

Article

Taxing for Good: How Tax Incentives Drive ESG Excellence in Chinese Firms

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Abstract

As a form of economic incentive, tax incentives can theoretically have a profound impact on corporate ESG performance by reducing the costs associated with fulfilling corporate social responsibilities and stimulating firms' intrinsic motivation for sustainable development. This study examines the impact of tax incentives on corporate ESG performance and its potential underlying mechanisms using a sample of Chinese A-share listed companies from 2009 to 2023. The empirical results indicate that tax incentives significantly enhance corporate ESG performance—firms receiving higher levels of tax incentives exhibit better ESG performance. This conclusion remains robust after a series of robustness tests. Further analysis reveals that the positive effect of tax incentives is more pronounced in the environmental and governance dimensions of ESG. Additionally, we find substantial heterogeneity in the impact of tax incentives on ESG performance. Specifically, the beneficial effects of tax incentives are more significant for state-owned enterprises, firms with weaker financial performance, and older (more mature) firms. More importantly, our findings demonstrate an inverted U-shaped relationship between the level of tax incentives and their impact on ESG performance, with the optimal tax incentive level estimated at approximately 85%. Furthermore, we unveil the mechanisms through which tax incentives influence corporate ESG performance. The results suggest that tax incentives improve ESG performance through multiple channels, including promoting green innovation, strengthening internal controls, facilitating the adoption of financial technology, and enhancing the quality of environmental information disclosure. This study contributes to and expands upon recent research within the resource-based view, offering valuable insights for corporate tax practices in developing countries and tax authorities' regulatory strategies.

Keywords: tax incentives; ESG performance; environmental information disclosure; green innovation



Academic Editor: Ștefan
Cristian Gherghina

Received: 23 May 2026

Revised: 8 July 2026

Accepted: 13 July 2026

Published: 19 July 2026

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1. Introduction

Although tax incentives are often viewed negatively from the perspective of social costs, this is primarily due to two concerns. First, tax incentives may lead to a “race to the bottom” among local governments, exacerbating fiscal deficits and resulting in insufficient public goods provision [1]. Second, tax incentives may undermine the fairness of the tax system, further intensifying social inequality [2]. However, tax incentives also have the potential to motivate firms to internalize external costs. Existing studies suggest that tax incentives effectively encourage firms to invest in environmental technologies

and equipment, thereby reducing pollution emissions [3]. Recent cross-country evidence further confirms the effectiveness of such green taxation policies in promoting sustainable development [4]. Consequently, tax incentives can serve as a mechanism for firms to internalize environmental externalities. From the perspective of externality theory, improving corporate ESG performance is a typical process of external cost internalization. Thus, a key question arises: can tax incentives significantly drive this internalization process and thereby enhance corporate ESG performance? Unfortunately, few studies have theoretically explored this issue in depth, and systematic empirical research examining the impact of tax incentives on ESG performance and their underlying mechanisms remains scarce.

Theoretically, tax incentives can significantly enhance corporate ESG performance through multiple mechanisms. First, tax incentives can effectively improve the quality of corporate environmental information disclosure. On one hand, governments often impose transparency requirements on firms as a condition for receiving tax benefits, thereby strengthening environmental information disclosure through monitoring and regulatory mechanisms. On the other hand, for firms, improving environmental information disclosure not only mitigates potential negative effects of public scrutiny but also fosters stronger collaboration with government authorities, earning trust and policy support [5]. Second, tax incentives play a crucial role in stimulating corporate green investment. By lowering the costs associated with developing green technologies and implementing environmental projects, tax incentives enhance the economic attractiveness of such investments, encouraging firms to increase expenditures on energy efficiency, clean energy development, and pollution control, thus reducing negative environmental externalities [6]. Third, tax incentives can strengthen firms' internal control capabilities. By alleviating tax burdens, firms gain additional resources to optimize management processes and corporate governance structures, thereby improving governance quality and enhancing long-term sustainability [7]. Additionally, tax incentives contribute to the advancement and application of financial technology in firms. Through policy guidance and financial support, tax incentives encourage firms to explore and adopt emerging technologies, thereby enhancing management efficiency and market competitiveness [8]. In summary, tax incentives, by reducing corporate tax burdens, drive improvements in multiple ESG dimensions, including environmental information disclosure, green investment, internal controls, and financial technology adoption. This not only strengthens firms' intrinsic motivation for sustainable development but also enhances their ability to identify and manage environmental, social, and governance risks, theoretically providing strong support for improving ESG performance.

While tax incentives theoretically enhance ESG performance through multiple mechanisms, systematic empirical research verifying their impact and underlying pathways is still lacking. To address this gap, this study empirically examines the effect of tax incentives on ESG performance using a sample of Chinese A-share listed firms from 2009 to 2023. Our findings indicate that tax incentives significantly enhance corporate ESG performance, with particularly strong effects on the environmental and governance dimensions. Further analysis reveals the underlying mechanisms through which tax incentives improve ESG performance, primarily by promoting green innovation, strengthening internal controls, facilitating financial technology adoption, and enhancing corporate information disclosure quality. Additionally, we explore the heterogeneity in the effects of tax incentives on ESG performance. The results show that state-owned enterprises, financially weaker firms, and older (more mature) firms benefit more from tax incentives, exhibiting greater improvements in ESG performance. Interestingly, further investigation reveals an inverted U-shaped relationship between tax incentives and ESG performance, with the most substantial positive impact occurring at a tax incentive rate of approximately 85%.

Compared to existing literature, this study makes three key contributions. First, it enriches research on the determinants of corporate ESG performance. As an important indicator of corporate sustainability, ESG performance has garnered increasing attention from scholars and practitioners alike [9]. Existing studies primarily explore ESG determinants from the perspectives of stakeholder influence and corporate governance. From a stakeholder perspective, prior research has identified several positive influences on ESG performance, including CEO narcissism [10], institutional investor ownership [11], foreign shareholding [12], media coverage [13], and public awareness of environmental issues [14]. Conversely, factors such as multiple large shareholders [15] and controlling shareholder pledges [16,17] have been found to negatively affect ESG performance. From a corporate governance perspective, prior research suggests that executive compensation incentives [18], corporate culture [19], digital transformation [20], and corporate globalization [21] positively impact ESG performance, while litigation risks [22] and cost leadership strategies [23] have detrimental effects. Previous studies have explored the impact of various government policies on ESG performance, highlighting different policy interventions in fostering corporate sustainability. For example, refs. [24,25] found that green credit policies positively impact corporate ESG performance, whereas [26] demonstrated that low-carbon city pilot policies significantly enhance ESG quality. However, as a key governmental tool for regulating market behavior, the effect of tax incentives on ESG performance has not been systematically examined. From the perspective of market failure, governments typically use taxation to address negative externalities by imposing higher taxes on polluting firms to cover environmental remediation costs. In contrast, tax incentives provide a market-oriented approach to internalizing external costs. By linking tax benefits to environmental governance, governments can incentivize firms to allocate more resources toward environmental management, green technology development, and social responsibility initiatives, ultimately improving ESG performance. From a tax theory perspective, tax incentives serve as a policy instrument for optimizing resource allocation by relinquishing part of fiscal revenue. Although tax incentives may reduce government tax revenue, they also alleviate direct government expenditures on environmental governance by shifting some of the responsibility to firms through market mechanisms. This study contributes to the literature by examining the role of tax incentives in ESG performance, extending tax theory applications to corporate environmental governance and social responsibility, and deepening the understanding of how externality internalization and tax incentives influence corporate behavior.

