



Digital Pathways to Drive Corporate ESG Development

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Abstract. With the development of digital economy, digital transformation has become an important issue globally, and ESG is a concept advocated by the United Nations to integrate environmental, social and governance (ESG) responsibilities into the development model of enterprises in order to form a sustainable business model. Therefore, it is important to analyze the path to promote sustainable corporate development. Based on the panel data of Chinese A-share listed companies from 2013-2023, the article explores the impact of government digital attention on corporate ESG development. The study finds that the government's digital attention has a significant role in promoting the environmental, social and governance aspects of corporate ESG development. Mechanism tests show that the government's digital attention promotes ESG development by enhancing firms' innovation capabilities. In addition, this paper also verifies the reliability of the results through robustness test and heterogeneity analysis, and finds that the ESG development of enterprises in the growth period is more significant after being concerned by the government. The findings provide theoretical basis and practical guidance for government policy making and corporate strategy.

Keywords: Government digital attention; corporate governance; ESG; mediating effects

1 Introduction

As human civilization has gradually moved from an industrial civilization to an ecological civilization, sustainable development has become a globally recognized value, and the concept of ESG (Environmental, Social and Governance) was born in the United Nations in 2004. The concept of ESG (Environmental, Social and Governance) was born in the United Nations in 2004, and has evolved from a questionable beginning to an important indicator of corporate value driven by the global sustainable development agenda and the wave of digital transformation. Looking around the world, ESG has been incorporated into the business strategies of almost all top investment institutions and corporations, deeply integrating the business objectives of corporate development with the vision of the long-term destiny of mankind, and driving rapid global change. The fulfillment of social responsibility by Chinese enterprises has a long history and fine tradition, and the establishment of public welfare departments and the release of social responsibility reports have become the mainstream practice of head

enterprises in various industries in recent decades. With the introduction of China's "dual-carbon" goal and the "14th Five-Year Plan", a number of national policies have been put in place to promote the sustainable development of society as a whole. The report of the 20th CPC National Congress pointed out that Chinese-style modernization is a modernization of harmonious coexistence between human beings and nature, and the ESG concept is highly compatible with the essential requirements of Chinese-style modernization, which organically unifies the new development concepts of innovation, coordination, greenness, openness, and sharing in the practice of Chinese-style modernization, and that the practice of ESG is the proper meaning of promoting high-quality development. Only when more and more people are committed and act with determination can our world achieve sustainable development and become better and better. Liu Xuexin and Cao Chengzi (2024) ^[1] explore the theoretical logic and practical path of how ESG (Environmental, Social, and Governance) principles can empower new quality productivity, highlighting ESG's role in enhancing economic performance and sustainability. Xie Haijuan, Sun Jiajia, Wang Menghui, and others (2024) ^[2] examine the dual driving effect of corporate ESG performance on the sustainability of innovation, suggesting that strong ESG performance can enhance both innovation capabilities and long-term corporate growth. Chen J. and Pan S. (2024) ^[3] discuss how digital infrastructure supports enterprise digitalization, emphasizing the role of digital technology innovation in enabling companies to leverage digital tools for more efficient operations and growth. Therefore, ESG is both the mission of enterprises and the foundation of sustainable development for the whole society. It is especially important to explore how to promote ESG development. Yang P., Yin Z., and Sun B. (2024) ^[4] focus on the application of digital technologies by enterprises, highlighting their positive impact on innovation efficiency and the importance of digital tools in fostering competitive advantage. Zhan S. and Huang Y. (2024) ^[5] explore how digital transformation can promote the development of new productive forces in Chinese enterprises, providing empirical evidence that digital adoption leads to improved productivity and innovation in A-share listed companies. Li Z., Chen J., and Wang W. (2023) ^[6] analyze China's national digital development strategy, presenting pathways, theoretical frameworks, and logical analyses to guide the country's digital transformation and technological innovation initiatives.

