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Public data opening and corporate ESG performance: Evidence from a quasi-natural experiment in China

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Abstract

Purpose – This study examines how public data opening (PDO) affects corporate ESG performance.

Theoretical framework – The study combines the slack resources theory, corporate governance theory, and other economic theories to highlight the mechanisms through which PDO may affect corporate ESG performance.

Design/methodology/approach – Considering the launch of Chinese provincial PDO platforms as a quasi-natural experiment, this study uses a difference-in-differences (DID) model with panel data from Chinese A-share corporations from 2012 to 2022 to analyze the potential effects of PDO on corporate ESG performance.

Findings – The results show that PDO effectively improves corporate ESG performance, particularly in regions with low informatization and marketization levels, as well as among corporations with a strong perception of uncertainty and state-owned enterprises. Mechanism analyses reveal that PDO may improve corporate ESG performance by reducing corporate information asymmetry, promoting digital transformation, and enhancing green innovation.

Practical and social implications of the research – The findings provide fresh insights for policymakers to promote the marketization of data elements and enhance corporate ESG performance, while also offering a reference for future research.

Originality/value – The study constructs a theoretical framework for how PDO affects corporate ESG performance, which extends and enriches the literature on the impacts of PDO and the factors influencing corporate ESG performance.

Keywords: Public data opening, Data elements, Corporate ESG performance, Difference-in-differences.

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1 Introduction

Public data is an important basic resource in the digital economy era, accounting for the largest proportion of data resources. It plays a fundamental, guiding, and exemplary role in the development and utilization of data elements. Public data opening (PDO) can maximize the public's right to use data elements, enabling social entities such as enterprises to better utilize "dormant" data to create commercial and social value (Nagaraj, 2022). Recently, countries have begun to build and launch PDO platforms. For example, the United States launched its open data portal, data.gov, in 2009. The United Kingdom formally launched its unified information and service website, gov.uk, in 2012. China has also been committed to promoting the open sharing of public data and has been gradually launching its PDO platforms since 2012, aggregating massive data resources from government and social entities.

PDO is widely considered beneficial for integrating data elements into production systems and is an important driver of economic growth (Goldfarb & Tucker, 2019). However, existing research has not addressed how PDO affects sustainable development or whether it can improve corporate environmental, social, and governance (ESG) performance. ESG performance is a comprehensive measure of a company's non-financial performance and an important indicator of its sustainable development capability (Feng & Nie, 2024). Considering that enterprises are both the main drivers of sustainable development and are the primary targets encouraged to create value using open data, it is timely and significant to investigate the impact of PDO on corporate ESG performance.

Theoretically, PDO can have multiple impacts on corporate ESG performance. For example, it can directly reduce enterprises' data acquisition costs, providing greater flexibility in corporate ESG practices. PDO can also accelerate data flows and promote information sharing among enterprises, which can further alleviate information asymmetry and enhance internal control quality, thus improving corporate ESG performance (Feng & Nie, 2024). Additionally, PDO can enhance enterprises' digital transformation capabilities, further boosting ESG performance (Chen & Zhang, 2024; Fang et al., 2023). Public data can also serve as a reference for enterprises' ESG innovations (Wang & Zhang, 2024). Government departments actively promote PDO to help enterprises improve their ESG performance management systems. For example, Beijing issued an implementation plan in June 2024 to promote the development of high-quality ESG systems. The plan mentioned improving the ease of searching for public ESG data and the orderly opening of data in areas such as the ecological environment, energy resources, and market regulation. Can PDO improve corporate ESG performance? What mechanisms underlie this phenomenon? These questions have not been effectively explored in the existing literature and are the focus of this study.

Based on prior analyses, this study uses a sample of Chinese A-share-listed enterprises from 2012 to 2022 to investigate the impact of PDO on corporate ESG performance. Specifically, it uses the launch of provincial PDO platforms as a quasi-natural experiment and applies a difference-in-differences (DID) specification in the empirical analyses. The main contributions of the study are as follows. First, it reveals that PDO positively influences corporate ESG performance, providing new insights and evidence on how to enhance corporate ESG performance while enriching its positive externalities. Existing literature on PDO primarily focuses on economic performance, such as corporate performance, firm digital transformation, and corporate resource allocation efficiency. However, few studies have examined the non-economic performance of PDO, such as corporate ESG performance. Meanwhile, extensive research on the factors influencing corporate ESG performance primarily focuses on two levels: macro-environmental and policy factors, and micro-level enterprise characteristics. Several recent studies have explored the impacts of data elements such as data assets generated within corporations and big data development on corporate ESG performance. However, none of these studies have explored the driving factors of corporate ESG performance from the perspective of public data. Therefore, this study supplements and extends the existing research on both the effects of PDO and the factors influencing corporate ESG performance.

Second, this study uses a multilevel theoretical framework to investigate how PDO influences corporate ESG performance, offering valuable insights for policymaking and future research. Specifically, the study draws on slack resources and corporate governance theories to examine the internal mechanisms and heterogeneous effects of PDO on corporate ESG performance, deriving a series of conclusions. These findings provide policymakers with a clearer understanding of the positive effects of PDO, allowing them to design more targeted and region-specific

public data policies. China is a developing country with strong data potential, where public data accounts for over 80% of information data resources (Nie et al., 2025a). Focusing on China as the research context, this study explores the role of PDO in enhancing corporate ESG performance. The conclusions provide empirical support for other developing countries adopting similar initiatives. Furthermore, future research can build on this study's theoretical framework and findings to explore the socioeconomic impacts of PDO in other countries and its interactions with other policies, systems, and environmental factors affecting corporate ESG performance.

The remainder of this paper is organized as follows. Sections 2, 3, and 4 present the literature review, hypotheses, and research design, respectively. Section 5 presents the empirical analyses, including the benchmark regression, robustness tests, and mechanism and heterogeneity analyses. Section 6 concludes.

2 Literature review

2.1 Public data opening

From a conceptual perspective, public data are resources with public attributes and include not only government internal administrative data but also data related to public interests generated by market entities during commercial activities. A PDO makes public data resources available in an open, free, and accessible manner (Luna-Reyes et al., 2014). Existing PDO research has mainly focused on obstacles, data availability and quality, evolutionary processes, and determinants (e.g., Conradie & Choenni, 2014; Nikiforova & McBride, 2021). However, these studies have largely overlooked the role of PDO in creating value (Goldfarb & Tucker, 2019).

A few studies have used quantitative data to analyze the value creation effects of PDO from different perspectives (e.g., Huber et al., 2022; Lei et al., 2023a). The research that is most relevant to this study explores the value creation of PDO from a micro-enterprise perspective. For example, using a sample of Chinese listed firms, Zhou et al. (2023) investigated the effect of PDO on firm performance and found positive effects. Using the China Tax Survey Database, Xu et al. (2024) examined the effect of PDO on firms' resource allocation efficiency and observed that the former effectively enhances the latter. This is due to the fact that PDO optimizes government–business relationships, reduces rent-seeking costs, and decreases information asymmetry. Chen and Zhang (2024) investigated the impact of PDO on corporate digital transformation using a DID specification and found that PDO can promote this transformation. Specifically, PDO reduces operating costs, strengthens management's strategic perceptions, and intensifies competition in local markets. Ma et al. (2024) used the DID method to examine the impact of establishing a PDO platform on corporate stock price crash risk. The results showed that PDO reduced such risks by improving operating performance and enhancing external monitoring.