Second, this study enriches research on the economic consequences of tax incentives. As a widely adopted policy tool globally, tax incentives have been extensively studied. Prior literature highlights several positive effects, such as promoting corporate innovation [27], optimizing resource allocation [28], reducing corporate pollution [3], and improving workforce quality [7]. Moreover, tax incentives have been found to enhance investment capabilities, particularly among financially constrained small firms [29]. Other studies suggest that tax incentives improve environmental performance and total factor productivity [30]. However, tax incentives also pose risks, including reduced government revenue [31] and exacerbation of social inequality through unfair distribution mechanisms [32]. Despite these extensive studies, little research systematically examines the relationship between tax incentives and corporate ESG performance.

Finally, this study deepens the understanding of externality theory. Traditional Pigouvian theory argues that resource misallocation occurs when private and social costs diverge, necessitating government intervention through taxation or subsidies. However, the Coase theorem suggests that Pigouvian taxes may reduce overall welfare in the presence of transaction costs. Our empirical findings indicate that tax incentives serve as an effective

mechanism for encouraging firms to improve ESG performance. Additionally, we uncover an inverted U-shaped relationship between tax incentives and ESG performance, suggesting that while moderate tax incentives enhance ESG outcomes, excessive incentives may reduce firms' incentives for improvement. These findings contribute to externality theory by providing new empirical insights into how governments can optimize tax policies to promote sustainable corporate behavior.

2. Theoretical Analysis

2.1. Tax Incentives and Corporate ESG Performance

The stakeholder theory emphasizes that corporations should balance and meet the needs of various stakeholders. Corporate ESG performance, which encompasses environmental responsibility, social responsibility, and corporate governance, fundamentally aims to achieve a win-win scenario for employees, customers, suppliers, communities, and the government [33]. Strong ESG performance enhances a company's social reputation and credibility, fostering greater trust and support from stakeholders [34]. This trust relationship helps businesses establish more stable supply chains, attract high-quality customers and investors, and secure better financing conditions, thereby generating additional corporate value, maintaining market competitiveness, and achieving long-term sustainable development [35,36]. For instance, addressing social issues can enhance consumer loyalty, while fostering a positive work environment can attract and retain talented employees. Thus, strategically oriented firms often actively seek to enhance their ESG performance.

The resource dependence theory posits that firms must effectively acquire and utilize external resources to ensure continuous operations and growth. As a government-provided resource, tax incentives significantly reduce corporate financial burdens and increase disposable funds. These additional financial resources can be reallocated to ESG-related initiatives such as environmental protection, social responsibility activities, and corporate governance improvements, thereby enhancing corporate ESG performance [37]. Specifically, green tax policies, such as environmental taxes and tax relief programs, incentivize firms to invest in energy management, waste management, environmental equipment, and green technology innovation, thereby improving environmental performance [38]. For example, firms with pollutant emissions below prescribed thresholds may qualify for tax reductions on environmental protection taxes, effectively encouraging pollution reduction while lowering compliance costs and improving environmental outcomes. Moreover, tax incentives provide companies with greater financial flexibility, enabling them to better fulfill their social responsibilities toward employees, consumers, and local communities. Tax policies can also encourage firms to actively engage in corporate social responsibility (CSR) initiatives, thereby improving their social performance [39]. For example, China's 2008 Corporate Income Tax Law raised the tax-deductible limit for corporate charitable donations from 3% of taxable income to 12% of total profits, effectively promoting philanthropy in China. Additionally, tax incentives are typically accompanied by strict tax enforcement measures, which can encourage firms to optimize internal oversight and governance mechanisms, reduce information asymmetry, and enhance transparency [5,40]. For example, tax incentives for corporate mergers and restructuring have facilitated structural adjustments and resource integration, strengthening firms' market competitiveness.

In summary, improving ESG performance provides firms with multiple benefits, incentivizing them to enhance their ESG initiatives. Tax incentives, by reducing financial burdens, theoretically facilitate firms' improvements in environmental, social, and governance dimensions.

2.2. Tax Incentives, Green Innovation, and ESG Performance

In recent years, China has implemented environmental protection taxes to impose financial pressure on polluting firms while simultaneously introducing tax incentives to support green development. These policies contribute positively to corporate ESG performance in multiple ways. First, tax incentives reduce the tax burden on green technology R&D, directly lowering research and development costs while increasing firms' internal funding. This reduces reliance on external financing and encourages greater investment in green innovation [41]. Second, market mechanisms such as environmental taxes increase pollution-related costs, compelling firms to develop green technologies to qualify for tax benefits, thereby gaining a competitive edge [42]. Furthermore, tax incentives enhance the return on investment for green innovation projects, making firms more inclined to adopt environmentally friendly technologies and projects when making investment decisions [6]. By leveraging clean technologies and reducing pollution emissions, green innovation directly enhances firms' environmental performance. Additionally, green innovation improves corporate social performance by increasing consumer and employee trust and loyalty [43]. Green innovation also necessitates organizational and managerial adjustments, which improve corporate governance by fostering transparency and accountability [44]. Lastly, firms that achieve better ESG performance through green innovation receive positive market and societal feedback, reinforcing their commitment to sustainable initiatives and creating a virtuous cycle. Thus, tax incentives facilitate corporate ESG development by promoting green innovation. Notably, the substantive environmental achievements generated by green innovation provide the necessary content for high-quality environmental information disclosure, creating a synergistic "substance-signal" effect.

2.3. Tax Incentives, Internal Controls, and ESG Performance

Internal controls serve as an essential mechanism for corporate supervision, governance, and operational optimization, ensuring legal compliance and mitigating fraud and mismanagement risks. Tax incentives reduce firms' tax burdens, providing them with additional financial resources to invest in internal control systems, such as hiring compliance personnel, upgrading information systems, and conducting employee training. Moreover, tax incentives often come with rigorous tax compliance requirements, promoting corporate transparency and accountability while strengthening governance structures [5]. A well-functioning internal control system can effectively reduce managerial opportunism and self-serving investment behaviors, thereby minimizing agency costs [45]. This ensures that management focuses on the firm's long-term interests rather than short-term personal gains, fostering responsible decision-making on ESG matters. Additionally, strong internal controls optimize resource allocation and enhance operational efficiency [46], improving firms' capacity to manage environmental and social challenges. Thus, tax incentives indirectly enhance ESG performance by improving corporate internal controls. Furthermore, this robust internal control framework serves as the institutional foundation that ensures the reliability of environmental information disclosure and the secure operation of FinTech applications.

2.4. Tax Incentives, FinTech, and ESG Performance

Financial constraints are a major obstacle to improving ESG performance [47]. Financial technology (FinTech), leveraging big data, cloud computing, and blockchain, significantly enhances financial services' efficiency and accessibility, alleviating firms' financial constraints and fostering ESG development. FinTech expands financial service coverage by leveraging internet platforms, breaking geographical and temporal barriers, and lowering financial service access costs. It also improves risk assessment and corporate credit evaluation, reducing information asymmetry between lenders and borrowers, thereby

increasing firms' access to credit and their likelihood of securing external financing. This, in turn, provides firms with the financial resources necessary to fulfill environmental and social responsibilities and improve governance [48]. Tax incentives play a key role in driving FinTech adoption and development by directly reducing initial investment costs and enhancing firms' risk tolerance for high-tech innovations [49]. They also strengthen firms' market competitiveness and facilitate knowledge and technology diffusion, further stimulating corporate innovation in FinTech [50,51]. Consequently, tax incentives promote FinTech adoption, indirectly improving ESG performance. Importantly, the technological capabilities introduced by FinTech, such as automated data tracking, act as a powerful enabler that further strengthens the effectiveness of corporate internal controls.