This paper is based on the panel data of China's A-share listed companies from 2003-2023, excluding the financial industry, ST companies, and sample missing companies, with a total of 26,285 samples, and the main contributions are as follows: first, the government's digital attention has a significant role in promoting the ESG performance of enterprises, and the impacts on the "environmental, social, and governance" aspects are explored separately. First, the government's digital attention significantly contributes to corporate ESG performance, and the impact on "environment, society and governance" is explored separately. It still holds after endogeneity test and robustness test. Second, it reveals the mechanism transmission effect of corporate innovation capability. Third, a heterogeneity analysis is conducted in terms of firms' growth life cycle and whether they are labor-intensive. This paper serves as a reference for exploring how the government's digital attention affects the relationship of firms' ESG performance.

2 Theoretical Analysis and Research Hypotheses

2.1 The Direct Impact of Government Digitalization Concerns on Corporate ESG Performance

Throughout the ESG ecosystem, international organizations provide guidance frameworks and standards for companies, asset managers, regulators and others. Enterprises conduct ESG compliance operations according to international standards and provide ESG data. Management organizations make investment decisions based on the ESG performance of companies and promote the popularization of ESG concepts. Regulators ensure ESG compliance through regulations and provide policy support. Research and evaluation organizations provide ESG research results and promote information transparency and market maturity. ESG evaluates companies from three main aspects: environmental aspects, mainly considering the impact of the company on the environment, such as how the company manages and controls the emission of various types of pollutants (including direct pollution generated by its own production and operation and indirect pollution generated by upstream and downstream) and the emission of greenhouse gases generated by its own production and operation in its production and operation, and the impact of climate change, such as the way it handles its wastes. The impacts of climate change, such as the treatment of waste, etc. Social aspects, mainly considering the impact of the enterprise on society, such as employee management, welfare and compensation, employee safety, relations with upstream and downstream suppliers and service providers, product safety, and the impact of the enterprise on the community in which it operates. In terms of governance, the main considerations are the organizational structure of the company, the interests of shareholders and management, the existence of corruption and financial fraud, the transparency of information disclosure, and business ethics.

According to stakeholder theory, stakeholder theory suggests that the success of a business depends not only on maximizing the interests of shareholders, but also on balancing and satisfying the needs of other stakeholders (e.g., government, customers, employees, community, etc.). The government is the most important external stakeholder. The government plays a key role in the development of enterprises through the formulation of policies, laws and regulations, regulatory instruments, etc. In October 2021, China issued the Opinions on the Complete and Accurate Comprehensive Implementation of the New Development Concept and Doing a Good Job in the Work of Peak Carbon and Carbon Neutrality, and the Action Program for Peak Carbon by 2030. Since the second half of 2021, a number of industry sectors in China have issued policy documents such as the Peak Carbon Implementation Plan, etc. The environmental (E) factor in ESG focuses on the impact of business activities on the environment, which is consistent with China's current implementation of the green development concept and the realization of the goal of "Peak Carbon and Carbon Neutrality". At the same time, realizing the goal of carbon neutrality requires huge capital investment in research and development of low-carbon and energy-saving technologies, as well as green upgrading of the entire industrial chain. The National Development and Reform Commission (NDRC), China Securities Regulatory Commission (CSRC), People's Bank of China

(PBOC), China Funds Association (CFA), State Administration of Financial Supervision and Administration of the People's Republic of China (SAFSAC) [illustration], and the Hong Kong Special Administrative Region (HKSAR) regulators have continued to promulgate relevant policies and put forward requirements on ESG disclosure for enterprises. This year, the digital transformation of governments has further increased their influence in corporate behavior, especially in driving companies towards sustainable development. The government's digital focus is not only manifested in the digitization of policies and regulations, but also in digital regulation and support for corporate disclosure, environmental governance, social responsibility, and sustainable development. Enterprises that ignore government requirements may face policy risks, insufficient financial support, or damage to their social reputation. Therefore, enterprises need to promote their ESG performance through digital change in the context of digital governance.

Hypothesis 1: Government digital focus significantly improves corporate ESG performance.

2.2 Government Digitalization Focuses on the Transmission Mechanisms that Affect Corporate ESG Performance

According to signaling theory, the government digitally communicates signals to firms about expectations regarding environmental protection, social responsibility and corporate governance, and these signals are able to influence firms' behavior through different transmission mechanisms.