2.2 Corporate ESG performance

Corporate ESG performance has become a popular academic research topic because it is an important indicator of a company's sustainable development capabilities. However, existing studies on the factors influencing corporate ESG performance have mainly focused on the macro environment, policies, and microenterprises. From the perspective of the macro environment and policies, Shu and Tan (2023) demonstrated the negative impact of carbon control policy risk on corporate ESG performance in China. Meanwhile, Lei et al. (2023b) examined how a green credit policy affects corporate ESG performance.

From the microenterprise perspective, research has explored the various dimensions affecting ESG performance, such as shareholder engagement, green investors, and investor attention (Barko et al., 2022; Gu, 2024). With the rapid development of the digital economy, many recent studies have analyzed the effects of digital transformation and innovation on corporate ESG performance (e.g., Fang et al., 2023; Feng & Nie, 2024; Lu et al., 2024). Furthermore, closely related to this study, existing research has examined the impact of data elements on corporate ESG performance (Li et al., 2024a; Li et al., 2024b). Li et al. (2024a) investigated how data assets generated within corporations impact ESG performance and found that data assets contribute to better ESG performance. Data assets enhance operational capacity and improve monitoring. Li et al. (2024b) examined the effect of big data development on corporate ESG performance, and their results showed that big data development can promote ESG performance by improving green innovation and information disclosure quality. However, this body of literature has not explored the driving forces of corporate ESG performance from a public data perspective.

3 Hypotheses development

3.1 Direct effect of PDO on corporate ESG performance

According to slack resources theory, a company will only engage in social value creation activities when it has surplus resources. PDO allows enterprises to use high-quality data to enhance governance, improve decision-making efficiency, and optimize resource allocation (Xu et al., 2024). This enables enterprises to allocate resources to ESG practices. At the same time, PDO enhances information transparency, which helps strengthen external oversight of corporate behavior (Zhao et al., 2025). This external pressure incentivizes companies to proactively optimize their governance structures and improve their environmental and social responsibility disclosures, thereby enhancing corporate ESG performance. From an internal governance perspective, data use itself can also function as an internal governance mechanism (Zhu, 2019). First, data can serve as an essential reference for enterprises to innovate and improve ESG activities, thereby enhancing corporate ESG performance. Second, data use helps integrate and share internal resources, effectively improving internal controls and promoting better ESG performance (Feng & Nie, 2024). Third, the effective use of data can boost digital transformation capabilities, further promoting improved ESG performance (Fang et al., 2023). Based on the above analysis, the following hypothesis is proposed:

H1: PDO can effectively improve corporate ESG performance.

3.2 Mediating roles in the effect of PDO on corporate ESG performance

Within the framework of slack resources theory, the preceding discussion explored the significant role of PDO in enhancing corporate ESG performance. Building on this, this study further investigates the indirect pathways through which PDO improves corporate ESG performance by focusing on three key dimensions: mitigating information asymmetry, promoting digital transformation, and facilitating green innovation. Drawing on innovation economics, the study examines how PDO may enhance corporate ESG performance by reducing information asymmetry through a corporate governance lens. PDO may also promote higher levels of digital transformation, thereby generating positive externalities associated with improved corporate ESG performance. Additionally, PDO may elevate ESG performance by fostering green innovation.

The essential characteristics of PDO are its non-exclusive nature, authority, and reliability (Wainwright et al., 2023). These characteristics can significantly reduce the costs of information acquisition and information asymmetry in internal governance, production, operations, and resource allocation processes (Xu et al., 2024). Additionally, PDO can promote the flow of data elements, enhance the transparency of internal information within enterprises, and reduce information asymmetry between stakeholders and enterprises (Wu & Li, 2025). According to corporate governance theory, information asymmetry can lead to adverse selection and moral hazard issues (Jensen & Meckling, 1976), which increase corporate governance costs and compromise stakeholders' interests. This, in turn, constrains corporate ESG performance. From this perspective, PDO may help reduce information asymmetry, which potentially improves corporate ESG performance. Hence, the following hypothesis is proposed:

H2a: PDO may improve corporate ESG performance by reducing corporate information asymmetry.

According to externality theory, public data reduces the costs for firms to acquire data independently because of its social shareability and authoritative nature (Chen & Zhang, 2024), providing more room for digital transformation in terms of costs. More importantly, public data, as a new type of virtual production factor, can be seamlessly integrated into various enterprise activities, supporting business management decisions and potentially enhancing corporate digital transformation (Zhou et al., 2023). Existing literature indicates that digital transformation may promote corporate ESG performance through multiple channels (Gu, 2024). First, it reduces agency costs and enhances goodwill (Fang et al., 2023). Second, it strengthens organizational resilience and decision-making efficiency (Guo et al., 2025). Third, it optimizes corporate governance structures (Yang et al., 2024). Based on this analysis, the following hypothesis is proposed:

H2b: PDO may improve corporate ESG performance by promoting corporate digital transformation.

According to innovation economics theory, PDO reduces uncertainty surrounding innovation and fosters knowledge spillovers, driving corporate green technology R&D and application, which can significantly enhance corporate ESG performance. For instance, Dong and Wang (2024) demonstrated that PDO boosts corporate green innovation efficiency by broadening knowledge and stimulating green innovation initiatives. Additionally,

PDO can encourage public participation in ecological and environmental governance, build public supervision and feedback mechanisms (Jiang et al., 2022), and ensure the effective application of data elements in green and low-carbon transformation, thereby promoting corporate green innovation. Existing literature has confirmed the important role of data elements, including public data and big data, in corporate green innovation (Dong & Wang, 2024). At the same time, corporate green innovation is considered an effective way to enhance corporate ESG performance. Specifically, Liu et al. (2024a) found that both radical and incremental green innovations are associated with better corporate ESG performance. Green innovation not only mitigates the negative environmental impacts of business operations but also strengthens performance in social responsibility fulfillment and internal governance (Wang & Zhang, 2024). Based on this analysis, the following hypothesis is proposed:

H2c: PDO may improve corporate ESG performance by facilitating corporate green innovation.

Figure 1 presents the study's theoretical framework.

4 Research design

4.1 Method

Following Nie et al. (2025b), we construct a two-way fixed effects (FE) DID model to examine the effect of PDO policy on corporate ESG performance.

$$ESG_{it} = \alpha_0 + \alpha_1 Pub\_data_{it} + \alpha X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

In Equation 1 i and t denote the firm and year, respectively; ESG is the dependent variable representing corporate ESG performance, proxied by Huazheng ESG Index ratings (Ren et al., 2023). The data were collected from the Wind Financial Terminal. The core independent variable Pub_data reflects PDO, characterized by the launch of provincial PDO platforms. When the province in which the corporation is located launches a PDO platform in a given year, Pub_data takes a value of one for that year and subsequent years, and zero otherwise. Figure 2 shows the years and number of PDO platforms launched during the sample period. The coefficient α_1 captures the effect of the PDO policy on ESG performance; X is a vector of control variables; μ and γ indicate firm and year FE, respectively; and ε is a random error term.

4.2 Variables

(1) Corporate ESG performance (ESG). Following Ren et al. (2023), we apply the Huazheng Index to measure corporate ESG performance. Compared with other indicators, this index has the advantages of being close to the Chinese market and having wide coverage and timeliness (Feng & Nie, 2024).

