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Original Paper

Research on the Impact of New Information Infrastructure Construction on Corporate ESG Performance

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Abstract
As the core network support and underlying computing foundation for the development of the digital economy, new information infrastructure acts as a critical engine to unlock digital productivity. It provides strong impetus for China to accelerate the formation of new-quality productive forces and advance high-quality economic development. Taking A-share listed firms from 2018 to 2024 as the research sample and the construction of Gigabit Cities as a quasi-natural experiment, this paper adopts the multi-period difference-in-differences (DID) model to empirically examine the impact of new information infrastructure construction on corporate ESG performance. The results show that new information infrastructure significantly and positively promotes corporate ESG performance. Mechanism tests indicate that new information infrastructure improves corporate ESG performance through two parallel channels: enhancing firms' green technological innovation and accelerating corporate digital transformation. Heterogeneity analysis reveals that the ESG-enhancing effect of new information infrastructure construction is more pronounced for non-state-owned enterprises, high-tech firms, enterprises in central and western regions, and firms in heavily polluting industries. This study enriches the literature concerning the non-economic effects of information infrastructure and puts forward policy implications for optimizing the layout of new-type infrastructure.

Keywords
New Information Infrastructure, Gigabit City, Corporate ESG Performance

1. Introduction

The Outline of the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China states: "We will firmly establish and act on the principle that lucid waters and lush mountains are invaluable assets. Guided by the goals of carbon peaking and carbon neutrality and supported by a sound institutional framework for ecological civilization, we will coordinate carbon reduction, pollution abatement, green expansion and economic growth, improve the quality of the ecological environment, consolidate ecological security barriers, and strengthen the drivers of green development". Against the backdrop of deep integration between global green and low-carbon transition and China's high-quality economic development, strengthening corporate ESG practices and improving corporate ESG performance constitute a key measure to realize China's green transition and high-quality sustainable development (Dong, 2026)[1]. Integrating environmental responsibility (E), social responsibility (S), and modern governance (G), the ESG philosophy is highly consistent with major national strategies including the dual-carbon strategy, rural revitalization and common prosperity. It serves as a vital instrument for firms to break through traditional growth modes and promote coordinated green transition between micro entities and the macro-economy.

Existing literature on the determinants of corporate ESG performance is mainly developed from internal and external perspectives. From an intra-firm perspective, factors such as internal Party-organization governance (Liu & Kong, 2022)[2], managerial excess compensation (Ferrell et al., 2016)[3], and corporate digital transformation (Liu et al., 2026)[4] exert influences on corporate ESG performance. A large body of scholarship also explores external determinants. For example, Lei et al. (2023)[5] find that common institutional ownership significantly reduces corporate ESG performance, and this effect is mainly driven by active institutional investors. Based on corporate investment preferences, Hong et al. (2024)[6] confirm that the low-carbon city pilot policy can significantly improve corporate ESG performance as well as performance in the E and G dimensions, and command-and-control environmental regulation serves as the primary channel for the pilot policy to function. The above literature explores the driving factors of corporate ESG performance from diverse perspectives, yet few studies discuss the impact of the rapidly evolving new-generation information infrastructure on corporate ESG performance.Amid the wave of digital-intelligent transformation, accelerating the application of emerging digital technologies is an essential means for firms to advance green and low-carbon transition, enhance governance performance and social-value creation, and thereby strengthen market competitiveness. Various infrastructures play a pivotal role in lowering the barriers for enterprises to adopt digital technologies, especially new information infrastructure. New information infrastructure represents a new-generation infrastructure centered on 5G, big-data centers, artificial intelligence, industrial Internet and the Internet of Things (Zhang, 2019)[7]. The improvement of corporate ESG performance essentially relies on the green transformation of production modes and digital upgrading of business operations, both of which are highly dependent on the effective support from new information infrastructure. On the one hand, by building high-efficiency platforms for green technology R&D, integrating environmental-monitoring data resources, and optimizing information transmission efficiency for green production processes (Wang & Guo, 2023)[0], new information infrastructure can effectively cut R&D costs, shorten innovation cycles for corporate green technological innovation, and deliver core technical support for the improvement of corporate environmental performance. On the other hand, new information infrastructure empowers corporate digital transformation and facilitates intelligent production processes and data-driven management decision-making (Song & Li, 2026)[9]. It not only improves operational efficiency and reduces resource consumption and carbon emissions, but also enhances corporate social and governance performance via optimizing supply-chain collaboration and improving corporate-governance mechanisms. Prior research has documented that new information infrastructure can effectively boost regional economic resilience, facilitate industrial-structure upgrading, promote corporate knowledge spillovers, and curb firms' tendency to divert resources from the real economy to the virtual sector (Hu & Shao, 2022; Wen et al., 2024; Wang et al., 2025; Sun et al., 2025)[10][11][12][13]. Nevertheless, most existing studies focus on macro-level outcomes and pay insufficient attention to the non-economic effects of new information infrastructure; in particular, few empirical studies investigate how new information infrastructure shapes corporate ESG performance. Accordingly, this paper takes the Gigabit City pilot policy as an exogenous shock to new information infrastructure construction in China, examines its impact on corporate ESG performance, and further evaluates the practical role of new information infrastructure in national economic and social development. This study aims to answer the following core questions: Does new information infrastructure construction significantly improve corporate ESG performance? If so, what are its specific transmission channels? Which firm-level characteristics moderate such effects? Specifically, this paper treats the Gigabit City pilot policy as a quasi-natural experiment. Using a sample of A-share listed firms in Shanghai and Shenzhen stock exchanges from 2018 to 2024, it empirically tests the impact and mechanisms of new information infrastructure construction on corporate ESG performance. The empirical results show that new information infrastructure construction significantly improves the ESG performance of firms located in pilot cities, and this finding survives a battery of robustness checks. Mechanism tests verify that new information infrastructure raises corporate ESG performance by promoting firms' green technological innovation and digital transformation. Heterogeneity analysis demonstrates that the ESG-promoting effect is more salient for non-state-owned enterprises, high-tech firms, enterprises in central-western China, and firms operating in heavily polluting industries. This paper makes several potential marginal contributions. First, focusing on the effect of new-generation information infrastructure construction on corporate ESG performance, it enriches literature on the determinants of corporate ESG performance. Although prior scholarship has generated abundant insights into information infrastructure and corporate ESG performance, most existing studies concentrate on early pilot policies such as the Broadband China strategy and Smart City initiative (Lv, 2024; Wu & Zhou, 2026)[14][15], while little empirical evidence is available regarding the Gigabit City pilot policy. Second, in terms of research perspective, this paper moves beyond prior studies that predominantly examine the economic consequences of new information infrastructure such as economic transition (Hu & Shao, 2022)[10] and industrial upgrading (Ma & Hui, 2025)[16]. By incorporating corporate ESG performance into the analytical framework, it expands research on the non-economic consequences of new information infrastructure from environmental, social and governance dimensions, and provides new empirical evidence for understanding how new information infrastructure shapes corporate sustainable development. Third, from the perspective of policy evaluation, drawing on the quasi-natural experiment of the Gigabit City pilot policy, this paper systematically uncovers the mechanisms and boundary conditions through which new information infrastructure construction affects corporate ESG performance. It deepens theoretical understanding of how digital technologies empower corporate social-responsibility behaviors, and offers theoretical and practical references for evaluating the sustainable-development effects of the Gigabit City pilot as well as for optimizing relevant policies on new information infrastructure in China. It also carries policy implications for the government to simultaneously advance Digital China construction, achieve dual-carbon goals, and promote high-quality economic development.