The guidance of government policies, as an integral part of influencing enterprise resource allocation and infrastructure, affects the sustainable development of enterprises, and also promotes the technological and industrial upgrading of enterprises through specific influence mechanisms. Corporate innovation capability, plays an important role in promoting corporate ESG performance. Due to the many challenges facing the current ESG enhancement of enterprises, intelligent management is required, and the optimization and innovation of the internal structure of enterprises is also an important path to enhance ESG. The variety of business types of enterprises will cause inconsistency in the statistical caliber of ESG information, the dispersion of ESG information of enterprises, and the definition and scope of the same indicator are not the same, and with the expansion of the scale of operation of enterprises, this problem will be more prominent. Meanwhile, the lack of process monitoring fails to identify and respond to potential ESG risks in a timely and effective manner. All these require enterprises to strengthen technological innovation.

Based on this, this paper proposes Hypothesis 2: The government is digitally focused on improving corporate ESG performance by increasing the level of corporate innovation.

3 Research Design

3.1 Sample Selection and Data Source

This paper adopts the data of China's A-share listed enterprises from 2013-2023, excluding the financial industry, ST and ST* enterprises, and enterprises missing from the sample. The number of patents is from Cathay Pacific's historical cooperation database; other data are from CSMAR database and Wind database. In order to exclude the influence of extreme values, all continuous variables are shrink-tailed by 1% up and down.

3.2 Variable Selection

3.2.1 Explained Variable

ESG Rating. CSI ESG Rating provides investors, enterprises and policy makers with a scientific and systematic sustainability evaluation tool by comprehensively assessing the performance of enterprises in the three dimensions of environment, social responsibility and governance. Its measurement method starts from data collection, dimension decomposition, weight allocation, score calculation and other aspects to ensure the scientificity and fairness of its assessment results.

3.2.2 Explanatory Variable

Government digitalization attention. Referring to Liu Maotao et al. (2023), Lei Hongzhu et al. (2022), text analysis was used, and word frequencies were derived from the government work reports of each city, which were downloaded from each government website.

3.3 Mediating Variable

Corporate Innovation. Referring to Hall (2001), Bradley et al. (2016), and Qingbin Meng (2019), the study measures the number of patent other citations of listed companies. The total number of patent applications filed by firms is treated by adding one to take the logarithm.

3.4 Control Variables

Referring to the previous research, five indicators, namely, enterprise total asset size, enterprise age, asset-liability ratio, shareholders' shareholding ratio, and net profit margin of total assets, are selected as control variables. The descriptions of the variables are shown in Table 1 on the following.

Table 1. Description of variables

Variable type	variable name	notation	Description of variables
explanatory variable	ESG performance	ESG	CSI ESG Rating
explanatory variable	Government digitisation focus	GDC	Frequency of words in digitised government texts
Mechanism variables	Enterprise Innovation	CI	LN (number of patent applications +1)
control variable	Total enterprise asset size	SIZE	LN (total enterprise asset size)
	Listing age	Age	LN (current year - year of listing + 1)
	Gearing ratio	Lev	Total liabilities at year-end/total assets at year-end
	Shareholders' shareholding	TS	Shares held by shareholders/total shares
	Net profit margin on total assets	ROA	Net profit/total assets
heterogeneity test	district	SMZQ	Growth 1 Maturity2 Decline3

3.5 Model Construction

This paper constructs the following benchmark model:

$$ESG_{it} = \partial + \beta GDC_{it} + \lambda control_{it} + \mu_i + \psi_t + \varepsilon_{it} \tag{1}$$

Among them, ESG represents the Huazheng rating level of corporate ESG performance, GDC stands for government green concern. 'i' and 't' denote the enterprise and year, respectively. 'Control' indicates control variables, 'μ' represents individual fixed effects, 'ψ' denotes time fixed effects, and 'ε' signifies random disturbance terms. This paper constructs a mediation effect model of government green concern on corporate innovation capability based on regional AI level and corporate innovation level. To verify this mediation mechanism, this paper constructs the following mediation effect model for testing based on equation

$$ESG_{it} = \beta_4 + \beta_5 GDC_{it} + \beta_6 CI_i + \lambda control_i + \varepsilon_4 \tag{2}$$

4 Empirical Results and Analysis

4.1 Analysis of Benchmark Regression Results

As shown in Table 2, column (1) represents the regression results without controlling for individual fixed effects and year fixed effects, with a coefficient of 0.0846 and significant at 0.1%. Column (2) represents the results when controlling for individual fixed effects and year fixed effects, with the addition of control variables. The coeffi-

cient is 0.0730 and significant at the 1% level, indicating that government digital attention has a significant positive impact on corporate ESG performance. After adding control variables, the regression coefficient of digital finance on corporate greenwashing behavior slightly changed but remained significant. This validates hypothesis 1. Columns (3), (4), and (5) respectively verified the different mechanisms of government digital attention on "environment, society, and governance" in ESG performance. The results showed that government digital attention had a significant promoting effect on E score, S score, and G score in ESG level.