2.5. Tax Incentives, Environmental Information Disclosure, and ESG Performance

Tax incentives enhance corporate environmental information disclosure through government oversight and firms' reputational and market trust considerations. Governments strengthen monitoring and auditing processes to ensure the proper allocation of tax incentives, often requiring beneficiary firms to submit detailed environmental performance reports and related disclosures. These requirements increase corporate transparency and incentivize firms to improve the quality of their environmental disclosures [52]. Additionally, firms that voluntarily enhance environmental information disclosure not only establish a reputation for transparency but also demonstrate their contributions to policy objectives, reinforcing their relationships with government authorities. As emphasized in the recent CSR literature, sustainability reporting serves as a critical tool for firms to demonstrate their commitment to environmental and social responsibilities beyond financial performance [53]. This can create opportunities for future policy support and collaboration [5]. As "green development" and "sustainability" gain increasing global attention, improved environmental disclosure quality and transparency help mitigate information asymmetry between firms and stakeholders, strengthening external oversight. Consequently, firms are encouraged to engage in better ESG practices to attract investors and secure government incentives [9,54]. Thus, tax incentives drive improvements in corporate environmental disclosure, leading to enhanced ESG performance. Figure 1 presents the theoretical framework of this study.

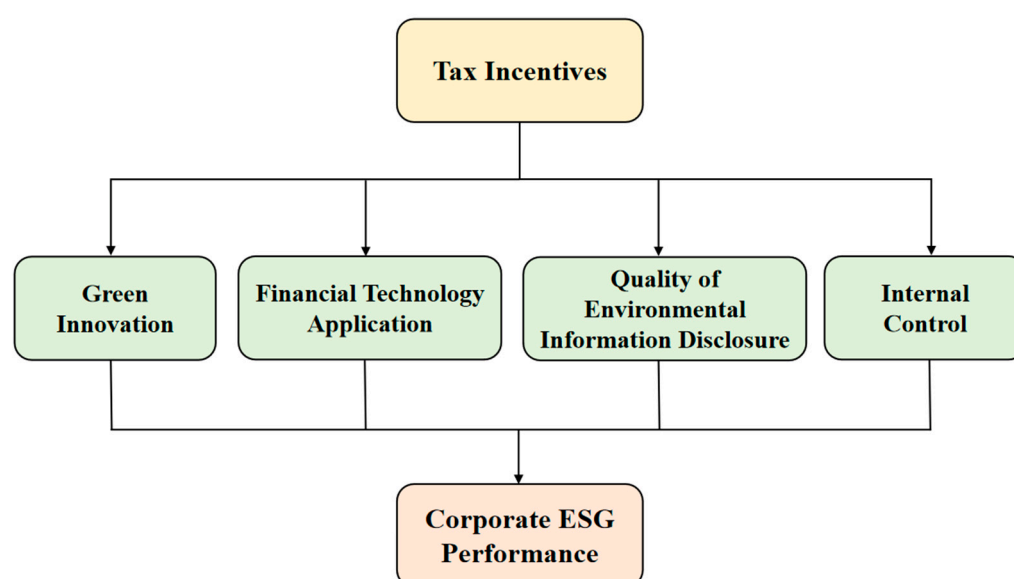


Figure 1. Theoretical analysis framework.

3. Research Design

3.1. Data Sources

This study uses a sample of Chinese A-share listed companies from 2009 to 2023. Data on ESG performance are obtained from the Huazheng Database, while data on internal control quality are sourced from the Dibo Database. Other financial and corporate governance-related data are collected from the CSMAR and CNRDS databases. To ensure data comparability and validity, we conduct the following preprocessing steps on the sample: (1) Exclusion of financial and insurance firms: Due to their unique organizational structures and accounting standards, the relevant indicators for these firms are not directly comparable to those of non-financial enterprises. (2) Exclusion of firms under ST (Special Treatment) and *ST status: Firms under these classifications exhibit financial distress, which may introduce bias into the estimation results. (3) Exclusion of firms with ROA (Return on Assets) exceeding 100% or below -100% : Extreme ROA values can significantly affect the robustness of statistical analysis, potentially leading to estimation bias or distortions in model results. (4) Exclusion of firms with negative net worth: These firms are likely to prioritize short-term survival over long-term strategic development and corporate governance, making them less representative of the broader corporate landscape. Removing such firms enhances the generalizability of the findings. (5) Exclusion of firms with zero independent directors: The absence of independent directors indicates an incomplete corporate governance structure, which may cause the data to deviate from the characteristics of mainstream listed companies. Eliminating these firms helps improve sample quality and ensures the external validity of the study's conclusions.

3.2. Model Specification and Variable Definitions

To examine the impact of tax incentives on corporate ESG performance, we construct the following empirical model (Equation (1)). Given the potential systematic influences of industry and time on corporate ESG performance, we follow [40] by incorporating industry fixed effects and year fixed effects into the model. This approach controls for industry-specific characteristics and exogenous shocks in particular years that might otherwise confound the estimation results. Additionally, we lag the dependent variable by one period to mitigate endogeneity concerns arising from reverse causality, thereby enhancing the reliability of the model estimates:

$$esgscore_{it+1} = \beta_0 + \beta_1 taxpre01_{it} + \tau \sum Controls_{it} + \mu_{ind} + v_t + \varepsilon_{it} \quad (1)$$

In this study, i and t represent the firm and the year, respectively. The dependent variable, $esgscore_{it+1}$ is the comprehensive ESG score of firm i in year $t + 1$, as published by the Huazheng Index. Compared to ESG ratings from other institutions, the Huazheng ESG score has several notable advantages: First, the Huazheng Index primarily relies on publicly disclosed data from listed companies while incorporating information from corporate social responsibility reports, sustainability reports, regulatory announcements, and media sources, ensuring comprehensive coverage and high credibility. Second, the Huazheng Index employs quantitative assessment methods, integrating algorithms and models to analyze and weight ESG indicators, thereby ensuring accuracy and comparability of the ratings. Lastly, the Huazheng Index rating system combines international standards with Chinese-specific characteristics, offering an ESG evaluation framework that is both locally relevant and internationally recognized. The key explanatory variable, $taxpre01_{it}$, is a binary indicator of whether a firm received tax incentives or tax rebates in year t . It equals 1 if the firm benefited from tax incentives and 0 otherwise.

$Controls_{it}$ represents the set of control variables. To mitigate the impact of omitted variable bias and ensure consistency with existing research [55,56], we incorporate the following control variables: Firm size (*lnsize*): The natural logarithm of total assets. Larger firms may have more resources to invest in ESG-related projects and initiatives. Firm age (*lnage*): Older firms tend to have more stable traditional operational models and may be slower in adopting emerging ESG strategies. Cash holdings ratio (*cash*): Firms with higher cash holdings have greater financial flexibility to allocate funds toward ESG investments [57]. Return on assets (ROA) (*roa*): Higher profitability provides firms with stronger financial capacity to implement ESG-related expenditures. Leverage ratio (*lev*): A higher debt-to-asset ratio may constrain ESG investments, as firms with high leverage tend to adopt more conservative financial strategies. State ownership (*soe*): State-owned enterprises (SOEs) are subject to stricter government oversight and may demonstrate superior ESG performance due to regulatory requirements and policy guidance [58]. Board size (*lnboard*): While a larger board may offer diverse perspectives, excessive board size can reduce decision-making efficiency and slow ESG strategy implementation. CEO duality (*dual*): Whether the board chairman concurrently serves as the CEO. Ownership concentration (*top1*): The shareholding ratio of the largest floating shareholder. Independent director ratio (*indep*): The proportion of independent directors on the board. Boards with a higher proportion of independent directors tend to provide stronger oversight and promote ESG initiatives [59]. Additionally, we incorporate industry fixed effects (μ_{ind}) to control for systematic differences across industries, ensuring that industry-specific characteristics do not bias the results. Year fixed effects (ν_t) are included to account for macroeconomic fluctuations, policy changes, and other cross-year factors that may systematically influence the dependent variable. The random error term is denoted as ε_{it} , while β_1 is the key coefficient of interest, representing the net effect of tax incentives on corporate ESG performance. Definitions of all key variables are provided in Appendix A.