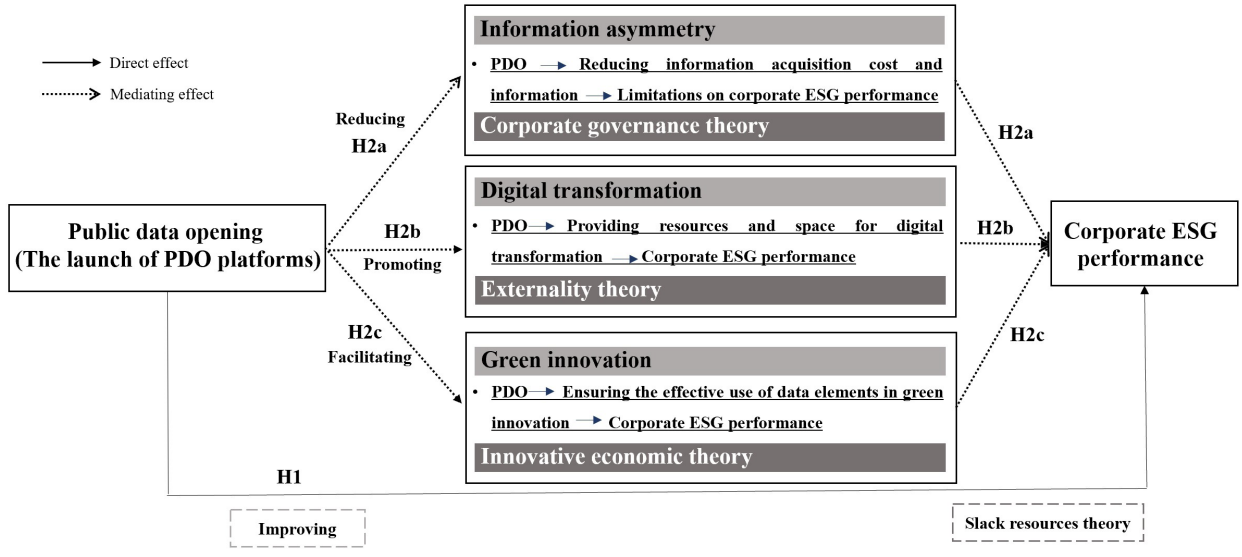

Figure 1. Theoretical analysis framework.

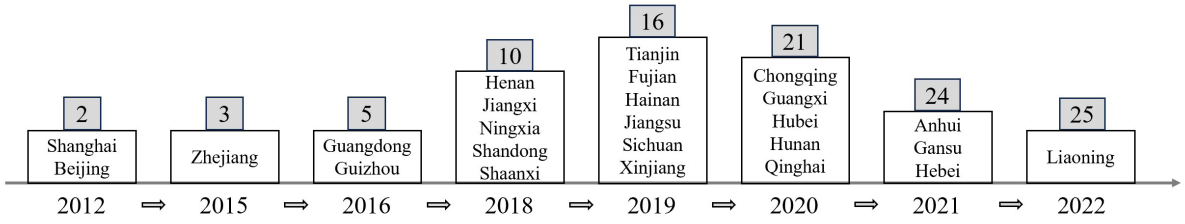

Figure 2. Years and number of PDO platforms launched.

(2) Public data opening (*Pub _ data*). This variable is depicted by the online launch of provincial PDO platforms. Specifically, when the province in which the enterprise is located launches a PDO platform, this variable takes a value of one in that year and beyond, and zero otherwise.

(3) Control variables. The model incorporates the following control variables: company size (*Size*), measured using the logarithm of the number of employees; asset–liability ratio (*Lev*), represented by the ratio of total liabilities to total assets; corporate age (*Age*), calculated as the natural logarithm of (current year – listing year + 1); return on assets (*Roa*), measured as the ratio of net profit to average total assets; cash flow (*Cflow*), defined as the ratio of net operating cash flows to total assets; capital expenditure ratio (*Invt*), measured by cash paid for the acquisition and construction of fixed assets, intangible assets, and other long-term assets/total assets at the end of the year; and ownership (*Soe*), which equals one for state-owned enterprises and zero for non-state-owned enterprises.

4.3 Data

We used Chinese A-share-listed companies from 2012 to 2022 as the research sample. The following treatments were applied: delisted enterprises, ST, *ST, and PT enterprises, financial enterprises, and enterprises with asset–liability ratios greater than one were excluded during the sample period. Continuous variables were winsorized at the 1% level. A total of 32,078 firm-year observations were obtained. The data used in this study were collected from the Wind Financial Terminal, the Chinese Research Data Services (CNRDS) platform, and the China Stock Market & Accounting Research (CSMAR) database. The data underwent rigorous checking to ensure accuracy (Supplementary Data 1 – Database). All analyses were performed using Stata statistical software (Supplementary Data 2 – Stata script). Table 1 presents the descriptive statistics.

5 Empirical analyses

5.1 Benchmark regression

Table 2 lists the estimation results for Equation 1. Columns (1) through (3) present the results without the control variables, while columns (4) through (6) include the control variables. The estimated coefficient of the core explanatory variable remains statistically significant at the 5% level or higher, regardless of whether the control variables are included. This finding provides preliminary evidence that PDOs enhance corporate ESG performance. Furthermore, as columns (3) and (6) show, the estimated coefficients of the core explanatory variable remain significantly positive after controlling for both firm and time fixed effects. This again demonstrates that PDO can enhance corporate ESG performance, thus supporting Hypothesis 1. Existing studies have shown that data elements play a significant role in corporate sustainability development (Li et al., 2024a, 2024b). These studies provide a theoretical basis for our findings and complementary evidence.

5.2 Robustness tests

5.2.1 *Parallel trend test*

The DID model assumes parallel trends. Thus, the ESG performance of enterprises in the treatment and control regions shows non-significant trends before the PDO platform was launched. We constructed the Equation 2 to conduct a parallel trend test:

Table 1
Data description analysis

Variables	Observations	Mean	Std Dev	Min	Max
ESG	32,078	4.19	1.16	1	8
Pub _ data	32,078	0.61	0.49	0	1
Size	32,078	7.66	1.24	4.32	11
Lev	32,078	0.41	0.20	0.06	0.89
Age	32,078	2.07	0.92	0	3.5
Roa	32,078	0.04	0.06	-0.21	0.27
Cflow	32,078	0.05	0.10	-10.22	2.22
Invt	32,078	0.05	0.05	0	0.64
Soe	32,078	0.35	0.48	0	1

Table 2
Benchmark regression

	(1)	(2)	(3)	(4)	(5)	(6)
	ESG	*ESG*	*ESG*	*ESG*	*ESG*	*ESG*
Pub _ data	0.2508***	0.2025***	0.0412**	0.2616***	0.1696***	0.0408**
	(0.0132)	(0.0168)	(0.0175)	(0.0124)	(0.0158)	(0.0172)
Size				0.1956***	0.1978***	0.2943***
				(0.0062)	(0.0062)	(0.0137)
Lev				-0.4360***	-0.4291***	-0.8539***
				(0.0396)	(0.0395)	(0.0577)
Age				-0.2169***	-0.2236***	-0.2388***
				(0.0080)	(0.0080)	(0.0188)
Roa				2.8848***	3.0203***	0.7199***
				(0.1431)	(0.1449)	(0.1296)
Cflow				-0.1996	-0.2036	-0.1274
				(0.1618)	(0.1670)	(0.1454)
Invt				0.6789***	0.5081***	1.4206***
				(0.1319)	(0.1311)	(0.1390)
Soe				0.3174***	0.3244***	-0.0384
				(0.0153)	(0.0153)	(0.0383)
Constant				2.9212***	2.9725***	2.6844***
				(0.0415)	(0.0418)	(0.1021)
Firm FE	/	/	√	/	/	√
Year FE	/	√	√	/	√	√
Observations	32,078	32,078	32,078	32,078	32,078	32,078
R-squared	0.0112	0.0251	0.5813	0.1176	0.1347	0.5998