2. Institutional Background and Theoretical Analysis

2.1 Institutional Background

By 2025, the added value of China's core digital-economy industries has accounted for more than 10.5 % of GDP, and China ranks second worldwide in terms of digital-economy scale. As the digital economy enters a new phase featuring in-depth application, standardized development and inclusive sharing, traditional information infrastructure can no longer underpin new business forms such as artificial intelligence, industrial Internet and the Internet of Vehicles. By building a digital-service system characterized by high-speed ubiquitous connectivity, cloud-network integration, intelligence and environmental friendliness, new information infrastructure lays a solid foundation for unlocking the value of data factors and empowering digital transformation across industries. The Outline of the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives through the Year 2035 explicitly proposes to "build high-speed, ubiquitous, space-ground integrated, interconnected, secure and efficient information infrastructure and strengthen capabilities for data perception, transmission, storage and computation". The 14th Five-Year National Informatization Plan also states that China shall "construct ubiquitous and intelligent network-connection facilities, promote high-speed and intelligent upgrading of urban broadband networks, and realize smooth evolution of networks, applications and terminals toward the next-generation Internet". Featuring computing-network integration, low-carbon operations and intelligent upgrading, new information infrastructure serves as a core foundation supporting Digital China and fostering new-quality productive forces.To accelerate the development of new information infrastructure, the Fifth Plenary Session of the 19th Central Committee proposed to "systematically deploy new infrastructure and speed up the construction of 5G communications, industrial Internet and big-data centers". The 2021 Government Work Report explicitly called for "scaling up the development of 5G networks and gigabit optical networks and enriching application scenarios". In March 2021, the Ministry of Industry and Information Technology (MIIT) officially released the Action Plan for Coordinated Development of Dual-Gigabit Networks (2021-2023). The plan aims to foster a group of Gigabit Cities and empower various sectors of the economy and society through coordinated development of gigabit optical networks and 5G networks, marking a new round of accelerated development of China's information infrastructure. The Gigabit City evaluation system covers seven core indicators including gigabit optical-network coverage, the proportion of 10G-PON ports, and the number of 5G base stations per 10 000 residents, grouped under three dimensions: network capacity, user adoption, and application synergy. After three years of implementation, by the end of 2024

China had built 4.251 million 5G base stations (30.2 stations per 10 000 residents), 28.2 million 10G-PON ports with gigabit service capacity, and 207 million gigabit-network subscribers. At the macroeconomic level, Gigabit City construction can effectively stimulate investment in information infrastructure, unlock information-consumption potential and inject new momentum into high-quality economic development. By driving digital upgrading on both production and consumption sides, it plays a key supporting role in building the new-development paradigm with domestic circulation as the mainstay and mutual reinforcement between domestic and international circulations. From an industrial perspective, large-scale deployment of dual-gigabit networks provides a solid network foundation for industrial digital transformation and constitutes a critical lever for deep integration between the real economy and the digital economy. As a core carrier for new information infrastructure construction in China, Gigabit City construction delivers interconnected underlying support for high-quality digital-economy development. Driven by central-government authorities, this policy is exogenous to individual firm behaviors. Its staggered roll-out across cities provides natural treatment and control groups for multi-period DID estimation, enabling credible identification of the causal effect of new information infrastructure construction on corporate ESG performance.

2.2 Theoretical Analysis

Characterized by data as a key production factor, high-speed interconnection, intelligent perception and open sharing (Pan & Wan, 2020)[17], new information infrastructure exhibits advantages including strong permeability, high synergy, wide coverage and low marginal costs (Yang & Wu, 2025)[18]. It provides a new technical foundation for firms' production-operation, decision-making and external supervision. On the one hand, the high-speed and low-latency properties of new-generation information infrastructure enable faster and more transparent transmission of corporate environmental data, social-responsibility performance and internal-governance information to stakeholders. Improved transparency compels firms to attach greater importance to their ESG performance so as to avoid reputational risks and gain market trust (Zhou et al., 2025)[19]. On the other hand, as a general-purpose technology, information infrastructure generates significant positive externalities and spillover effects, attracting high-skilled talent and advanced technologies, optimizing firms' factor allocation efficiency and furnishing resource bases for ESG-related activities. Furthermore, governments can leverage digital platforms to monitor corporate pollution emissions and regulatory compliance in real time, while the public and media can more easily access and supervise corporate ESG information via the Internet. Enhanced internal and external pressures in turn push firms to improve ESG performance (Ling & Jin, 2026)[20]. Based on the above reasoning, this paper puts forward Hypothes is H1:

H1:New information infrastructure construction significantly improves corporate ESG performance.

By optimizing innovation environments and resource allocation, new information infrastructure stimulates corporate green technological innovation and thereby enhances ESG performance. First, improved information infrastructure accelerates the spillover and diffusion of green-technology knowledge, lowering search and trial-and-error costs for corporate R&D; meanwhile, digital R&D tools raise R&D efficiency and shorten green-innovation cycles. Second, via online platforms, investors can better identify corporate green-innovation potential, channel capital toward green projects, ease financing constraints for green innovation, and thus promote corporate green technological innovation (Yang et al., 2026)[21]. By adopting clean-production technologies and energy-saving and emission-reduction processes, firms directly mitigate environmental pollution and improve environmental-dimension performance (Bibri et al., 2024)[22]. In addition, green technological innovation creates high-skill, low-risk green jobs, optimizes corporate human-resource structures, improves working conditions and expands career-development opportunities for employees, reflecting firms' social-responsibility commitments (Lin & Huang, 2026)[23]. Environment-friendly products supported by green technologies cater to consumers' environmental preferences, help firms build responsible brand images, strengthen market competitiveness and social reputation, and realize win-win outcomes for economic and social benefits, ultimately lifting overall corporate ESG performance. Accordingly, Hypothesis H2 is proposed:

H2: New information infrastructure construction improves corporate ESG performance by promoting corporate green technological innovation.