4. Empirical Analysis

4.1. Descriptive Statistics of Main Variables

Table 1 presents the descriptive statistics of the key variables used in this study. The mean ESG composite score is 73.25, with a maximum of 91.55 and a minimum of 36.62, indicating that corporate ESG performance is generally at a relatively high level but varies considerably across firms. Among the three ESG dimensions, the average scores for environmental (E), social (S), and governance (G) performance are 60.87, 74.59, and 79.20, respectively. These figures suggest that firms perform relatively better in the social and governance dimensions, whereas environmental performance remains comparatively weaker and has greater room for improvement. The mean value of the tax incentives dummy variable is 0.760, suggesting that about 76.0% of firm-year observations received tax incentives or tax rebates. The average value of the continuous tax incentive variable is 0.154, indicating that the overall intensity of tax incentives differs substantially across firms. Regarding green innovation, the mean value of *rgpatent* is 0.0789, indicating that green patent applications account for approximately 7.89% of firms' total patent applications on average. Its standard deviation is 0.157, which exceeds the mean, suggesting substantial cross-firm variation in the green orientation of patenting activities. The maximum value of 1 indicates that, in some firm-year observations, all patent applications are classified as green patents. The average level of FinTech adoption, measured by *Infintech*, is 3.144, with a maximum of 7.546 and a minimum of 0, indicating substantial variation in firms' use of financial technology. In terms of corporate governance, the mean value of the internal control index is 6.427, with a standard deviation of 1.289 and a maximum value of 9.954, suggesting that most firms have a relatively sound level of internal control, although

meaningful cross-firm differences remain. The mean value of environmental information disclosure is 7.521, with values ranging from 0 to 37, indicating large differences in the extent of environmental disclosure across firms. The descriptive statistics of the control variables are broadly consistent with those reported in previous studies [13,60], suggesting that the sample is generally representative of Chinese A-share listed firms.

Table 1. Descriptive statistics of main variables.

Variable	Obs	Mean	Std.	Min	Max
esgscore _{t+1}	41,705	73.25	5.026	36.62	91.55
esggrade _{t+1}	41,696	4.149	0.942	1	8
escore _{t+1}	41,705	60.87	7.366	29.46	92.30
sscore _{t+1}	41,705	74.59	9.322	0	100
gscore _{t+1}	41,705	79.20	6.889	19.60	97.33
taxpre01	41,705	0.760	0.427	0	1
taxpre	41,705	0.154	0.209	0	1
rgpatent	39,780	0.0789	0.157	0	1
lnfintech	41,705	3.144	1.450	0	7.546
ICI	37,476	6.427	1.289	0	9.954
EID	41,468	7.521	6.846	0	37
lnsize	41,705	12.97	1.476	5.731	22.10
lnage	41,705	2.888	0.368	0.693	4.290
cash	41,705	17.47	14.25	0.0363	99.25
roa	41,705	3.880	7.180	−96.52	78.59
leverage	41,705	42.35	21.24	0.708	99.76
soe	41,705	0.358	0.479	0	1
lnboard	41,705	2.132	0.207	1.386	3.045
dual	41,705	0.290	0.454	0	1
top1	41,705	34.52	15.09	0.286	89.99
indep	41,705	37.42	5.436	14.29	80

ESG data are from Huazheng; internal control data are from Dibo; financial and governance data are from CSMAR and CNRDS. See Appendix A for variable definitions.

4.2. Baseline Results

Table 2 presents the baseline estimates. Column (1) reports the results without control variables or fixed effects, while Columns (2) to (5) sequentially add year fixed effects, industry fixed effects, and firm-level controls. The coefficient on taxpre01 is positive and statistically significant at the 1% level across all specifications. In the preferred specification in Column (5), the coefficient is 0.281, indicating that firms receiving tax incentives are associated with higher subsequent ESG scores after accounting for observable firm characteristics and fixed effects. The magnitude of the coefficient decreases after fixed effects and controls are introduced, suggesting that differences in firm characteristics and common time- or industry-level factors explain part of the unconditional relationship. However, the coefficient remains positive and highly significant, which supports the view that tax incentives are positively related to firms' ESG performance. This result is consistent with the argument that tax incentives may relax financial constraints and provide firms with greater flexibility to allocate resources to ESG-related activities. The underlying mechanisms are examined in later sections [61].

Table 2. Baseline results.

Variables	(1)	(2)	(3)	(4)	(5)
	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}
taxpre01	0.820 *** (0.117)	0.678 *** (0.118)	0.634 *** (0.112)	0.279 *** (0.096)	0.281 *** (0.095)
lnsize				1.186 *** (0.043)	1.158 *** (0.044)
lnage				−0.742 *** (0.142)	−0.676 *** (0.143)
cash				0.020 *** (0.003)	0.020 *** (0.003)
roa				0.150 *** (0.006)	0.150 *** (0.006)
lev				−0.040 *** (0.003)	−0.040 *** (0.003)
soe				0.694 *** (0.113)	0.703 *** (0.117)
lnboard					0.550 ** (0.257)
dual					0.143 * (0.086)
top1					0.004 (0.003)
indep					0.059 *** (0.008)
Industry FE	No	No	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Constant	72.631 *** (0.111)	72.740 *** (0.110)	72.773 *** (0.102)	60.318 *** (0.649)	56.909 *** (0.930)
Observations	41,705	41,705	41,705	41,705	41,705
R-squared	0.005	0.017	0.079	0.226	0.230

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The estimation results of the control variables align with theoretical expectations. Firm size, cash holdings ratio, return on assets (ROA), state ownership, independent director ratio, and board size all exhibit a significant positive impact on ESG performance, which is consistent with the resource-based view (RBV) framework. A larger firm size and higher cash holdings provide the necessary financial resources for investing in ESG-related initiatives, while higher ROA indicates strong profitability and sustainable development potential. State-owned enterprises (SOEs) tend to demonstrate better ESG performance due to their greater social responsibilities, stricter government oversight, and policy guidance. The presence of independent directors enhances corporate governance transparency and decision-making independence, fostering improvements in environmental, social, and governance aspects. A larger board may provide firms with more diverse expertise, richer external networks, and stronger monitoring capabilities, which collectively facilitate the formulation and implementation of ESG strategies. Conversely, firm age and leverage ratio exhibit a negative impact on ESG performance, which is also in line with theoretical expectations. According to organizational inertia theory, older firms may face path dependence, making them less adaptable to evolving ESG requirements. A high leverage ratio constrains firms' ability to invest in ESG-related projects, as financial resources are prioritized for debt repayment. Overall, these findings further confirm the critical role of resource endowment and organizational characteristics in shaping corporate ESG performance.

4.3. Robustness Checks

To ensure the robustness of our findings and address potential endogeneity concerns, this section conducts a battery of rigorous tests. These include alternative dependent variable specifications, regressions on ESG sub-dimensions, instrumental variable (IV) estimation, entropy balancing, dose–response modeling, Mundlak correlated random effects estimation, Double Machine Learning Estimation, multi-level clustered standard errors, interactive fixed effects, and permutation-based placebo tests.