Note: Clusters of robust standard errors are indicated in parentheses. $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

$$ESG_{it} = \beta_0 + \beta_1 Pub\_data_{it}^{-9} + \beta_2 Pub\_data_{it}^{-8} + L + \beta_{11} Pub\_data_{it}^{9} + \beta_{12} Pub\_data_{it}^{10} + \beta X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

where $Pub\_data^{\pm k}$ denotes a series of dummy variables relative to the year the PDO platform went online. In the k years before (or after) the launch of the PDO platform, Pub_data^{-k} (or Pub_data^{k}) takes a value of one, and

zero otherwise. To avoid multicollinearity, we removed the year before the launch of the PDO platform (i.e., Pub_data^{-10}) (The sample period spans from 2012 to 2022. Given that the earliest policy implementation year (2012) is 10 years before the endpoint (2022) and the latest implementation year (2022) is 10 years after the starting point (2012), the resulting observation window is [-10, +10]). Table 3 presents the full set of event-

Table 3
Parallel trend test

	(1)	(2)
	ESG	*ESG*
Pub_data^{-1}	0.1393	0.1537
	(0.1300)	(0.1281)
Pub_data^{-2}	0.1048	0.1151
	(0.1275)	(0.1258)
Pub_data^{-3}	0.0577	0.0633
	(0.1251)	(0.1235)
Pub_data^{-4}	0.0339	0.0372
	(0.1234)	(0.1220)
Pub_data^{-5}	-0.0295	-0.0287
	(0.1230)	(0.1217)
Pub_data^{-6}	-0.0285	-0.0337
	(0.1213)	(0.1199)
Pub_data^{-7}	-0.0026	-0.0213
	(0.1199)	(0.1187)
Pub_data^{-8}	0.0451	0.0618
	(0.1241)	(0.1229)
Pub_data^{-9}	0.0050	0.0164
	(0.1296)	(0.1288)
Pub_data^{0}	0.1997	0.2215*
	(0.1320)	(0.1300)
Pub_data^{1}	0.2115	0.2379*
	(0.1356)	(0.1334)
Pub_data^{2}	0.2117	0.2484*
	(0.1386)	(0.1362)
Pub_data^{3}	0.2110	0.2561*
	(0.1422)	(0.1396)
Pub_data^{4}	0.2519*	0.3062**
	(0.1465)	(0.1437)
Pub_data^{5}	0.2573*	0.3367**
	(0.1505)	(0.1476)
Pub_data^{6}	0.2580*	0.3451**
	(0.1544)	(0.1513)
Pub_data^{7}	0.3662**	0.4461***
	(0.1603)	(0.1572)
Pub_data^{8}	0.4704***	0.5568***
	(0.1661)	(0.1626)
Pub_data^{9}	0.4660***	0.5660***
	(0.1699)	(0.1664)

Note: Clusters of robust standard errors are indicated in parentheses. * p< 0.1; ** p < 0.05; *** p < 0.01.

Table 3
Continued...

	(1)	(2)
	ESG	*ESG*
Pub _ data[10]	0.4374**	0.5419***
	(0.1767)	(0.1727)
Constant	4.0190***	2.5273***
	(0.1276)	(0.1597)
Control variables	/	√
Firm FE	√	√
Year FE	√	√
N	32,078	32,078
R^2	0.5822	0.6008

Note: Clusters of robust standard errors are indicated in parentheses. * p< 0.1; ** p < 0.05; *** p < 0.01.

study coefficients with confidence intervals. Columns (1) and (2) report the regression coefficients for each period and exclude and include the control variables, respectively. Figure 3 presents the results of the parallel trend test after adding the control variables. We find that regardless of whether control variables are included, the coefficients prior to the launch of the PDO platform are all insignificant, indicating that no significant difference exists in corporate ESG performance between the control and treatment groups. Based on this analysis, the parallel trend test is satisfied.

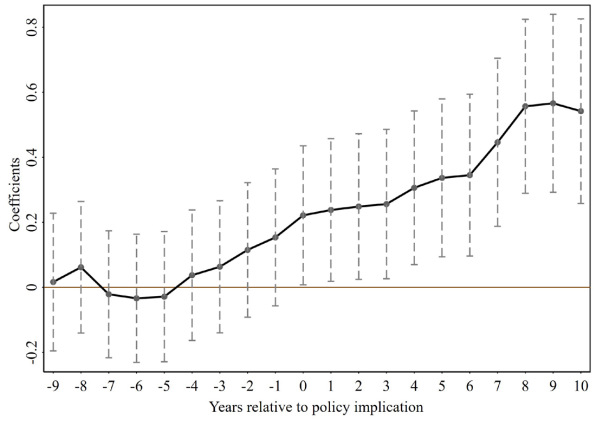

Figure 3. Parallel trend test (control variables are controlled).

5.2.2 *PSM-DID and entropy balance estimation*

The implementation of the PDO may be affected by the level of regional informatization development. This results in the non-random selection of pilot cities and may lead to selection bias. To effectively address this issue, we apply propensity score matching and difference-in-differences (PSM-DID) alongside entropy balance estimation to estimate our model. Specifically, we use the kernel matching method for PSM-DID estimation. In addition, compared to PSM-DID, entropy balance estimation better minimizes the interference of selection bias with no sample loss. Both methods require the selection of matching covariates. Following Zhao and Ma (2025), our study ensures covariate validity by utilizing the control variables from the benchmark regression as covariates. As shown in Figure 4, the PSM-DID balance test confirms that the standardized biases are under 10% for all covariates. Additionally, the entropy-balancing matching results are presented in Table 4. It can be seen

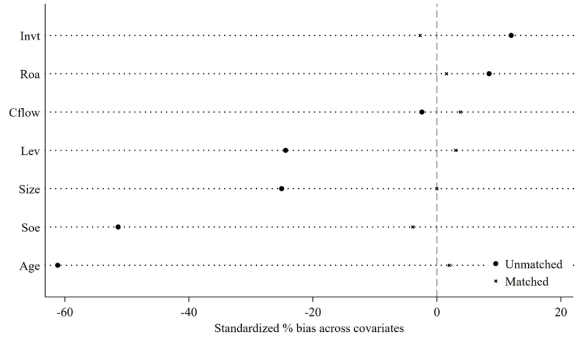

Figure 4. Balance test result of PSM.

that the differences in the mean, variance, and skewness between the treatment and control groups are reduced after matching. Using the matched samples, we re-estimated the regressions. As shown in Table 5, the coefficients of