New information infrastructure construction furnishes underlying network support and application scenarios for corporate digital transformation, which further shapes ESG performance. On the one hand, it lowers the thresholds and costs of digital transformation, enabling small-and medium-sized enterprises to adopt cloud computing, big-data analytics and other technologies, and promoting digital renovation across production, management and marketing processes (He et al., 2025)[24]. Digital transformation improves operational efficiency and optimizes management-decision workflows, strengthening firms' internal-control and risk-response capacities and thus enhancing governance-dimension performance. On the other hand, digital transformation reshapes how firms interact with stakeholders (Matarazzo et al., 2021)[25]. Firms can respond more precisely to demands from consumers and investors and strengthen social-responsibility fulfillment. For instance, digital supply-chain management helps firms better control suppliers' environmental-compliance risks; digital customer-service systems enable timely responses to public concerns. Based on the above analysis, Hypothesis H3 is formulated:

H3: New information infrastructure construction improves corporate ESG performance by promoting corporate digital transformation.

3. Research Design

3.1 Sample and Data Sources

This study selects A-share listed firms in Shanghai and Shenzhen stock exchanges from 2018 to 2024 as the research sample. Data sources are as follows: corporate ESG performance is measured by Huazheng ESG ratings obtained from the Wind database; the list of Gigabit City pilot cities is retrieved from the official website of the Ministry of Industry and Information Technology. To guarantee sample accuracy, cities where only partial districts or counties were selected as pilot sites are excluded, as are firms registered in Hong Kong, Macao and Taiwan. Corporate financial indicators are sourced from the

CSMAR database; city-level macroeconomic data (city-level GDP) come from the China City Statistical Yearbook; green-technological-innovation data are obtained from the China Research Data Service Platform (CNRDS), where green-patent application and grant counts are identified according to green-patent classification codes. Missing values are imputed via interpolation. Key variables are winsorized at the 1 % level to mitigate the influence of outliers. ST, *ST, financial-sector listed firms and observations with severe data missingness are excluded. Finally, 18 368 valid firm-year observations are retained to construct a balanced panel dataset.

3.2 Model and Variables

From 2021 to 2023, the National Development and Reform Commission and the Ministry of Industry and Information Technology designated more than 200 cities as demonstration Gigabit Cities. This paper regards the Gigabit City pilot policy as a quasi-natural experiment for new information infrastructure construction and builds a multi-period DID model with two-way fixed effects on the basis of the standard DID framework. The specific model is specified

$$ESG_{it} = \alpha_0 + \alpha_1 DID_{it} + \sum \beta_j Control_{\mathrm{it}} + Symbol_i + year_t + \varepsilon_{\mathrm{it}}$$

Where ESG_{it} denotes the ESG performance of firm i in year t. DID_{it} is a dummy variable that equals 1 if city where firm i is located has been designated as a Gigabit City in year t, and 0 otherwise. $Control_{it}$ represents a set of control variables affecting the explained variable, including firm age in logarithm (ListAge), firm size (Size), return on total assets (ROA), Tobin's Q (TobinQ), institutional-investor shareholding ratio (Inst), proportion of independent directors (Indep), and city-level economic development (ln_gdp). μ_i stands for firm fixed effects, λt for year fixed effects, and ε_{it} for the stochastic disturbance term.

Explained variable (ESG). This paper adopts Huazheng ESG ratings as the proxy for corporate ESG performance. Widely used in academic research on economics and corporate innovation, this indicator enjoys high scholarly recognition (Xie & Lü, 2022)[26]. Huazheng ESG ratings classify A-share listed firms into nine grades ranging from C to AAA in ascending order of ESG performance. Following common practice in the literature, these nine grades are assigned values from 1 to 9, with higher values indicating better corporate ESG performance, yielding firm-level ESG scores.

Core explanatory variable (DID). Constructed following the logic of difference-in-differences estimation, DID_{it} takes the value 1 for firms located in Gigabit City pilot cities in and after the policy-implementation year, and 0 otherwise; firms in non-pilot cities are always coded 0. This dummy captures the policy shock brought about by new information infrastructure construction.

Control variables (Control). Drawing on Lei et al. (2023)[5], this paper selects the following control variables to alleviate omitted-variable bias. ListAge (firm age): log of current year minus founding year plus 1. Size (firm size): natural logarithm of year-end total assets. ROA (return on assets): ratio of net profit to average total assets. TobinQ (Tobin's Q): ratio of firm market value to total assets. Inst (institutional shareholding): number of shares held by institutional investors divided by total share capital.

Indep (independent-director ratio): number of independent directors divided by total number of board directors. ln_gdp (city-level economic level): natural logarithm of city-level GDP.

Mediator variables. Consistent with theoretical hypotheses, two mediating channels are examined: corporate digital-transformation intensity and corporate green-innovation level. (1) Digital transformation (DIGI_text). Following Zhao et al. (2021)[27], textual analysis of annual corporate reports is conducted. Keyword frequencies in four dimensions (digital-technology adoption, Internet-based business models, intelligent manufacturing, and modern information systems) are counted to reflect corporate digital-transformation intensity. (2) Corporate green technological innovation, measured by green-patent-application counts of listed firms. Referring to Xu & Cui (2020)[28], green-patent-application counts are log-transformed. Given the right-skewed distribution of green-patent data, the logarithmic transformation is performed after adding 1 to patent counts. Descriptive statistics for all variables are reported in Table 1.