4.3.1. Alternative Measurement of the Dependent Variable

Measurement errors in the dependent variable may lead to estimation bias. By substituting alternative indicators for the dependent variable, we can assess the robustness of our estimates and determine whether they are significantly affected by measurement errors. If the results remain consistent after replacing the dependent variable, we can conclude that the baseline regression results are robust and less likely to be influenced by measurement bias. To this end, following [9], we adopt an alternative measure of corporate ESG performance—the Huazheng Index ESG rating—in our robustness checks. The Huazheng ESG rating consists of nine levels, ranging from AAA (highest) to C (lowest), which we assign numerical values from 1 to 9, forming a new measurement variable, esggrade_{t+1} , as the alternative dependent variable. The regression results, presented in Table 3, indicate that after replacing the dependent variable, the estimated coefficient of tax incentives on corporate ESG performance remains significantly positive at the 1% level. This finding reinforces the robustness of our baseline regression conclusions.

Table 3. Results using an alternative measurement of the dependent variable.

Variables	(1)	(2)	(3)	(4)	(5)
	esggrade_{t+1}	esggrade_{t+1}	esggrade_{t+1}	esggrade_{t+1}	esggrade_{t+1}
taxpre01	0.154 *** (0.023)	0.134 *** (0.023)	0.124 *** (0.022)	0.056 *** (0.019)	0.056 *** (0.018)
lnsize				0.235 *** (0.008)	0.229 *** (0.009)
lnage				−0.160 *** (0.028)	−0.147 *** (0.028)
cash				0.004 *** (0.001)	0.004 *** (0.001)
roa				0.026 *** (0.001)	0.026 *** (0.001)
lev				−0.008 *** (0.001)	−0.008 *** (0.001)
soe				0.119 *** (0.022)	0.120 *** (0.023)
Inboard					0.115 ** (0.051)
dual					0.024 (0.017)
top1					0.001 (0.001)
indep					0.013 *** (0.002)
Industry FE	No	No	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Constant	4.031 *** (0.021)	4.047 *** (0.021)	4.054 *** (0.020)	1.647 *** (0.127)	0.919 *** (0.183)
Observations	41,696	41,696	41,696	41,696	41,696
R-squared	0.005	0.015	0.085	0.235	0.240

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3.2. Regression on ESG Sub-Dimensions

Given that different stakeholders, including governments and investors, place varying degrees of emphasis on corporate performance in environmental protection, social responsibility, and corporate governance, and that tax incentives may have differentiated effects across these dimensions, we further examine the impact of tax incentives on the three major components of ESG. This allows for a more precise assessment of how tax incentives influence each dimension and, in turn, contribute to overall ESG performance. Additionally, this analysis serves as a robustness check for our baseline regression results. The regression results are reported in Table 4. The findings indicate that tax incentives have a significantly positive effect on environmental performance ($\beta = 0.601$, $p < 0.01$) and governance performance ($\beta = 0.234$, $p < 0.05$), and a positive but marginally significant effect on social performance ($\beta = 0.340$, $p < 0.1$). These results further confirm the positive role of tax incentives in driving corporate ESG development and are consistent with the predictions of our baseline regression. Notably, the impact of tax incentives is more pronounced on environmental and governance performance than on social performance, suggesting that tax policies are more closely linked to firms' ecological protection and internal governance improvements than to their social responsibility fulfillments.

Table 4. Results of regression on ESG sub-dimensions.

Variables	(1)	(2)	(3)
	escore _{t+1}	sscore _{t+1}	gscore _{t+1}
taxpre01	0.601 *** (0.140)	0.340 * (0.182)	0.234 ** (0.113)
lnsize	1.741 *** (0.066)	1.344 *** (0.079)	0.660 *** (0.052)
lnage	−0.086 (0.208)	−1.152 *** (0.260)	−0.679 *** (0.163)
cash	−0.010 ** (0.004)	0.002 (0.005)	0.046 *** (0.003)
roa	0.028 *** (0.007)	0.155 *** (0.009)	0.224 *** (0.008)
lev	−0.005 (0.004)	0.004 (0.005)	−0.088 *** (0.003)
soe	0.143 (0.181)	−1.006 *** (0.211)	2.082 *** (0.132)
lnboard	0.435 (0.394)	1.435 *** (0.470)	0.146 (0.286)
dual	−0.191 (0.139)	0.325 ** (0.153)	0.203 ** (0.101)
top1	−0.003 (0.005)	−0.014 ** (0.006)	0.018 *** (0.004)
indep	−0.001 (0.013)	0.001 (0.016)	0.130 *** (0.009)
Constant	37.562 *** (1.447)	57.072 *** (1.660)	67.873 *** (1.049)
Observations	41,715	41,715	41,715
R-squared	0.232	0.239	0.282

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

This may be attributed to the more explicit cost–benefit relationship associated with the environmental and governance dimensions, where tax incentives directly reduce financial burdens related to green investment and governance enhancement. In contrast, corporate social responsibility (CSR) initiatives often involve more complex external coor-

dination and long-term returns, making them less immediately responsive to tax incentives. From a policy perspective, these findings suggest that tax policy design should further enhance the guiding role of tax incentives—not only encouraging firms to actively fulfill social responsibilities but also ensuring that they prioritize environmental protection and governance improvements alongside economic performance. This approach would better support the achievement of sustainable development goals (SDGs).

4.3.3. Instrumental Variable Estimation

Although a series of robustness checks confirm that tax incentives have a significantly positive impact on corporate ESG performance, concerns regarding endogeneity due to reverse causality remain. For instance, firms with higher ESG performance may, in turn, attract more tax incentives from the government (reverse causality). Additionally, omitted variable bias could lead to biased estimates. For example, unobservable factors such as CEO characteristics may simultaneously influence a firm's eligibility for tax incentives and ESG performance. To address potential endogeneity issues arising from reverse causality and omitted variable bias, we employ the instrumental variable (IV) approach. Specifically, we select the tax incentive coverage rate for firms in the same industry, city, and year as an instrumental variable. The rationale for this choice is twofold: First, the tax incentive coverage rate within the same year, city, and industry reflects the overall policy inclination at the industry and regional levels and is strongly correlated with whether an individual firm receives tax incentives (satisfying the relevance condition of an instrumental variable). Second, regarding the exclusion restriction, the tax incentive coverage rate of firms in the same industry, city, and year is an external macro-environmental characteristic that cannot directly determine a firm's internal ESG governance decisions, nor can it directly provide financial support or reputational endorsement to the firm. This instrument can only influence an individual firm through "peer effects" or "regional competitive pressure," prompting the firm to actively seek tax incentives to maintain industry competitiveness. Thus, it affects ESG performance primarily through the endogenous channel of tax incentive receipt, satisfying the exclusion restriction. Therefore, this instrumental variable satisfies the exogeneity condition.

The regression results using the instrumental variable approach are reported in Table 5. We first examine the validity of our selected instrumental variable. The Kleibergen–Paap rk LM statistic is 38.410 ($p < 0.01$), strongly rejecting the null hypothesis of under-identification, confirming that the instrument is relevant. The Kleibergen–Paap rk Wald F statistic is 38.896, exceeding the Stock–Yogo critical value for a 10% maximal IV size (approximately 16.38), thereby rejecting the null hypothesis of weak identification. These diagnostics collectively confirm that our instrumental variable satisfies the relevance condition.