Table 2. Benchmark regression

Age		-0.0643**	-0.0223***	0.0013	-0.0004
		(-2.093)	(-5.160)	(0.303)	(-0.139)
Lev		-0.8058***	-0.0402***	0.0137**	-0.1150***
		(-16.980)	(-6.016)	(2.020)	(-23.171)
TS		0.0520	0.0138	0.0078	0.0008
		(0.845)	(1.593)	(0.885)	(0.130)
ROA		0.3042***	-0.0115	0.0689***	0.0547***
		(3.494)	(-0.934)	(5.529)	(6.009)
_cons	3.4583***	-0.0841	3.7114***	3.7076***	4.1698***
	(14.180)	(-0.223)	(69.939)	(68.780)	(105.818)
FE	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
N	26285	26285	26285	26285	26285
R ²	0.5848	0.5950	0.5683	0.5633	0.4960

4.2 Endogeneity and Robustness Tests

(1) Replace the regression method in column 1 of Table 3. Replacing the bidirectional fixed effects model with the OLS model for robustness testing, the regression coefficients of various indicators on the innovation capability of enterprises have been significantly improved. This indicates that the empirical results have a certain degree of robustness. (3) Regarding endogeneity issues, in order to ensure the credibility of the regression, this article conducts endogeneity tests on the explanatory variables using first-order lag and second-order lag treatments. As shown in Table 4, column 1 represents the lagged one period treatment, column 2 represents the lagged two period treatment, and the regression coefficients are both significant at 0.1%.

Table 3. Robustness Tests

	(1) ESG
GDC	0.4304*** (18.980)
SIZE	0.2157*** (41.150)
Age	-0.0149***

	(-19.220)
Lev	-0.7133***
	(-22.307)
TS	0.1875***
	(5.091)
ROA	1.2996***
	(14.452)
_cons	-4.0940***
	(-18.784)
FE	Yes
Year	Yes
N	26285
R ²	0.1264

Table 4. Endogeneity Test

	(1) CI	(2) CI
GDC	1.8735*** (20.053)	2.8702*** (16.322)
SIZE	0.5778*** (56.394)	0.5737*** (48.389)
Age	-0.0462*** (-30.755)	-0.0463*** (-27.036)
Lev	-0.3321*** (-5.195)	-0.3032*** (-4.097)
TS	-1.1051*** (-15.042)	-1.1501*** (-13.655)
ROA	1.2792*** (7.351)	1.3516*** (6.870)
_cons	-25.0488*** (-30.544)	-33.6030*** (-22.089)
FE	Yes	Yes
Year	Yes	Yes
N	24344	19463
R ²	0.1607	0.1150

5 Further Analysis

5.1 Impact Mechanism Test

Impact mechanism test: The regression coefficients in columns (1) to (3) of Table 5 are all significant, indicating the validity of hypothesis 2. The innovation capability of enterprises has a supplementary effect, thereby promoting the improvement of their ESG level. According to the theory of resource dependence, enterprise innovation is not only influenced by internal resources, but also by external resources. Government digital attention, as a policy driven external resource impact, provides critical external

support by enhancing regional digital infrastructure, enabling enterprises to utilize these resources for ESG development applications.