4. Empirical Results and Analysis

4.1 Descriptive Statistics

Table 1. Descriptive Statistics of Main Variables

	Obs	Mean	SD	Min	Median	Max
ESG	18368	4.235	1.155	1.000	4.000	9.000
DID	18368	0.461	0.499	0.000	0.000	1.000
Size	18368	22.578	1.342	20.230	22.381	26.647
ROA	18368	0.033	0.062	-0.230	0.033	0.198
Indep	18368	37.958	5.451	33.330	36.360	57.140
ListAge	18368	3.110	0.262	2.398	3.135	3.664
TobinQ	18368	1.846	1.107	0.798	1.500	7.244
Inst	18368	40.847	25.000	0.162	42.210	90.201
ln_gdp	18368	9.333	1.041	5.335	9.467	10.895

Baseline Regression Outcomes: Table 2 presents baseline regression results. Column (1) reports estimation without control variables, and Column (2) includes full controls. Regardless of whether control variables are incorporated, the coefficient on DID is significantly positive at the 1 % statistical level, demonstrating that Gigabit City policy significantly improves corporate ESG performance and validates Hypothesis H1. After adding control variables, the R-squared rises from 0.019 to 0.032, indicating improved model explanatory power, while the magnitude and significance of the DID coefficient remain largely unchanged, supporting the robustness of baseline estimates.

Table 2. Baseline Regression Results

	(1)	(2)
	ESG	ESG
DID	0.1211***	0.1156***
	(3.8091)	(3.6377)
Size		0.2931***
		(6.6840)
ROA		0.2756
		(1.4400)
Indep		0.0083***
		(2.6331)
ListAge		0.6604
		(1.4772)
TobinQ		-0.0583***
		(-4.1058)
Inst		0.0017
		(1.0494)
ln_gdp		-0.1690
		(-1.0106)
Constant	4.3152***	-2.9483
	(270.2728)	(-1.3998)
Observations	18,368	18,368
R-squared	0.019	0.030
Symbol FE	Yes	Yes
year FE	Yes	Yes

Robust t-statistics in parentheses

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

5. Robustness and Endogeneity Tests

5.1 Parallel-Trend Test

Satisfying the parallel-trend assumption is a prerequisite for valid DID estimation. Following Beck et al. (2010)[29], this study adopts the event-study specification for parallel-trend assessment:

$$ESG_{it} = \alpha_0 + \sum_{n=3}^{n=-3} DID_{it}^{t-n-e_i} \alpha_n + \sum \beta_j Control_{\text{it}} + Symbol_i + year_t + \varepsilon_{\text{it}}$$

Where e_i denotes the year when firm i is exposed to policy treatment. $D_{it}^{t-ei}=n$ equals 1 if $t-e_i=n$, and 0 otherwise. The pre-policy period $n=-1$ is set as the benchmark group. The parallel-trend assumption holds if pre-treatment coefficients are not statistically different from zero. Estimation results are plotted in Figure 1.

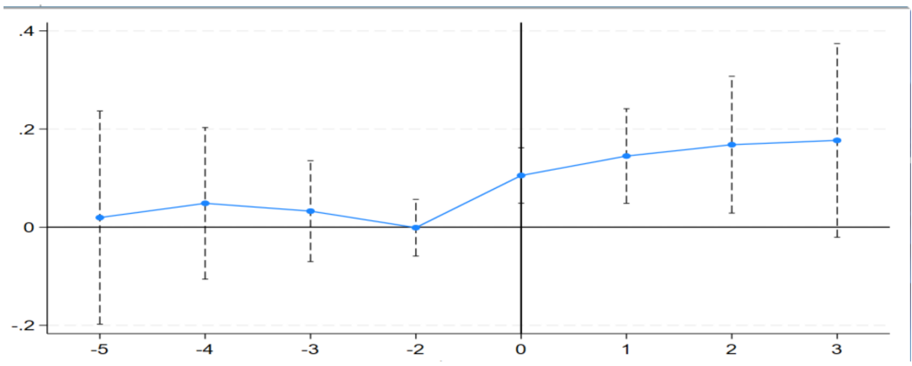


Figure 1. Parallel-Trend Graph

As illustrated in Figure 1, before policy implementation, the ESG-performance gap between treatment-group and control-group firms fluctuates near zero; pre-treatment coefficients are not significantly different from zero and exhibit no systematic trending patterns, which supports the parallel-trend assumption. Coefficients become significantly positive in the policy-implementation year and later periods, showing that the policy-induced ESG improvement emerges immediately and persists over time. Collectively, there exists no systematic difference in ESG performance between treatment and control groups prior to policy shocks, satisfying the identification assumption for the DID model.

5.2 Heterogeneous-Treatment-Effect Test

Callaway & Sant'Anna (2021)[30] point out that multi-timepoint DID estimators represent weighted averages of group-specific treatment effects and rest on the homogeneous-treatment-effect assumption. In reality, firms may respond heterogeneously to the same policy, potentially generating estimation bias. Following de Chaisemartin & d'Haultfoeuille (2020)[31], this paper conducts diagnostic tests for heterogeneous-treatment-effect bias in two-way fixed-effect multi-period DID. Weight diagnostics reveal that among 8 474 weight terms, 5 486 are positive and 2 987 are negative; negative weights account for 35.24 %, which implies potential estimation bias. The corrected average-treatment-effect estimator proposed by de Chaisemartin & d'Haultfoeuille (2020) yields a corrected coefficient of 0.161, significant at the 1 % level. This paper further estimates dynamic treatment effects following Sun & Abraham (2021)[32]; Figure 2 plots corrected dynamic effects within the 95 % confidence interval. Pre-policy coefficients fluctuate around zero and are insignificant, while post-policy coefficients are significantly positive. These findings confirm that Gigabit City construction still exerts significant positive effects on corporate ESG performance after accounting for bias stemming from heterogeneous treatment effects, corroborating the robustness of baseline conclusions.

