digital finance has a significant effect on the ESG performance of enterprises in the eastern and central regions, while the impact on enterprises in the western region is not obvious. On the one hand, it may be that the digital infrastructure and financial resources endowment in the eastern and central regions are ahead of those in the western regions, and the digital financial services capabilities are relatively strong. On the other hand, the eastern and central regions are relatively early in the marketization process, with relatively complete factor markets and good competitive relations, while the western region is restricted by problems such as imperfect market mechanisms and unobstructed factor flow, and digital finance has not yet played a role in promoting enterprise ESG. It is concluded that the promotion of digital finance to the digital transformation of enterprises is more obvious in the eastern and central regions where finance and economy are developed. At this stage, we should coordinate the construction of digital infrastructure in various regions and improve the relevant market mechanism, reduce the "digital divide", and achieve balanced regional development. In addition, the digital transformation of enterprises significantly promotes the ESG performance of enterprises in the Eastern and Western regions.

Table 2 Property rights of enterprises and Regional level

Variables	State-owned	Non-state-owned	East	Middle	West
Dgt	0.0016*	0.0049**	0.0046**	0.0029**	0.0013**
	(0.0009)	(0.0025)	(0.0029)	(0.0015)	(0.0007)
Size	0.1012***	0.0897***	0.2087**	0.1897***	0.1306**
	(0.0107)	(0.0332)	(0.1018)	(0.0332)	(0.0647)
Lev	-0.2683***	-0.2087	-0.2683***	-0.2687	-0.2538***
	(0.0359)	(0.1378)	(0.0359)	(0.1378)	(0.0354)
Roa	0.0553	0.0695	0.0953**	0.0495**	0.0771*
	(0.0493)	(0.1965)	(0.0731)	(0.0069)	(0.0175)
TobinQ	0.0063**	0.0196	0.0031**	0.0196*	0.0087
	(0.0027)	(0.0139)	(0.0027)	(0.0039)	(0.1007)
Cash	-0.0052	-0.0091	-0.0052	-0.0091	-0.1022
	(0.0037)	(0.0109)	(0.0037)	(0.0109)	(0.0110)
Insholding	0.1230**	0.1763	0.1077**	0.1083	0.0877*
	(0.0402)	(0.1399)	(0.0301)	(0.1909)	(0.1087)
Top1	0.0018**	0.0012	0.0028**	0.0002	0.0003
	(0.0007)	(0.0018)	(0.007)	(0.0018)	(0.0405)
Indratio	0.1306**	0.1337	0.1306**	0.1337	0.1338
	(0.0647)	(0.1869)	(0.0617)	(0.1877)	(0.1888)

BM	-0.0578**	-0.1186	-0.0578**	-0.1186	-0.1554*
	(0.0262)	(0.0761)	(0.0262)	(0.0761)	(0.0601)
Time-fixed	Yes	Yes	Yes	Yes	Yes
effect					
Individual-	Yes	Yes	Yes	Yes	Yes
fixed effect					
Observations	19063	4151	9063	7151	4442
Adj.R2	0.0101	0.0458	0.0704	0.0558	0.0554

Note: *, **, and *** indicate significance levels of 10%, 5%, and 1% respectively.

5. Conclusions and Recommendations

The digital transformation of enterprises provides technical means to enhance the ESG performance of enterprises, and improving ESG performance can enhance enterprise value through obtaining more financial support and promoting green technology innovation in reverse. This paper empirically examines the effect of digital transformation on improving the ESG performance of enterprises and draws the following three conclusions: First, the main regression analysis shows that digital transformation has a positive effect on the improvement of the ESG performance of enterprises. Digital transformation helps enterprises to develop green innovative products more efficiently, apply innovation results to environmental, social and governance dimensions. Second, heterogeneity analysis shows that ESG performance improves the value of non-state-owned enterprises more significantly than that ofstate- owned enterprises. Third, in the eastern and central regions, the level of digital development has a significant promoting effect on the ESG performance of enterprises, while the impact on the western region is less. Based on the above conclusions, this paper puts forward the following policy recommendations:

First, improve enterprise ESG performance using digitalization. Enterprises can improve ESG performance by promoting digital transformation, increasing investment in environmental protection, social responsibility. The government and relevant departments can further improve the evaluation and application of ESG, continuously optimize the macro policy framework of enterprise digital transformation, expand the role of ESG performance in optimizing enterprise financing environment, further exert the advantages brought by digitalization.

Second, deepen the development of digital technology, improve the construction of digital infrastructure such as big data, cloud computing, and blockchain in all regions, especially in the central and western regions, maximize the development of data production factors, and improve the efficiency of resource allocation. Through digital technology, scientific and technological innovation to improve the effect of energy conservation and emission reduction, establish a digital platform for enterprises to fulfill social responsibilities, cultivate digital talents, and improve the level of digital governance of enterprises.

Third, at the level of the government and regulators, the relevant departments can encourage by increasing bank credit, reducing taxes and fees, and increasing government transfer payments, or they can punish by administrative penalties, establishing negative lists, and reducing loans. State-owned enterprises should play a leading role in achieving the "dual carbon" goal, tap the advantages of emerging technologies such as big data, artificial intelligence, and cloud computing to promote green innovation. At the same time, the government should also improve the laws and regulations related to information disclosure.

Fourth, adhere to the leading role of innovation in the development of enterprises, increase investment in green innovation projects, build a green supply chain, and strive to achieve green

transformation and development. In terms of corporate governance, we should improve the operating efficiency of the company, increase the degree of

ownership concentration, strengthen the functions of the board of directors, and strengthen internal supervision and control. In terms of enterprise operation, strengthen the application and innovation of digital technology in all aspects of marketing, management, production, and operation and explore the transformation of digital technology on traditional production modes.

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