Table 4
EB analyses

Panel A: Before Matching	Treat			Control		
	Mean	**Variance**	**Skewness**	**Mean**	**Variance**	**Skewness**
Size	7.643	1.528	0.314	7.961	1.698	0.03572
Lev	0.4121	0.04138	0.2557	0.4629	0.04534	0.08207
Age	2.043	0.8491	-0.5864	2.555	0.5486	-1.564
Roa	0.03886	0.00391	-0.776	0.03376	0.003414	-0.3384
Cflow	0.04797	0.009799	-38.9	0.05028	0.008495	-2.98
Invt	0.04957	0.002306	2.02	0.04376	0.00239	2.639
Soe	0.334	0.2224	0.704	0.5821	0.2434	-0.3329
Panel B: After Matching	Treat			Control		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Size	7.643	1.528	0.314	7.644	1.528	0.3074
Lev	0.4121	0.04138	0.2557	0.4122	0.04138	0.383
Age	2.043	0.8491	-0.5864	2.045	0.8492	-0.5893
Roa	0.03886	0.00391	-0.776	0.03886	0.003911	-0.6558
Cflow	0.04797	0.009799	-38.9	0.04799	0.0098	-3.338
Invt	0.04957	0.002306	2.02	0.0496	0.002307	1.972
Soe	0.334	0.2224	0.704	0.3338	0.2225	0.7047

Note: "Treat" and "Control" refer to the treatment and control groups, respectively. Panels A and B report the means, variances, and skewness of the covariates in the two groups before and after matching.

Table 5
PSM-DID and entropy balance estimation

	(1)	(2)	(3)	(4)
	ESG	*ESG*	*ESG*	*ESG*
	PSM-DID		**Entropy balance**	
Pub _ data	0.2632**	0.2193**	0.1442***	0.1320***
	(0.1048)	(0.1035)	(0.0195)	(0.0190)
Constant	3.9555***	2.2609***	4.0195***	2.1139***
	(0.0350)	(0.4278)	(0.0077)	(0.0894)
Control variables	/	√	/	√
Firm FE	√	√	√	√
Year FE	√	√	√	√
Observations	2,881	2,881	32,078	32,078
R-squared	0.7463	0.7575	0.5844	0.6053

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$; *** $p < 0.01$.

the core explanatory variables remain significantly positive under both the PSM-DID and entropy balancing matching methods, regardless of whether the control variables are included, and their directions align with the benchmark regression results. These findings strongly demonstrate that the conclusions remain valid after effectively controlling for sample selection bias.

5.2.3 *Placebo test*

Exogenous random factors may interfere with the benchmark estimation results. To further confirm the causal relationship between PDO and corporate ESG performance, we conducted a placebo test (Feng & Nie, 2026). Specifically, we repeated the following process 500

times: we artificially constructed virtual experimental and control groups, and we conducted a virtual regression.

Figure 5 shows the kernel densities of the spurious estimated coefficients of *Pub _ data* for these 500 iterations. The results show that most of the spurious estimated coefficients are distributed around zero and follow a normal distribution, while the estimated coefficient of the benchmark regression (i.e., 0.0408) is distributed to the right of zero, indicating that randomly simulated shocks do not significantly affect firms' ESG performance. This analysis excludes the interference of non-time-varying confounding factors to some extent, supporting the positive impact of PDO on corporate ESG performance.

5.2.4 *Counterfactual estimation framework*

To validate the benchmark results, we also used the counterfactual estimation framework proposed by Liu et al. (2024b) to estimate the effect of PDO. The framework generally uses information from individuals not subject to policy treatment to model the counterfactual situation of those who are, and then compares the modeled values with the actual observed values. Table 6 presents the counterfactual estimation results. We found that the coefficient of *Pub _ data* is significantly positive, which further supports the positive effect of PDO on corporate ESG performance.

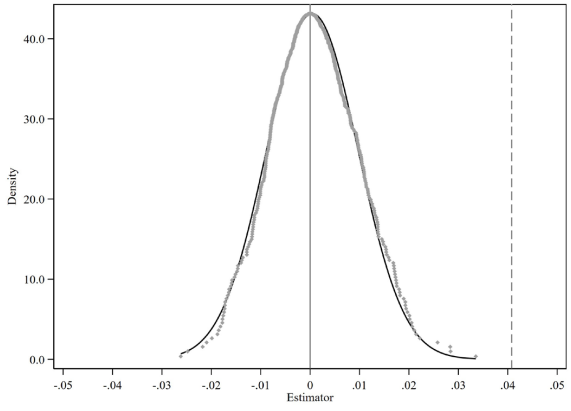

Figure 5. Placebo test.

5.2.5 *Heterogeneous treatment effect*

Existing studies have pointed out that multi-period DID under two-way FE may produce bias. This is because the core method of multi-period DID is weighted aggregation. The treatment effects of different treatment groups at different policy implementation time points are first estimated and then averaged according to corresponding weights (Baker et al., 2022). However, as policy effects may vary across groups and periods, the estimates may still be biased due to the presence of "bad treatment groups" or negative weighting issues, even if the parallel trends assumption is satisfied (Chaisemartin & D'Haultfoeuille, 2020). To address this issue, this study employs three heterogeneous treatment effect estimation methods: did_imputation by Borusyak et al. (2024); the event study by Sun and Abraham (2021); and stackedev by Cengiz et al. (2019). The pre-event average treatment effects estimated using these three robust heterogeneous estimators are largely insignificant. As shown in Table 7, all average treatment effects are statistically significant at the 5% level or higher, with positive coefficients, reinforcing the benchmark regression findings.

5.2.6 *Instrumental variable estimation*

While the previously described benchmark regression results and series of robustness tests support the core finding that PDO enhances corporate ESG performance, the estimation still faces an endogeneity problem. Although major characteristic variables affecting corporate ESG performance were controlled for, the possibility that other factors were omitted from the regression model cannot

Table 6
Counterfactual estimation framework

	(1)	(2)
	ESG	*ESG*
Pub _ data	0.1273***	0.1400**
	(0.0535)	(0.0582)
Control variables	/	√
Observations	32,078	32,078

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$; *** $p < 0.01$.

be ruled out. Cities in which firms demonstrate stronger ESG performance tend to have advantages in terms of digital infrastructure, economic development, and public environmental awareness. Therefore, local governments may be incentivized to prioritize PDO implementation. Accordingly, this study employed an instrumental variable estimation to mitigate the endogeneity problem. Following Shao et al. (2025), topographic relief was selected as the instrumental variable. The rationale for choosing this instrumental variable is as follows. From a relevance perspective, topographic relief directly affects the construction and maintenance costs of urban digital infrastructure. Flatter terrain facilitates the deployment of fiber-optic networks and the siting of data centers, accelerating PDO implementation. From an exogeneity perspective, topographic relief, as a natural geographic characteristic, has no direct influence on corporate operational decisions or social responsibility practices. Consequently, it does not directly affect corporate ESG performance, thus satisfying the exogeneity requirement for an instrumental variable.

As topographic relief is a time-invariant variable, this study created two instrumental variables by combining it with the previous year's national internet penetration rate and number of internet users. Columns (1) and (2) of Table 8 report the estimation results for *IV1*, and columns (3) and (4) present the results for *IV2*. The coefficients of *IV1* and *IV2* are -0.0013 and -0.0245, respectively, and both are statistically significant at the 1% level, negative, and satisfy the relevance condition. Additionally, the Cragg–Donald Wald F statistic and the Kleibergen–Paap rk Wald F statistic are significantly greater than 10, indicating that there is no weak instrumental variable problem. Columns (2) and (4) show that the coefficients

Table 7
ATT of the three robust estimators

	(1)	(2)	(3)
	did_imputation	**eventstudyinteract**	**stackedev**
Pub _ data	0.0905**	0.2050**	0.1533***
	(0.0377)	(0.0867)	(0.0498)
Control variables	√	√	√
Firm FE	√	√	√
Year FE	√	√	√

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$; *** $p < 0.01$.