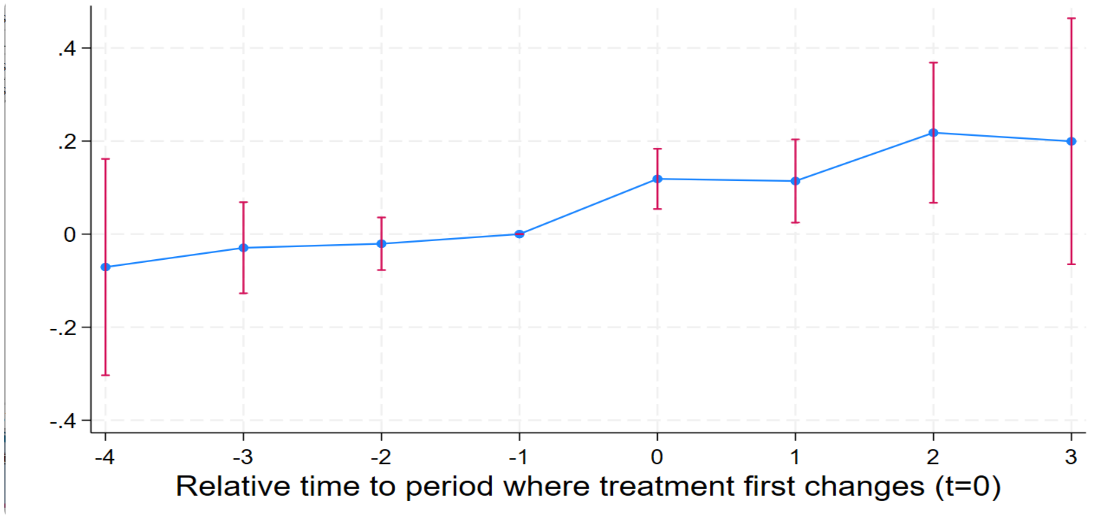


Figure 2. Heterogeneous-Treatment-Effect Dynamic Estimates

5.3 Propensity-Score-Matching DID (PSM-DID)

Policy pilot assignments are often non-random in real-world contexts, raising concerns about sample-selection bias. To mitigate such bias, this paper implements PSM-DID as a robustness check. All control variables are used as covariates for matching. Caliper matching (caliper radius = 0.1) and kernel matching are separately applied to match control-group observations for treated firms. The DID specification is re-estimated on the matched samples. Results are shown in Table 3. Under both matching algorithms, coefficients for the core explanatory variable remain significantly positive at the 10 % level, verifying the reliability of baseline findings.

Table 3. PSM-DID Estimation Results

	(1)	(2)
	Caliper Matching	Kernel Matching
DID	0.0620*	0.0621*
	(1.6470)	(1.6505)
Size	0.2955***	0.2955***
	(6.0122)	(6.0119)
ROA	0.3808	0.3801
	(1.5019)	(1.4996)
ListAge	0.0576	0.0572
	(0.1096)	(0.1088)
TobinQ	-0.0551***	-0.0552***
	(-2.9792)	(-2.9862)
Inst	0.0016	0.0016

	(0.8384)	(0.8394)
Indep	0.0032	0.0032
	(0.8263)	(0.8336)
ln_gdp	-0.1139	-0.1139
	(-0.6915)	(-0.6912)
Constant	-1.8114	-1.8110
	(-0.8029)	(-0.8027)
Observations	8,886	8,887
R-squared	0.499	0.499
Symbol FE	Yes	Yes
year FE	Yes	Yes

Robust t-statistics in parentheses

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

5.4 Placebo Tests

Drawing on Chen et al. (2025)[33], this paper conducts time-placebo and space-placebo tests to assess causal inference validity and rule out confounding from omitted variables and random factors.

1. Time-Placebo Test

To exclude the possibility that improved ESG performance stems from unobserved time trends or concurrent policies rather than Gigabit City construction, the policy-implementation time is artificially lagged by 1-3 periods to construct pseudo-treatment timing for multi-timepoint DID estimation. As shown in Figure 3, all pseudo-policy effect point estimates fluctuate around zero, and 95 % confidence intervals include zero for all pseudo-treatment periods. The null hypothesis of zero placebo effect cannot be rejected. It suggests that observed ESG improvements in baseline regressions represent real causal effects of new information-infrastructure policies instead of time trends or random shocks, and the time-placebo test is passed.

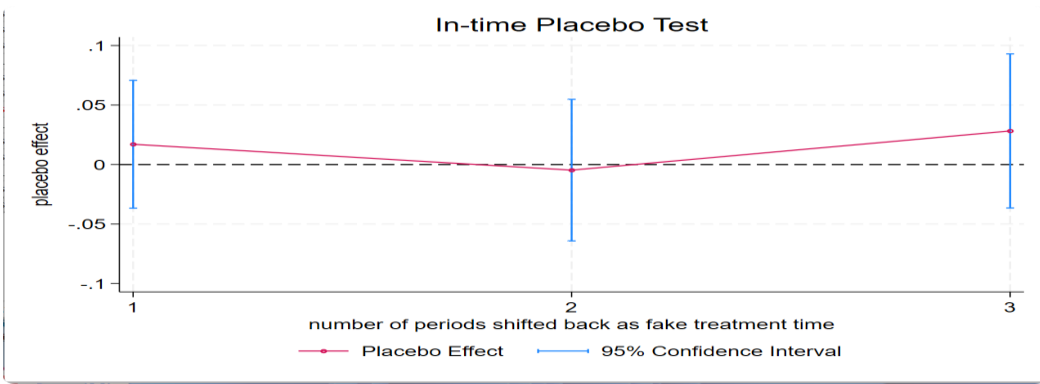
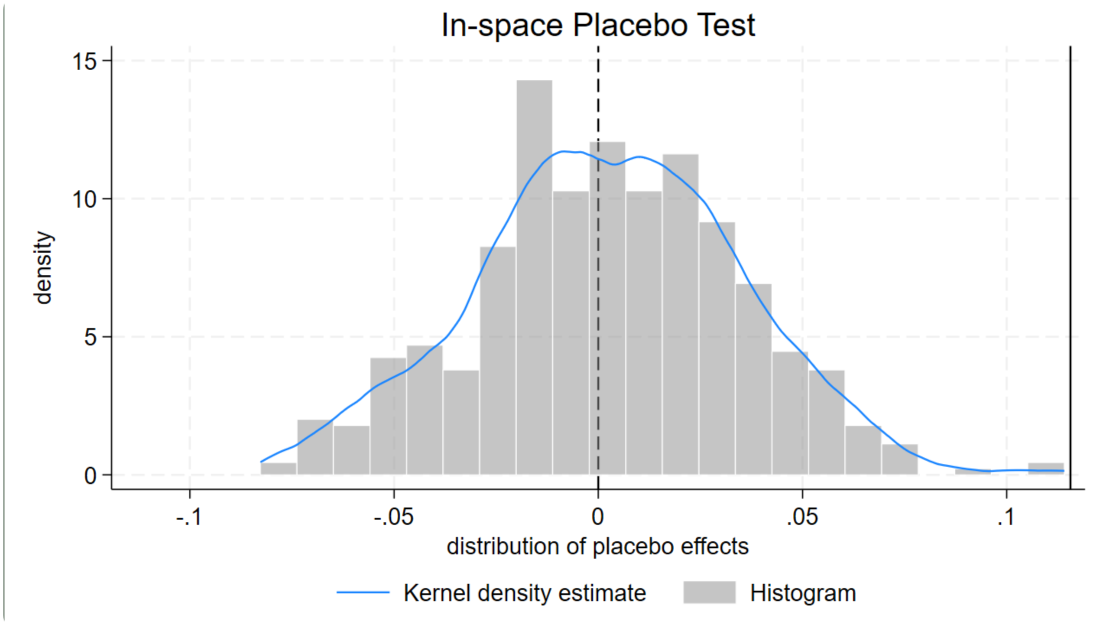