Regarding the exogeneity of the instrument, we argue that the industry–city–year tax incentive coverage rate represents an external policy environment that is unlikely to directly determine a firm's internal ESG governance decisions, satisfying the exclusion restriction. The endogeneity test (Durbin–Wu–Hausman) yields p -values of 0.0365 and 0.0209 for the two dependent variables, respectively, both below the 5% significance level. This suggests that the difference between OLS and IV estimates is statistically significant, implying that endogeneity may be a concern in the baseline specification, and thus the IV approach is more appropriate for addressing it. Columns (1) and (2) show that tax incentives remain significantly positive at the 5% significance level for both ESG composite scores and ESG ratings, with coefficients of 3.968 and 0.861, respectively. Overall, after addressing potential endogeneity through the IV approach, the positive impact of tax incentives on corporate ESG performance remains statistically significant, reinforcing the credibility of our main conclusion. Appendix A Table A2 reports the corresponding first-

stage regression results. The dependent variable in the first-stage regressions is *taxpre01*, and the excluded instrument is *taxiv*. The coefficient of *taxiv* is positive and statistically significant at the 1% level in both specifications, with estimated coefficients of 0.088 and 0.094, respectively. This indicates that firms located in industry–city–year cells with higher tax incentive coverage are more likely to receive tax incentives themselves. Moreover, the first-stage F-statistics are 29.10 and 33.56, both well above the conventional threshold of 10, suggesting that the instrument has strong explanatory power for the endogenous variable and that weak-instrument concerns are unlikely to drive the IV results. These first-stage findings further support the relevance condition of the instrumental variable strategy.

Table 5. Result of instrumental variable regression.

Variables	(1)	(2)
	<i>esgscore_{t+1}</i>	<i>esggrade_{t+1}</i>
<i>taxpre01</i>	3.968 ** (1.834)	0.861 ** (0.365)
<i>Insize</i>	0.949 *** (0.115)	0.183 *** (0.023)
<i>Inage</i>	−0.653 *** (0.150)	−0.142 *** (0.030)
<i>cash</i>	0.023 *** (0.004)	0.005 *** (0.001)
<i>roa</i>	0.152 *** (0.006)	0.026 *** (0.001)
<i>lev</i>	−0.041 *** (0.003)	−0.008 *** (0.001)
<i>soe</i>	0.646 *** (0.125)	0.107 *** (0.025)
<i>Inboard</i>	0.632 ** (0.276)	0.133 ** (0.055)
<i>dual</i>	0.132 (0.091)	0.021 (0.018)
<i>top1</i>	0.006 * (0.003)	0.001 * (0.001)
<i>indep</i>	0.060 *** (0.008)	0.013 *** (0.002)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Kleibergen–Paap rk Wald F statistic	38.896	38.900
Kleibergen–Paap rk LM statistic	38.410 ***	38.410 ***
Endogeneity test(<i>p</i> _value)	0.0365	0.0209
Observations	41,705	41,696
R-squared	0.080	0.054

The values in parentheses are robust standard errors clustered at the firm level, *** *p* < 0.01, ** *p* < 0.05, * *p* < 0.1.

4.3.4. Entropy Balancing Method

To address potential selection bias arising from observable firm characteristics that may simultaneously affect both the receipt of tax incentives and corporate ESG performance, we employ an entropy balancing approach. This method constructs a set of weights for the control group (firms that did not receive tax incentives) such that the covariate distributions—including means, variances, and skewness—of the treatment and control groups are exactly balanced. Unlike traditional weighting methods, entropy balancing achieves optimal covariate balance by solving a maximum-entropy optimization problem that minimizes the deviation of the weights from uniform distribution while satisfying predefined balance constraints. This procedure ensures that the weighted control

group closely resembles the treatment group across observed firm characteristics, thereby mitigating self-selection concerns and enhancing the reliability of causal inference (see Appendix A Figure A2 for details).

The entropy-balanced regression results are presented in Table 6. After applying the entropy weights, the sample comprises 41,705 observations for the ESG score model and 41,696 for the ESG rating model. The estimated coefficients for the tax incentive variable remain positive and statistically significant at conventional levels—0.249 ($p < 0.05$) for ESG scores and 0.051 ($p < 0.01$) for ESG ratings—while controlling for industry and year fixed effects, as well as a comprehensive set of firm-level covariates. The results demonstrate that even after rigorously adjusting for observable differences between treated and untreated firms through entropy weighting, tax incentives continue to exert a significantly positive impact on corporate ESG performance. This finding confirms the robustness of our main conclusions against potential self-selection bias, providing further evidence that the observed positive relationship between tax incentives and ESG performance is not merely driven by systematic differences in firm characteristics.

Table 6. Entropy balancing estimation results.

Variables	(1)	(2)
	esgscore _{t+1}	esggrade _{t+1}
taxpre01	0.249 ** (0.100)	0.051 *** (0.020)
lnsize	1.176 *** (0.065)	0.231 *** (0.013)
lnage	−0.885 *** (0.184)	−0.183 *** (0.036)
cash	0.025 *** (0.004)	0.005 *** (0.001)
roa	0.153 *** (0.007)	0.027 *** (0.001)
lev	−0.038 *** (0.003)	−0.008 *** (0.001)
soe	0.846 *** (0.149)	0.143 *** (0.028)
lnboard	0.452 (0.332)	0.113 * (0.065)
dual	0.072 (0.108)	0.008 (0.021)
top1	0.003 (0.004)	0.001 (0.001)
indep	0.055 *** (0.011)	0.012 *** (0.002)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Constant	57.431 *** (1.200)	0.985 *** (0.233)
Observations	41,705	41,696
R-squared	0.241	0.253

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3.5. Dose–Response Model

To further analyze the promotional effect of tax incentives on corporate ESG performance and examine how this effect varies across different levels of tax incentives, we employ a dose–response model. The results are illustrated in Figure 2. As the level of tax incentives increases from the lower quantiles to the higher quantiles, its positive impact on

ESG performance gradually strengthens. However, once the tax incentive level exceeds the 96th percentile, its positive effect begins to decline. The estimated dose–response function reveals an inverted U-shaped relationship between tax incentive levels and their effect on ESG performance. This pattern suggests the existence of an “optimal point” for tax incentives, beyond which the marginal benefits start to diminish. Specifically, the turning point is located at the 96th percentile of the sample distribution, corresponding to a dose value of approximately 85.36 (i.e., around 85% of the tax incentive level), where the promotional effect of tax incentives on ESG performance reaches its maximum.

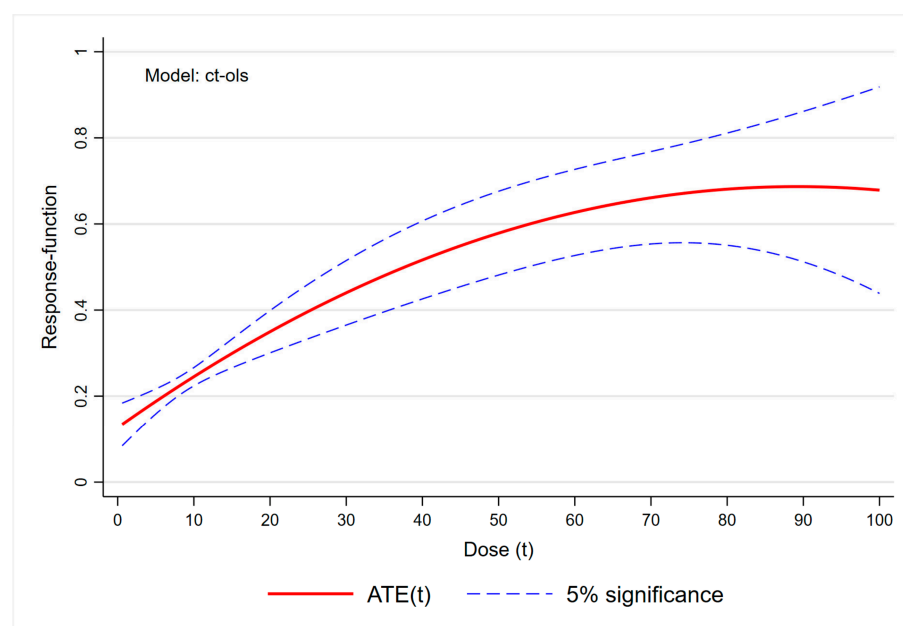


Figure 2. Results of dose–response model.