Table 8
Instrumental variable estimation

	(1)	(2)	(3)	(4)
	Pub _ data	*ESG*	*Pub _ data*	*ESG*
	First-Stage	*Second-Stage*	*First-Stage*	*Second-Stage*
IV1	-0.0013***			
	(0.0003)			
IV2			-0.0245***	
			(0.0061)	
Pub _ data		1.1025*		1.0466*
		(0.6517)		(0.5982)
Cragg-Donald Wald F statistic	26.321		32.075	
Kleibergen-Paap rk Wald F statistic	20.653		16.198	
Control variables	√	√	√	√
Firm FE	√	√	√	√
Year FE	√	√	√	√
Observations	29,078	29,078	29,078	29,078
R-squared	0.7062	-0.0916	0.7063	-0.0774

Note: Clusters of robust standard errors are indicated in parentheses. * $p< 0.1$; *** $p < 0.01$.

of the core explanatory variables are significantly positive, further validating the benchmark regression results.

5.2.7 *Dual machine learning method*

Following Xing et al. (2023), we used the double dual machine learning (DDML) method to further verify the causal effect of PDO on corporate ESG performance. We used a random forest algorithm to predict the results and trained it using *k*-fold cross-validation with $k = 4$. Column (1) in Table 9 shows the estimation results. To validate the robustness of the DDML estimation, we replaced the random forest algorithm with the Lasso algorithm. Column (2) reports the estimation result. Columns (1) and (2) show the partial linear model's estimation results. We also used the DDML method to build a more general interactive model for analysis. Column (3) presents the estimated results.

According to the results in columns (1) to (3), the approach used for the DDML estimation does not affect the conclusion that PDO enhances corporate ESG performance; it only changes the magnitude of the effect to a certain extent. This result supports the robustness of the original conclusion.

5.2.8 *Further controls for other relevant policies*

During the sample period, other relevant policies may also have affected PDO and corporate ESG performance, which could interfere with our findings. To mitigate this interference, our model controls for the following three relevant policies:

(1) Digital infrastructure policy (*Dig _ infra*). Specifically, we apply the Broadband China pilot as a proxy for digital infrastructure policy. The key objective of this policy was to upgrade regional digital infrastructure. Existing studies have demonstrated the positive effects of this policy on corporate ESG performance (Zhai et al., 2023).

(2) Data-trading platform policy (*Data _ trade*). This policy is an important initiative to promote the marketization of data factors. The first data-trading platform went online in Beijing in 2014, significantly affecting enterprise behavior. Theoretically, data factor marketization can promote data factor flows, reduce transaction costs, and enhance enterprises' operational capacity (Li et al., 2024a).

(3) Government informatization construction policy (*Gov _ infor*). We apply the integration of informatization and industrialization pilot zones as a representative policy for government informatization construction. Existing studies discuss its effects on corporate digital technological innovation and green innovation (Li, 2024). Table 10 summarizes the results. We found that the positive effect of PDO on corporate ESG performance is robust.

5.2.9 *Replacing the dependent and independent variables*

To enhance the robustness of the results, this study employs alternative variable measurements by replacing both the dependent and independent variables and examining whether the findings are sensitive to different measurement approaches. Corporate ESG performance serves as the

Table 9
DDML method

	(1)	(2)	(3)
	ESG	*ESG*	*ESG*
	$k = 4$	*Lasso*	*Interactive model*
Pub _ data	0.2119***	0.2606***	0.2367***
	(0.0188)	(0.0007)	(0.0009)
Control variables	√	√	√
Firm FE	√	√	√
Year FE	√	√	√
Observations	32,078	32,078	32,078
R-squared	0.0037	0.1825	0.0101

Note: Clusters of robust standard errors are indicated in parentheses. *** $p < 0.01$.

core dependent variable. Mainstream evaluation systems include Huazheng, Bloomberg, SynTao Green Finance, Wind, and CNRDS ESG ratings (Feng & Nie, 2024). The benchmark regressions employ Huazheng ESG Index ratings as the primary proxy variable. Due to the availability and completeness of the data coverage of the alternative indicators, we conducted a robustness test measuring corporate ESG performance using CNRDS ESG ratings and re-estimating the regressions. As shown in column (1) of Table 11, the coefficient of Pub_data remains positive and statistically significant. Moreover, Lei et al. (2023a) re-estimated the benchmark regression using the China Open Data Index as a proxy variable for Pub_data. Data for this index were obtained from the *Report on the Open Utilization of Public Data in China*. This index has been released annually since 2017 and comprehensively evaluates the openness and utilization levels of local public data. The indicator system and evaluation areas of the index have differed across years, with more areas covered over time. To provide a comprehensive analysis, we used cross-sectional data from 2021 and 2022 to examine the relationship between the index and corporate ESG performance. The empirical results are shown in columns (2) and (3) of Table 11. Specifically, PDO significantly contributes to ESG performance. These results further support the benchmark regression findings.

5.3 Mechanism analyses

To verify hypotheses H2a to H2c, we constructed the following mediation effect model (Nie et al., 2025b):

$$M_{it} = \beta_0 + \beta_1 Pub\_data_{it} + \beta X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (3)$$

$$ESG_{it} = \gamma_0 + \gamma_1 Pub\_data_{it} + \gamma_2 M_{it} + \gamma X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (4)$$

Table 10
Control for other policies

	(1)	(2)	(3)
	ESG	*ESG*	*ESG*
	Dig _ infra	*Data _ trade*	*Gov _ infor*
Pub _ data	0.0395**	0.0408**	0.0409**
	(0.0172)	(0.0172)	(0.0172)
Control variables	√	√	√
Firm FE	√	√	√
Year FE	√	√	√
Observations	32,078	32,078	32,078
R-squared	0.5998	0.5998	0.5998

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$.

Table 11
Replacing the dependent and independent variables

	(1)	(2)	(3)
	ESG	*ESG*	*ESG*
	CNRDS ESG Rating	**2021 PDO Quality**	**2022 PDO Quality**
Pub _ data	0.2662*	0.0017**	0.0044***
	(0.1402)	(0.0007)	(0.0009)
Constant	27.2297***	2.4565***	2.7207***
	(0.0925)	(0.1331)	(0.1321)
Control variables	√	√	√
Observations	32,078	3,207	3,395
R-squared	0.7001	0.1825	0.1800

Note: Clusters of robust standard errors are indicated in parentheses. * $p< 0.1$; ** $p < 0.05$; *** $p < 0.01$.

In Equation 3 and Equation 4 M_{it} represents the mechanism variables, which incorporate the following three aspects: (1) Information asymmetry (*Inf _ asy*). PDO reduces information asymmetry between firms and external stakeholders, thereby improving disclosure quality and enhancing corporate ESG performance. Referring to previous studies (Luo et al., 2023), we constructed an index to measure information asymmetry. A higher value indicates greater information asymmetry. The data were obtained from CSMAR. (2) Digital transformation (*Dig _ tran*). Accessibility of public data facilitates corporate digital technology adoption and resource efficiency optimization, which may contribute to improved ESG performance. This indicator is measured using word-frequency statistics from annual enterprise reports (Fang et al., 2023). The keyword statistics include five dimensions: artificial intelligence, blockchain, cloud computing, big data technologies, and digital technology application. The data were derived from CSMAR. (3) Green innovation (*Gre _ inno*). Open access to public environmental data reduces uncertainty in corporate green technology R&D, thereby enhancing sustainable innovation capabilities. Patents are a widely used index for measuring innovation output, and invention patents better reflect innovation quality. Therefore, we use the number of green invention patents to measure the level of corporate green innovation (Zhu & Tan, 2022).