Figure 3. In-time Placebo Test

2. Space-Placebo Test

To further validate baseline robustness, treatment-group and control-group assignments are randomly reassigned while keeping original treatment timing and sample structure unchanged to construct pseudo-treatment and pseudo-control groups. Firm-year two-way fixed-effect models are estimated, and the Monte-Carlo simulation is repeated 500 times to obtain the distribution of placebo effects. As shown in Figure 4, placebo-effect estimates are symmetrically distributed around zero, consistent with theoretical expectations for random assignment. The true treatment-effect value lies in the right tail of the simulated placebo-effect distribution and deviates substantially from the distribution center. Both two-sided and right-sided p-values are significant at the 1 % level, rejecting the null hypothesis of zero treatment effect. It confirms that baseline outcomes are not driven by random chance but reflect genuine policy effects of new information infrastructure construction; the space-placebo test is satisfied.



	Coefficient	P-value Two-sided	P-value Left-sided	P-value right-sided
DID	0.115600	0.0000	1.0000	0.0000

Figure 4. In-space Placebo Test

5.5 Instrumental-Variable Approach

To address potential endogeneity concerns, this paper follows Huang et al. (2019)[34] and adopts the number of telephones per million inhabitants in 1984 as the basis for constructing an instrumental variable. From the perspective of China's Internet-development history, cities with higher fixed-telephone penetration rates in 1984 possessed better foundations for communication-network deployment, user information-exchange habits and communication-infrastructure investment, which laid innate advantages for subsequent broadband upgrading and gigabit-network construction. Hence, 1984 telephone penetration correlates with current Gigabit City roll-out. Meanwhile, fixed-telephone networks from 1984 have long been phased out with advances in mobile communications and Internet technologies; they exert no direct influence on contemporary corporate operations and ESG decision-making. In addition, historical telephone deployment was determined by administrative planning and geographical conditions under the planned-economy system and is not directly correlated with omitted variables affecting current corporate ESG performance. To resolve the problem that static historical variables would be absorbed in two-way fixed-effect models, this study constructs the interaction term between 1984 telephones-per-million-population and Internet-penetration rate as the time-varying instrumental variable, which preserves the exogeneity of historical instruments while generating temporal variation.

Table 4 reports instrumental-variable regression results. First-stage outcomes show that the Kleibergen-Paap rk LM statistic yields a p-value of 0.000. Both the Kleibergen-Paap Wald rk F statistic (98.429) and the Cragg-Donald Wald F statistic (111.323) exceed the 10 % critical value (16.38) from the Stock-Yogo weak-identification test, confirming the validity of the selected instrumental variable. Second-stage regression demonstrates that Gigabit City construction still exerts a significantly positive effect on corporate ESG performance at the 1 % statistical level. This further corroborates the positive causal impact of Gigabit City construction on corporate environmental, social and governance performance, mitigates endogeneity bias and guarantees the robustness and reliability of research findings.

Table 4. Instrumental-Variable Estimation

	First-stage	Second-stage
	DID	ESG
DID		1.8820***
		(3.0854)
IV	0.0024***	
	(9.9208)	
Size	0.0045	0.3212***
	(0.4756)	(6.4810)
ROA	-0.0158	0.3136
	(-0.3527)	(1.4152)
ListAge	0.0247	0.5031
	(0.3126)	(1.0278)
TobinQ	-0.0077*	-0.0453***
	(-1.9285)	(-2.7067)
Inst	0.0007*	-0.0005

	(1.7792)	(-0.2642)
Indep	-0.0004	0.0086**
	(-0.5134)	(2.4047)
ln_gdp	0.0893*	-0.2074
	(1.8671)	(-1.0563)
Constant	-0.7078	
	(-1.3267)	
Observations	16,387	16,387
R-squared	0.810	0.200
Symbol FE	Yes	Yes
year FE	Yes	Yes
(Kleibergen-Paap rk Wald F	98.429（16.38）	
(Kleibergen-Paap rk LM	87.909***	
Cragg-Donald Wald F	111.323（16.38）	

Robust t-statistics in parentheses

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

5.6 Alternative Measure for the Explained Variable

Empirical conclusions may be sensitive to variable measurement approaches. To further test robustness, this paper re-estimates regressions using alternative Wind ESG ratings. Ratings from CCC to AAA are assigned values 1-9. Results are reported in Column (1) of Table 5. The coefficient on the core explanatory variable remains significantly positive at the 5 % level, supporting baseline findings.

5.7 Controlling for Concurrent Confounding Policies

Other concurrent policies during Gigabit City implementation may influence corporate ESG performance. To eliminate interference from the Smart-Construction City pilot policy, this paper adds its dummy variable as an additional control in baseline regressions. Column (2) in Table 5 shows that after controlling for this confounding policy, the coefficient on DID is still significantly positive at the 1 % level, demonstrating that the ESG-promoting effect of new information infrastructure construction is not contaminated by other concurrent policies.

5.8 Double-Machine-Learning Estimation

To guard against bias induced by model-specification errors, this paper conducts robustness checks via machine-learning methods following Zhang & Li (2023)[35]. The sample is split in a 1:4 ratio. The ElasticCV model within double-machine-learning is applied with cross-fitting to mitigate model-specification bias and subjectivity in variable selection, improving the robustness and credibility of policy-effect estimation. As reported in Column (3) of Table 5, the coefficient for the core explanatory variable remains positive and significant at the 1 % level.