4.3.6. Mundlak Correlated Random Effects Estimation

Considering that unobserved firm-level heterogeneity may simultaneously affect both tax incentive acquisition and corporate ESG performance, this paper further examines the estimation results under the firm fixed effects specification. However, from an econometric perspective, the firm fixed effects model primarily relies on within-firm time-varying variation in the explanatory variables for identification. Specifically, in a model with firm fixed effects, the variation actually used for identification after within-group demeaning of the core explanatory variable is $\text{Taxpre01}_{it} - \overline{\text{Taxpre01}}_i$. If a firm’s tax incentive status remains largely unchanged over the sample period, the within-firm variation in this variable is very limited; for firms with completely unchanged tax incentive status, the within-firm variation is zero, which cannot provide valid identifying information for the firm fixed effects estimation. Consequently, including firm fixed effects absorbs a substantial amount of cross-firm variation in the tax incentive variable, causing the estimation to rely primarily on the minority of firms that experience changes in tax incentive status. This may lead to reduced estimation precision, inflated standard errors, and even insignificance of the core coefficient.

In light of this, this paper does not adopt the firm fixed effects specification as the sole identification strategy. Instead, we further employ the Mundlak Correlated Random Effects (CRE) model as a robustness test. The Mundlak correlated random effects estimation results are presented in Table 7. The Mundlak CRE model incorporates firm-level means of time-varying explanatory variables into the random effects framework, thereby allowing firm unobserved effects to be correlated with the explanatory variables and relaxing the assumption of zero correlation between unobserved individual effects and explanatory

variables imposed by the traditional random effects model. This approach can partially absorb persistent firm-level unobserved heterogeneity while preserving the between-firm variation in tax incentives that carry substantive economic meaning. For policy variables such as tax incentives that exhibit strong persistence, the Mundlak CRE model can distinguish the within-firm change effect from the between-firm long-term exposure effect under conditions of limited within-firm variation, thus providing more appropriate robustness evidence for our baseline conclusions.

Table 7. Mundlak Correlated Random Effects Estimation.

Variables	(1)	(2)
	esgscore _{t+1}	esggrade _{t+1}
taxpre01	0.157 * (0.091)	0.032 * (0.017)
lnsize	0.659 *** (0.073)	0.140 *** (0.014)
lnage	−2.414 *** (0.362)	−0.579 *** (0.072)
cash	0.013 *** (0.003)	0.003 *** (0.001)
roa	0.102 *** (0.005)	0.016 *** (0.001)
lev	−0.025 *** (0.003)	−0.006 *** (0.001)
soe	1.196 *** (0.243)	0.215 *** (0.045)
lnboard	−0.144 (0.319)	0.007 (0.063)
dual	0.027 (0.099)	−0.007 (0.019)
top1	0.004 (0.005)	0.001 (0.001)
indep	0.030 *** (0.009)	0.009 *** (0.002)
mtaxpre01	0.291 (0.196)	0.057 (0.038)
mlnsize	0.648 *** (0.087)	0.115 *** (0.017)
mlnage	2.497 *** (0.397)	0.590 *** (0.079)
mcash	0.005 (0.006)	0.001 (0.001)
mroa	0.155 *** (0.014)	0.033 *** (0.003)
mlev	−0.011 ** (0.005)	−0.001 (0.001)
msoe	−0.392 (0.278)	−0.070 (0.052)
mlnboard	0.817 * (0.470)	0.107 (0.092)
mdual	0.060 (0.162)	0.025 (0.031)
mtop1	−0.010 (0.007)	−0.002 * (0.001)
mindep	0.052 *** (0.016)	0.008 ** (0.003)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Constant	51.467 *** (1.229)	−0.078 (0.241)
Observations	41,705	41,696
R-squared	0.251	0.265

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3.7. Double Machine Learning Estimation

To further address potential model specification bias, we employ the Double Machine Learning (DML) approach as a robustness check. DML combines machine learning

algorithms with causal inference frameworks to flexibly control for high-dimensional confounders without imposing strong functional form assumptions. We adopt a partially linear regression model with 5-fold cross-fitting and estimate the average treatment effect on the treated (ATET) and the average treatment effect (ATE) using four different algorithms: Elastic Net, Ridge, Lasso, and Support Vector Machine (SVM).

The estimation results are presented in Table 8. Across all four algorithms, both ATET and ATE estimates are positive and statistically significant at the 1% level, with ATET ranging from 0.384 to 1.045 and ATE ranging from 0.383 to 1.107. The significance of both ATET and ATE carries important economic implications. ATET captures the average effect of tax incentives on firms that actually received them, confirming that the policy delivers tangible ESG benefits to its intended beneficiaries. ATE, representing the expected effect for a randomly selected firm, indicates that the positive impact would persist even if tax incentives were extended more broadly across the population. The alignment of these two estimates reinforces the robustness of our findings against functional form misspecification and machine learning algorithm choices. Together, these results confirm that tax incentives exert a robust promoting effect on corporate ESG performance, which is consistent with our baseline findings and indicates that the positive relationship is not an artifact of linear functional form assumptions.

Table 8. Double Machine Learning Estimation.

Variables	(1)	(2)	(3)	(4)
	Elastic	Ridge	Lasso	SVM
ATET	0.406 *** (0.111)	0.461 *** (0.117)	0.384 *** (0.102)	1.045 *** (0.097)
ATE	0.383 *** (0.102)	0.409 *** (0.108)	0.408 *** (0.111)	1.107 *** (0.115)
Observations	41,705	41,705	41,705	41,705
Firm controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

The values in parentheses are robust standard errors. 5-fold cross-fitting is applied in the DML procedure. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3.8. Additional Robustness Tests

First, we calculate robust standard errors clustered at the firm level and industry level, respectively. The purpose of clustering at the firm level is to control for serial correlation within the same firm across different years, thereby eliminating potential estimation bias. Meanwhile, clustering at the industry level accounts for correlations among firms within the same industry, particularly when firms are subject to similar external shocks or policy changes. The detailed regression results are reported in Appendix A Table A3. Columns (1) and (2) use the ESG composite score (esgscore) as the dependent variable, with standard errors clustered at the industry level and city level, respectively. The results show that tax incentives have a significantly positive effect on corporate ESG scores at the 1% significance level. Columns (3) and (4) use the ESG composite rating as the dependent variable, with standard errors clustered at the industry level and city level, respectively. Again, the results indicate that tax incentives significantly improve ESG ratings at the 1% significance level. These findings confirm that the baseline regression results remain robust.

Second, we introduce industry-year and city-year interaction fixed effects to further address potential endogeneity concerns arising from omitted variables. On the one hand, industry-year fixed effects help control for time-varying industry-level factors, such as technological progress, changes in market demand, and industry policy adjustments, all of

which may influence corporate ESG performance. On the other hand, city-year fixed effects account for time-varying regional factors, such as changes in local economic policies and environmental regulations, which may also affect ESG performance. The detailed results are reported in Appendix A Table A4. Columns (1) and (2) separately incorporate industry-year and city-year fixed effects, respectively. Compared with the baseline regression results, the positive effect of tax incentives on ESG performance decreases slightly but remains statistically significant at the 1% level. Column (3) includes both industry-year and city-year fixed effects simultaneously, and the results still indicate that tax incentives have a significantly positive impact on corporate ESG performance at the 5% level. These findings further confirm the robustness of our baseline estimates.