To verify the theoretical hypotheses regarding the influence mechanisms, we first estimate Equation 1 to obtain the coefficient α_1 , which represents the total effect of PDO on corporate ESG performance. Second, we estimate the coefficient β_1 in Equation 2, which demonstrates the effects of PDO on the three mechanism variables. We then introduce the mechanism variables into Equation 1 and estimate Equation 3 to obtain the coefficients γ_1 and γ_2 .

5.3.1 *Information asymmetry*

Table 12 shows the mechanism analysis results for information asymmetry. The coefficient of *Pub _ data* in column (1) indicates that PDO significantly enhances corporate ESG performance. Column (2) shows that the coefficient of *Pub _ data* is negative and significant at the 1% level, indicating that PDO effectively reduces information asymmetry. The coefficients of *Inf _ asy* in column (3) are significantly negative, indicating that information asymmetry does not enhance corporate ESG performance. Meanwhile, the coefficients of *Pub _ data* in column (3) are significantly positive, with a magnitude of 0.0377, which is smaller than the magnitude of 0.0408 in column (1). According to the steps for testing the mechanism analysis model, we conclude that information asymmetry is one of the mechanisms through which PDO enhances corporate ESG performance. Therefore, H2a is verified. Classical literature shows that information asymmetry is often caused by inadequate information sharing (Clarkson et al., 2007). Meanwhile, information asymmetry may increase

Table 12
Information asymmetry

	(1)	(2)	(3)
	ESG	*Inf _ asy*	*ESG*
Pub _ data	0.0408**	-0.0265***	0.0377**
	(0.0172)	(0.0063)	(0.0171)
Inf _ asy			-0.1152***
			(0.0186)
Constant	2.6831***	1.2682***	2.8292***
	(0.1024)	(0.0441)	(0.1049)
Control variables	√	√	√
Firm FE	√	√	√
Year FE	√	√	√
Observations	32,055	32,055	32,055
R-squared	0.5994	0.7098	0.6001

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$; *** $p < 0.01$.

governance costs (Myers & Majluf, 1984). Moreover, our findings align with those of Zhou and Wu (2025), who demonstrate that reducing information asymmetry contributes to higher corporate ESG rankings. This result suggests that mitigating information asymmetry may be a mechanism through which PDO enhances corporate ESG performance.

5.3.2 *Digital transformation*

Table 13 shows the mechanism analysis results for digital transformation. The coefficient of *Pub _ data* in column (1) indicates that PDO can significantly enhance corporate ESG performance. Column (2) shows that the coefficient of *Pub _ data* is positive and significant at the 1% level, indicating that PDO can effectively promote digital transformation. The coefficients of *Pub _ data* and *Dig _ tran* in column (3) are both significantly positive, and the magnitude of the former is 0.0389, which is smaller than the magnitude of 0.0408 in column (1). These results indicate that PDO is associated with higher levels of corporate digital transformation, which are correlated with improved ESG performance. Therefore, H2b is validated. The findings of this study are consistent with those of previous studies. For example, Chen and Zhang (2024) proved that PDO reduces corporate operating costs, refines managerial strategic cognition, and ultimately intensifies market competition, which may effectively drive digital transformation to higher levels. Chen and Ren (2025) further revealed that digital transformation significantly enhances corporate ESG performance, with every 1% increase in digitalization leading to a 0.048% improvement in corporate ESG performance.

5.3.3 *Green innovation*

Table 14 presents the results of the green innovation mechanism analysis. The coefficients of *Pub _ data* in columns (1) and (2) are both positive and significant, indicating that PDO effectively promotes corporate ESG performance and green innovation. The coefficients of *Pub _ data* and *Gre _ inno* in column (3) are both positive and significant; however, the magnitude of the former is smaller than that in column (1). Hence, PDO is associated with enhanced green innovation capability, which contributes to improved corporate ESG performance, and H2c is supported. Existing research shows that environmental regulation policies can effectively promote corporate ESG performance by encouraging green innovation (Lv & Wang, 2025; Wang & Zhang, 2024). Both radical and progressive green innovation can actively enhance corporate ESG performance (Liu et al., 2024a), suggesting that green innovation may serve as a potential mechanism through which PDO improves ESG performance, which is consistent with our findings.

Table 13
Digital transformation

	(1)	(2)	(3)
	ESG	*Dig _ tran*	*ESG*
Pub _ data	0.0408**	0.0593***	0.0389**
	(0.0172)	(0.0142)	(0.0172)
Dig _ tran			0.0321***
			(0.0074)
Constant	2.6844***	-0.3271***	2.6949***
	(0.1021)	(0.0873)	(0.1022)
Control variables	√	√	√
Firm FE	√	√	√
Year FE	√	√	√
Observations	32,078	32,078	32,078
R-squared	0.5998	0.8105	0.6001

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$; *** $p < 0.01$.

Table 14
Green innovation

	(1)	(2)	(3)
	ESG	*Gre _ inno*	*ESG*
Pub _ data	0.0408**	0.0201***	0.0391**
	(0.0172)	(0.0057)	(0.0172)
Gre _ inno			0.0823***
			(0.0190)
Constant	2.6844***	-0.0419	2.6878***
	(0.1021)	(0.0260)	(0.1020)
Control variables	√	√	√
Firm FE	√	√	√
Year FE	√	√	√
Observations	32,078	32,078	32,078
R-squared	0.5998	0.6710	0.6001

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$; *** $p < 0.01$.

5.4 Heterogeneity analyses

5.4.1 *Regional heterogeneity*

Differences in the regional environments of corporations may lead to heterogeneity in the impact of PDO on corporate ESG performance. We discuss this heterogeneity at two regional levels: (1) informatization and (2) marketization.

(1) Regional informatization. We apply the proportion of total postal and telecommunications services to GDP to measure the provincial informatization level, and we obtained the relevant data from CSMAR. Based on the sample median, we divided corporations into high- and low-informatization groups. Columns (1) and (2) of Table 15 show the regression results for these two groups.

(2) Regional marketization. We use the marketization index to measure the provincial marketization level. The data were derived from the China Market Index Database (Feng & Nie, 2024). The sample is divided into high- and low-marketization groups according to the median marketization index of the sample. Columns (3) and (4) present the grouped regression results.

We find that the coefficient of *Pub _ data* is only significant in the low-informatization and low-marketization groups. One possible reason for this result is that, in regions with relatively low informatization and marketization levels, the flow and marketization of data elements are hindered. The launch of a PDO platform in these regions accelerates data sharing and marketization. This enables enterprises to integrate public data into their production, operations, and governance processes, thereby improving their ESG practices.

5.4.2 *Corporate heterogeneity*

Differences in corporate characteristics may also cause variations in the effects of PDO on corporate ESG performance. We investigate corporate heterogeneity from two perspectives: (1) how corporations perceive uncertainty and (2) corporate ownership.