Table 5. Alternative Dependent Variable, Controlling Concurrent Policy, Double-Machine-Learning

	(1)	(2)	（3）
	windesg	ESG	
DID	0.0763**	0.1057***	0.1066***
	(2.5268)	(3.3568)	(4.3182)
Smart-Construction City pilot		0.0945**	
		(2.4914)	
Size	0.1005***	0.2951***	
	(2.8358)	(6.7227)	
ROA	-0.0857	0.2686	
	(-0.5287)	(1.4024)	
Indep	-0.0061**	0.0084***	
	(-2.3327)	(2.6596)	
ListAge	0.5761	0.6208	
	(1.6390)	(1.3905)	
TobinQ	-0.0084	-0.0581***	
	(-0.5958)	(-4.0997)	
Inst	-0.0001	0.0017	
	(-0.0891)	(1.0301)	
ln_gdp	-0.1929	-0.1443	
	(-1.4110)	(-0.8626)	
Constant	3.0102*	-3.1031	-0.0001
	(1.7827)	(-1.4752)	(0.0151)
Observations	18,267	18,347	18,368
R-squared	0.032	0.031	
Symbol FE	Yes	Yes	Yes
year FE	Yes	Yes	Yes

Robust t-statistics in parentheses

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

5.8 Mediating-Effect Analysis

This paper follows Jiang (2022)[36] to investigate transmission mechanisms. Table 6 reports mechanism-test results for the two channels: green technological innovation and digital transformation. Firm fixed effects and year fixed effects are included in all regressions to eliminate firm-level heterogeneity and time-trend disturbances and ensure estimation reliability.

Column (1) of Table 6 presents regression outcomes of new information infrastructure construction on corporate green technological innovation. The coefficient is significantly positive at the 1 % statistical level, indicating that new information infrastructure construction significantly raises corporate green-technological-innovation levels, which supports Hypothesis H2. The underlying logic is as follows: furnished with digital and intelligent technical support, new information infrastructure helps firms optimize production processes, reduce resource consumption and pollutant emissions at source, improve environmental performance, and lower environmental-compliance costs and risks (Han & Ge, 2025)[0]. Green technological innovation sends positive market signals regarding corporate social-responsibility fulfillment, attracts investor attention, compels firms to optimize internal-governance structures, build more comprehensive environmental-and-social risk-management systems, strengthen the execution of ESG strategies, lift governance standards (Qi & Zhu, 2024)[38], and eventually enhance overall corporate ESG performance.

Column (2) of Table 6 reports regression results of new information infrastructure construction on corporate digital transformation. The coefficient is significantly positive at the 5 % statistical level, demonstrating that new information infrastructure construction accelerates corporate digital-transformation processes and validating Hypothesis H3. From the resource-based view and corporate-governance theory, new information infrastructure such as 5G, big-data centers and industrial Internet delivers underlying hardware support and application carriers for corporate digital transformation. It effectively lowers technical barriers and implementation costs for corporate digital transformation (Zhang & Yi, 2025)[39] and promotes digital upgrading across production-operation, internal-management and stakeholder-communication workflows (Du et al., 2024)[40]. Digital transformation improves corporate operational efficiency and internal-governance mechanisms via process optimization and directly enhances the governance dimension of ESG performance. Meanwhile, digital tools enable precise energy-saving, emission-reduction and effective social-responsibility fulfillment (Zhang et al., 2025)[41], simultaneously optimizing environmental and social dimensions and comprehensively lifting overall corporate ESG levels.

Table 6. Regression Results for Mediating Variables

	(1)	(2)	(3)	(4)
	Green-tech Innovation	ESG	DIGI_text	ESG
DID	0.0423***	0.1171***	0.0008***	0.1158***
	(2.9477)	(3.9791)	(2.6072)	(3.9332)
Green-tech Innovation		-0.0364**		
		(-2.2240)		
DIGI_text				-0.2445
				(-0.3188)
Size	0.0401***	0.2945***	0.0041***	0.2941***
	(2.7671)	(9.9036)	(5.7376)	(9.8343)
ROA	0.0977	0.2791*	-0.0081***	0.2736*
	(1.2536)	(1.7463)	(-3.1236)	(1.7102)
ListAge	-0.4372***	0.6445**	-0.0009	0.6602**
	(-3.1924)	(2.2930)	(-0.1688)	(2.3492)
TobinQ	0.0053	-0.0581***	-0.0001	-0.0583***
	(0.8975)	(-4.8203)	(-0.8528)	(-4.8379)
Inst	0.0004	0.0017	-0.0000	0.0017
	(0.6445)	(1.4299)	(-0.7352)	(1.4154)
Indep	0.0005	0.0084***	-0.0000	0.0083***
	(0.4429)	(3.5386)	(-0.4361)	(3.5286)
ln_gdp	-0.0847	-0.1721	0.0003	-0.1689
	(-1.2778)	(-1.2651)	(0.1617)	(-1.2418)
Constant	1.5176**	-2.8931*	-0.0730***	-2.9661*
	(2.0077)	(-1.8652)	(-2.9878)	(-1.9110)
Observations	18,368	18,368	18,368	18,368
R-squared	0.026	0.031	0.067	0.030
Symbol FE	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes

Robust z-statistics in parentheses

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

5.9 Heterogeneity Analysis

Heterogeneity-test outcomes reveal substantial heterogeneous effects of Gigabit City construction on corporate ESG performance.

Following Pan et al. (2019)[42], firms are divided into heavily-polluting and non-heavily-polluting subsamples. Regression results show significant policy effects only within heavily-polluting firms. Heavily-polluting firms face stricter environmental-regulation and ESG-disclosure requirements. Digital and intelligent infrastructure brought by new information infrastructure delivers technical tools for energy conservation, emission reduction and green transition (e.g., industrial Internet, intelligent environmental-monitoring systems). These tools directly help firms cut pollutant emissions, satisfy environmental-compliance obligations and rapidly improve the environmental dimension of ESG performance, yielding stronger policy incentives. Drawing on Shen et al. (2021)[43], regional heterogeneity is explored. Results indicate that the policy's ESG-promoting effect is considerably stronger for firms in central-western China than for eastern-region firms, reflecting the role of new-infrastructure construction in bridging regional-development gaps. The central-western region suffers from relatively weak pre-existing digital-infrastructure foundations. As a key on-the-ground policy for new information-infrastructure development, Gigabit City construction rapidly remedies regional digital-infrastructure shortcomings and helps local firms upgrade ESG governance capacities. By contrast, eastern-region firms already possess high digital-development levels, so the marginal improvement induced by the policy is relatively limited. From the perspective of property-rights nature (Dai & Kong, 2017)[44], the ESG-enhancing effect of new information-infrastructure construction is significant for non-state-owned enterprises but insignificant for state-owned enterprises. State-owned enterprises naturally undertake policy mandates and social-responsibility tasks; their ESG performance is strongly constrained by administrative requirements and starts from a relatively high baseline, so marginal improvements driven by new information infrastructure are limited. For non-state-owned enterprises, ESG improvements rely more on market-driven incentives. New information infrastructure effectively lowers costs for green transition and ESG governance, generating more prominent empowerment effects. Following Peng & Mao (2017)[45], heterogeneity across technology intensity is examined. The policy effect proves significant among high-tech firms but insignificant for non-high-tech firms. New information infrastructure construction is highly compatible with the technical attributes and business scenarios of high-tech firms, directly empowering technological innovation and ESG governance and realizing synergies between innovation and sustainable development. Non-high-tech firms are less dependent on new information infrastructure; empowerment effects cannot be effectively transmitted to ESG performance, and hence policy effects are insignificant.The above heterogeneity results uncover the boundary conditions for how new information infrastructure construction shapes corporate ESG performance and furnish empirical foundations for differentiated policy formulation. Policymakers should prioritize new-information-infrastructure investment targeting non-state-owned enterprises and high-tech firms, precisely empower corporate green transition and ESG improvement, and foster high-quality economic development.