Table 5. Mediation effect test

	(1) ESG	(2) CI	(3) ESG
GDC	0.0720** (2.574)	0.0861** (2.204)	0.0707** (2.525)
SIZE	0.1969*** (16.780)	0.5024*** (30.674)	0.1889*** (15.772)
Age	-0.0643** (-2.093)	-0.0893** (-2.082)	-0.0629** (-2.048)
Lev	-0.8058*** (-16.980)	-0.2286*** (-3.451)	-0.8022*** (-16.903)
TS	0.0520 (0.845)	0.3867*** (4.502)	0.0459 (0.745)
ROA	0.3042*** (3.494)	-0.2079* (-1.710)	0.3075*** (3.532)
CI			0.0158*** (3.271)
_cons	-0.0841 (-0.223)	-9.1869*** (-17.469)	0.0611 (0.161)
FE	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	26285	26285	26285
R ²	0.5950	0.8068	0.5952

5.2 Heterogeneity Analysis

According to the heterogeneity test of the enterprise lifecycle theory, Table 6 shows that companies in the growth stage are receiving more significant attention from the government's digitalization efforts, resulting in a more significant improvement in ESG levels. There are significant differences in development goals, resource allocation, and strategic management directions among companies in the growth, maturity, and decline stages. Firstly, compared to the other two types, enterprises in the growth stage have greater resource demands and are more sensitive to external government policy signals. Secondly, growth stage enterprises require more financing to facilitate their development. ESG serves as an important criterion for evaluating a company's credit rating and capital market recognition. Good ESG performance can attract more investors and banks. Thirdly, growing enterprises have stronger market adaptability and innovation capabilities, and their management models are more flexible and adaptable, and have not yet been fixed. Therefore, adjusting ESG strategies has lower costs and is more susceptible to policy influences.

Table 6. Heterogeneity test

	(1) Growth	(2) Maturity	(3) Decline
GDC	0.1265** (2.497)	0.0200 (0.490)	0.1436 (0.959)
SIZE	0.2131*** (10.247)	0.2271*** (12.377)	0.1163 (1.324)
Age	-0.1777 (-1.500)	-0.0706* (-1.934)	0.0425 (0.428)
Lev	-0.8610*** (-10.453)	-0.7279*** (-10.067)	-0.1479 (-0.452)
TS	0.1488 (1.317)	-0.0337 (-0.354)	-0.3698 (-1.017)
ROA	0.1647 (1.094)	0.0819 (0.627)	-0.9176 (-1.160)
_cons	-0.8162 (-1.193)	-0.1042 (-0.180)	0.1720 (0.067)
FE	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	10227	13160	1563
R ²	0.6589	0.6645	0.7682

6 Conclusion and Recommendations

Based on empirical results, this article proposes the following suggestions: (1) Deepen the construction of government digital policies, take the market as the guide, use financial subsidies and other means to stimulate the enthusiasm of enterprises for innovation, promote the combination of enterprise innovation with artificial intelligence, blockchain technology, etc., thereby improving the enthusiasm of enterprise ESG transformation. (2) The innovation capability of enterprises is an important mechanism for improving their ESG performance. Improve digital governance, strengthen investment in artificial intelligence, stimulate and support the development of enterprise artificial intelligence technology, and cultivate new era scientific and technological talents. Enterprises should enhance their core competitiveness internally, while accepting government support, adhere to internal governance, and improve their internal innovation capabilities through deepening industry university research cooperation. (3) Differentiated policies and supervision should be implemented for enterprises in different life cycles, and precise policies should be implemented. Implement incentive policies for growth stage enterprises to help them achieve the transformation from technological innovation to ESG practical application first. Solve the problem of financing difficulties and assist with ESG fund investment. For mature enterprises, the culture of ESG corporate social responsibility should be deeply conveyed to employees. Based on the improvement of the internal mechanism of the enterprise, an ESG rating system should be established to enhance the brand effect and market position, and form a sustainable development strategy with ESG as the core. Declining enter-

prises may face difficulties, and the government needs to encourage them to cooperate with mature enterprises in the growth stage and formulate relevant policies to provide support.

The current ESG practice is still in a rapid development process, and the international community's ESG related standards are constantly evolving and improving. Many countries and regions are formulating stricter ESG related regulations and guidelines, which prompts companies to pay more attention to the implementation of ESG concepts and constantly adapt to new regulatory requirements; With the advancement of digital technology, enterprises are able to better track, measure, and report their ESG performance. To further accelerate the fulfillment of corporate social responsibility and promote sustainable development, it is not only necessary to rely on internal governance, but also external government support and take active actions to improve.

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