(1) Corporate uncertainty perceptions. This indicator reflects differences in how corporations perceive policy uncertainty. Studies show that firms with higher perceptions of uncertainty tend to engage less in social responsibility. These data were obtained from Nie et al. (2020). According to the sample median of this indicator, corporations are divided into two groups: those with strong uncertainty perceptions and those with weak uncertainty perceptions. Columns (1) and (2) in Table 16 present the estimation results for these two groups. We find that the coefficient of *Pub _ data* is positive and significant only in the group with a strong uncertainty perception. One possible explanation for this is that corporations with a stronger perception of policy uncertainty have a greater need for PDO. PDO can effectively

Table 15
Regional heterogeneity

	(1)	(2)	(3)	(4)
	ESG	*ESG*	*ESG*	*ESG*
	High-Informatization	**Low-Informatization**	**High-Marketization**	**Low-Marketization**
Pub _ data	0.0079	0.1326***	-0.0251	0.1356***
	(0.0254)	(0.0457)	(0.0353)	(0.0279)
Constant	2.5132***	2.6730***	2.4389***	2.8946***
	(0.1955)	(0.1483)	(0.1753)	(0.1509)
Control variables	√	√	√	√
Observations	16,213	15,865	16,136	15,942
R-squared	0.6948	0.6390	0.6598	0.6266

Note: Clusters of robust standard errors are indicated in parentheses. *** $p < 0.01$.

Table 16
Corporate heterogeneity

	(1)	(2)	(3)	(4)
	ESG	*ESG*	*ESG*	*ESG*
	Strong Uncertainty Perception	**Weak Uncertainty Perception**	**State-Owned**	**Non-State-Owned**
Pub _ data	0.0795***	0.0164	0.0644**	0.0458**
	(0.0262)	(0.0278)	(0.0275)	(0.0222)
Constant	2.4662***	2.6263***	2.0854***	2.1705***
	(0.1652)	(0.1685)	(0.2151)	(0.1275)
Control variables	√	√	√	√
Observations	17063	15015	11,082	20,996
R-squared	0.6538	0.6516	0.6396	0.5994

Note: Clusters of robust standard errors are indicated in parentheses. ** $p < 0.05$; *** $p < 0.01$.

enhance information transparency, and firms with stronger uncertainty perceptions are more willing to utilize public data to increase efficiency and improve ESG performance (Xu et al., 2024; Zhou et al., 2023).

(2) Corporate ownership. We divided the sample into state-owned and non-state-owned groups according to ownership. Columns (3) and (4) present the grouped estimation results. The coefficients of *Pub _ data* are both positive and significant for these two groups, and the magnitude is greater for state-owned enterprises. One possible reason for this is that state-owned enterprises may have a comparative advantage in analyzing, utilizing, and creating value from public data. This finding is consistent with the suggestion of Zhou et al. (2023) that PDO positively contributes more to the operating efficiency of state-owned enterprises than to that of non-state-owned enterprises.

6 Conclusions and policy implications

6.1 Conclusions

PDO is an important measure for marketizing data elements and can be a significant force in promoting corporate ESG performance. However, existing literature has not fully discussed the relationship between PDO and corporate ESG performance. Using a sample of Chinese A-share corporations from 2012 to 2022, this study examined the impact of PDO on corporate ESG performance based on a quasi-natural experiment

involving the launch of provincial PDO platforms using a DID model.

The following conclusions were drawn. First, the preliminary findings from the benchmark regression reveal that PDO significantly improves corporate ESG performance. This conclusion remained robust after several robustness tests, including the placebo test, the DDML method, counterfactual estimation, and reexamination of the effect of PDO quality. Mechanistic analysis reveals that PDO may enhance information transparency and reduce information asymmetry between firms and stakeholders, thereby positively influencing corporate ESG performance. As a new production factor, PDO may contribute to corporate management decision-making, support digital transformation, and potentially enhance ESG performance. Additionally, PDO effectively reduces transaction costs in green innovation elements, stimulates corporate green innovation, and provides technological empowerment to enhance corporate ESG performance. Third, further analyses demonstrate that the positive effect of PDO on corporate ESG performance is only significant in regions with low informatization and marketization. Additionally, the positive effect is greater in corporations with a strong perception of uncertainty and state-owned enterprises than in corporations with weak perceptions of uncertainty and non-state-owned enterprises.

6.2 Policy implications

The first category of implications for this work involves policymakers, who should actively promote the establishment of comprehensive, systematic, and high-quality PDO platforms. This ensures that data related to the environment, society, governance, and other areas can be safely disclosed to the public. The following implementation pathways should be prioritized. First, refined open standards should be established at the data level for different industries. Second, the release of core data should be prioritized. This data relates directly to corporate ESG performance and includes information such as environmental monitoring and social responsibility fulfillment. This not only enhances data transparency but also provides enterprises and all sectors of society with rich data resources, promoting the effective allocation and efficient use of these resources. At the incentive level, the government should provide substantive support, such as tax incentives and financing facilitation, to enterprises that actively utilize public data for digital transformation and green innovation. At the regional coordination level, policymakers should consider constructing data infrastructure and determining the scope of data for the PDO in accordance with regional characteristics. Particular attention should be paid to enterprises that are highly susceptible to policy uncertainty, with measures to enhance the stability and predictability of data openness and reduce the institutional costs of accessing and utilizing public data.

The second category involves corporations, which should recognize the opportunities offered by PDO and actively acquire and use public data to enhance their ESG performance. First, by acquiring environmental monitoring data and corporate social responsibility reports from regulators in real time, enterprises can dynamically optimize green production decisions to hedge against compliance risks and mitigate the constraints caused by information asymmetry. Second, industrial data, such as process energy consumption and waste treatment, should be explored and combined with artificial intelligence analysis tools to promote green innovation in production processes. Finally, corporations should leverage public data to enhance their digital transformation capabilities and further utilize digital technologies to explore the value of public data more deeply. Enterprises should establish cross-departmental data governance teams to integrate public data into all aspects of their green decision-making, production process optimization, and investment and financing decisions. Finally, corporations should actively participate in formulating and discussing government policies regarding PDO. They should provide timely feedback on issues related to data acquisition and usage and promote the value creation of PDO through positive interactions with the government.

6.3 Limitations and further directions

However, this study has certain limitations. First, although the study found that PDO has a positive effect on corporate ESG performance, the research sample only included Chinese listed companies, which limits the generalizability of the study's conclusions. Future research could expand the sample size to examine whether the findings remain consistent across firms from different countries, developmental stages, or industries. Second, the study examined three theoretical mechanisms: mitigating information asymmetry, digital transformation, and green innovation. It is important to note that the mechanism

analysis does not establish a definitive causal relationship, but rather has certain enlightening significance. However, the mediating mechanism analysis model still faces unresolved endogeneity controversies, and no perfect solution has been found to date. Future research would benefit from combining the latest econometric methods to more accurately identify the effects of mechanism variables and enhance the reliability of the research findings. Third, this study measured PDO based on policy shocks from establishing provincial PDO platforms. Due to data limitations, it was not possible to disaggregate public data types further or examine the effects of other public data categories. In the future, under the conditions surrounding data permissions, the impact of different types, degrees of openness, and qualities of public data should be explored to further improve the research system.

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SUPPLEMENTARY MATERIAL

Supplementary material accompanies this paper.
Supplementary Data 1 – Database
Supplementary Data 2 – Stata Script

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The full data supporting the findings of this study have been made available at:
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The authors have no conflicts of interest to declare.

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