Table 7. Heterogeneity-Analysis Regression Results

	(1)	(2)	(3)	(4)
	pollute	N_pollute	East	West_Mid
DID	0.1441**	0.0520	0.0602*	0.2344***
	(2.4525)	(1.5185)	(1.6710)	(4.2783)
Size	0.0493	0.3679***	0.2853***	0.3200***
	(0.7281)	(10.9517)	(8.4964)	(5.0116)
ROA	0.0315	0.3451**	0.1135	0.8540**
	(0.0814)	(1.9735)	(0.6292)	(2.4876)
ListAge	0.1078	0.5581*	0.8533***	0.0451
	(0.1477)	(1.8294)	(2.6983)	(0.0739)
TobinQ	-0.1187***	-0.0415***	-0.0453***	-0.1020***
	(-3.5974)	(-3.2083)	(-3.3294)	(-3.9591)
Inst	0.0038	0.0016	0.0011	0.0036
	(1.3919)	(1.1589)	(0.7829)	(1.4088)
Indep	0.0022	0.0093***	0.0109***	0.0022
	(0.4020)	(3.5541)	(3.9654)	(0.4832)
ln_gdp	-0.1522	-0.2404	0.1000	-0.5847***
	(-0.5965)	(-1.4896)	(0.5574)	(-2.7261)
Constant	3.9201	-3.8541**	-6.1710***	1.5111
	(1.1571)	(-2.0958)	(-3.0396)	(0.5435)
Observations	3,949	14,403	13,734	4,634
R-squared	0.518	0.489	0.478	0.502
Symbol FE	Yes	yes	yes	Yes
Year FE	Yes	Yes	Yes	Yes

	(5)	(6)	(7)	(8)
	SOE	N_SOE	HighTech	N_HighTech
DID	0.0612	0.1548***	0.1733***	0.0290
	(1.2040)	(4.3080)	(4.7059)	(0.6081)
Size	0.2356***	0.3007***	0.2199***	0.2654***
	(4.1195)	(8.5293)	(5.7176)	(5.5225)
ROA	0.1857	0.2779	0.0231	0.9930***
	(0.5193)	(1.5644)	(0.1198)	(3.5133)
ListAge	0.4004	1.1108***	-0.2513	0.9297**
	(0.7575)	(3.1891)	(-0.6856)	(2.0759)

TobinQ	-0.0662**	-0.0598***	-0.0571***	-0.0843***
	(-2.4317)	(-4.4416)	(-4.0643)	(-3.6270)
Inst	0.0026	0.0006	0.0020	0.0017
	(1.0150)	(0.3935)	(1.3229)	(0.8042)
Indep	0.0069*	0.0078**	0.0059**	0.0109***
	(1.8810)	(2.4582)	(1.9620)	(2.9496)
ln_gdp	-0.3855*	-0.0245	-0.3432**	0.2058
	(-1.7529)	(-0.1397)	(-1.9942)	(0.9440)
Constant	0.8441	-5.9517***	3.0543	-7.1531***
	(0.2928)	(-2.9790)	(1.5104)	(-2.7701)
Observations	6,451	11,863	11,158	7,186
R-squared	0.498	0.497	0.483	0.530
Symbol FE	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes

Robust z-statistics in parentheses

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

6. Conclusions and Policy Implications

This paper systematically analyzes the impact and transmission mechanisms of new information-infrastructure construction on corporate ESG performance and draws the following main conclusions. First, new information-infrastructure construction significantly improves corporate ESG performance, and this finding holds after a battery of endogeneity treatments and robustness checks. Second, green technological innovation and corporate digital transformation constitute two key mediating channels through which new information infrastructure affects corporate ESG performance. New information infrastructure stimulates green technological innovation by cutting R&D costs and facilitating knowledge spillovers. It drives digital transformation by lowering technical barriers and furnishing application scenarios. Together, these two channels enhance corporate environmental, social and governance performance. Third, heterogeneity analysis demonstrates that the policy effect exhibits substantial cross-firm variation: the promoting effect is more pronounced for non-state-owned enterprises, high-tech firms and heavily-polluting-industry firms.

Based on the above conclusions, this paper puts forward the following policy implications:

(1) Accelerate the deployment and inclusive penetration of new information infrastructure. Governments should continue to scale up investment in 5G, big-data centers, industrial Internet and related fields. In particular, efforts should be made to narrow the digital divide between eastern and central-western China and guarantee inclusive access to information infrastructure. Improved hardware facilities can deliver solid foundational support for corporate digital transformation and green innovation.

(2) Promote in-depth integration between new-infrastructure development and green-development strategies. When formulating information-infrastructure plans, policymakers should fully consider their guiding roles for green development. Authorities should encourage the construction of green data centers, popularize energy-saving technologies, and guide firms to leverage digital technologies for green R&D so as to realize coordinated advancement of digitalization and green transition.

(3) Strengthen policy guidance and incentive mechanisms for digital transformation. Governments should roll out special policies supporting corporate digital renovation enabled by information infrastructure. For example, digital-transformation subsidies and tax incentives can be provided, and digital-service platforms can be built to lower digital-transformation barriers for small-and medium-sized enterprises and enhance their ESG-governance capacities.

(4) Improve ESG-regulation and information-disclosure systems. Regulatory authorities should take advantage of information infrastructure to boost regulatory efficiency and build digital and intelligent ESG-supervision platforms. Meanwhile, unified ESG-information-disclosure standards should be established. Firms should be encouraged to conduct high-quality information disclosure via digital tools, and market-based mechanisms should be leveraged to incentivize firms to upgrade their ESG performance.

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