Finally, to test the robustness of the effect of tax incentives on ESG performance, we conduct a permutation test as a placebo test. Specifically, we randomly shuffle the tax incentive variable within the dataset to construct a set of pseudo-policy variables with no actual policy implications. These pseudo-policy variables are generated by randomly rearranging the observed tax incentive data, thereby simulating a policy variable that should have no real effect and producing a set of hypothetical random effects. We then perform regression analyses using these pseudo-policy variables and repeat the permutation 1000 times. In each iteration, we record the estimated coefficients and their significance levels and plot the distribution of the estimated coefficients for the pseudo-policy variable. The detailed results are shown in Appendix A Figure A1. The results indicate that, in the vast majority of simulations, the estimated coefficients of the pseudo-policy variable are statistically insignificant, and their distribution is centered close to zero. This finding provides evidence against the possibility that our baseline results are driven by random noise or other unobserved factors, thereby further confirming the robustness of the baseline estimates.

5. Heterogeneity Analysis

5.1. Ownership Structure

Based on ownership structure, firms can be classified into state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs). Although both types share similar corporate governance structures, their governance objectives and effectiveness differ, and their motivations for ESG development vary accordingly. To examine this heterogeneity, we divide the sample into SOEs and non-SOEs and estimate the impact of tax incentives separately. The regression results, reported in Table 9, Columns (1) and (2), show that tax incentives significantly enhance ESG performance for SOEs, with an estimated coefficient of 0.435 ($p < 0.01$), while the effect for non-SOEs is positive but not statistically significant (coefficient of 0.115, $p > 0.1$). This indicates that the positive effect of tax incentives on ESG performance is predominantly driven by SOEs. This finding can be explained through stakeholder theory, which emphasizes that firms must balance the interests of multiple stakeholders in decision-making. For SOEs, in addition to shareholder interests, the expectations of the government, the public, and employees also play a crucial role. SOEs often face higher public scrutiny in terms of social responsibility and sustainable development. Tax incentives not only reduce financial burdens but also motivate SOEs to enhance ESG efforts to meet governmental and societal expectations [11,62]. In contrast, non-SOEs primarily improve ESG performance for profit-driven reasons, using ESG initiatives to signal sustainability to investors, enhance reputation, and boost stock market performance, ultimately leading to higher corporate value [45]. However, the insignificant coefficient for non-SOEs suggests that tax incentives alone may not be sufficient to incentivize ESG engagement among these firms, possibly because they face stronger short-term profit pressures or have alternative channels for resource allocation. Therefore, when receiving tax incentives, SOEs are more likely to align with national strategies, actively fulfilling social and environmental

responsibilities, while non-SOEs may prioritize short-term benefits and risk mitigation, paying relatively less attention to ESG improvements.

Table 9. Results of heterogeneity analysis on the impact of tax incentives.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}
	Soe	Non-Soe	Good	Poor	Mature	Young
taxpre01	0.435 *** (0.091)	0.115 (0.072)	0.137 * (0.074)	0.394 *** (0.085)	0.546 *** (0.087)	0.122 * (0.074)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	52.484 *** (0.847)	57.189 *** (0.835)	55.532 *** (0.836)	54.735 *** (0.812)	56.718 *** (1.097)	54.796 *** (0.777)
chi2(1)	7.60 ***		5.14 **		13.43 ***	
Observations	14,910	26,795	20,851	20,854	18,929	22,776
R-squared	0.292	0.207	0.148	0.264	0.275	0.209

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

To further verify whether the difference in tax incentives' effects between SOEs and non-SOEs is statistically significant, we conduct a chi-squared ($\chi^2(1)$) test for coefficient differences. The results show a $\chi^2(1)$ value of 7.60, which is significant at the 1% level, confirming that the effect of tax incentives on ESG performance is significantly stronger for SOEs than for non-SOEs.

5.2. Firm Performance

Firm performance is a key indicator of financial and operational health. To accurately assess the differentiated effects of tax incentives on firms with varying performance levels, ensure policy precision and fairness, and optimize resource allocation, we conduct a heterogeneity analysis based on firm performance. The regression results, reported in Table 9, Columns (3) and (4), indicate that tax incentives significantly enhance ESG performance for both high-performing and low-performing firms, with estimated coefficients of 0.137 ($p < 0.1$) and 0.394 ($p < 0.01$), respectively. Notably, the effect is stronger for low-performing firms. This may be because tax reductions free up additional financial resources, alleviating financial constraints and enabling these firms to invest in environmental improvements, social responsibility initiatives, and governance enhancements. Additionally, tax incentives may serve as an incentive for reputation enhancement, attracting investment and increasing market competitiveness, further encouraging low-performing firms to take proactive ESG measures. In contrast, high-performing firms typically possess stronger financial capabilities and can independently invest in ESG initiatives. Although tax incentives provide additional financial support, they may not fundamentally alter these firms' existing ESG strategies [9].

To test whether the difference in tax incentives' effects between high- and low-performing firms is statistically significant, we conduct a chi-squared ($\chi^2(1)$) test for coefficient differences. The results show a $\chi^2(1)$ value of 5.14, which is significant at the 5% level, confirming that tax incentives have a significantly stronger effect on ESG performance for low-performing firms than for high-performing firms.

5.3. Firm Age

Firms of different ages exhibit significant differences in organizational routines, resource accumulation, and strategic flexibility. To assess the effectiveness and variability

of tax incentives across firms at different stages of their lifecycle and promote balanced progress in corporate sustainability, we conduct a heterogeneity analysis based on firm age. The regression results, reported in Table 9, Columns (5) and (6), indicate that tax incentives significantly enhance ESG performance for both older (large age) and younger (small age) firms, with estimated coefficients of 0.546 ($p < 0.01$) and 0.122 ($p < 0.1$), respectively. However, the effect is significantly stronger for older firms. This finding can be explained through organizational legitimacy and resource-based view theories. Older firms tend to have more established organizational structures, greater institutional knowledge, and deeper institutional linkages, which enable them to better interpret and respond to policy signals [63]. They also face higher legitimacy pressures from regulators, communities, and other stakeholders, as their long-term survival depends on maintaining a positive public image and conforming to societal expectations. Tax incentives provide additional fiscal room for these established firms to reinforce their ESG commitments without disrupting ongoing operations. In contrast, younger firms, while more flexible in decision-making, often face greater resource constraints and are more focused on survival and growth. Their ESG investments may be more opportunistic or reactive, and the marginal impact of tax incentives on their ESG performance is relatively weaker due to competing needs for capital in product development and market expansion. Moreover, younger firms may lack the internal capabilities and institutional support to effectively channel tax savings into systematic ESG improvements.

To verify whether the difference in tax incentives' effects between older and younger firms is statistically significant, we conduct a chi-squared ($\chi^2(1)$) test for coefficient differences. The results show a $\chi^2(1)$ value of 13.43, which is significant at the 1% level, confirming that the impact of tax incentives on ESG performance is significantly stronger for older firms than for younger firms.

6. Mechanism Analysis

Causal Mediation Analysis

Our baseline findings establish that tax incentives significantly enhance corporate ESG performance. To further investigate the underlying transmission channels, we employ a causal mediation analysis framework [64,65] to formally test whether green innovation, internal control quality, FinTech application, and environmental information disclosure serve as important mediating mechanisms through which tax incentives affect ESG performance. This approach decomposes the total effect (TE) of the treatment variable into a natural indirect effect (NIE) and a natural direct effect (NDE). The NIE captures the portion of the total effect that operates through the proposed mediator, while the NDE represents the residual effect that is not transmitted via the mediator.

We conduct separate mediation analyses for each proposed channel. Following the baseline specification, all models include the full set of control variables, as well as industry and year fixed effects. The mediator variables are defined as follows. Green innovation (rgpatent) is measured as the share of green patent applications in the firm's total patent applications in the current year. Internal control (ICI) is proxied by the firm's internal control quality score, sourced from the DIB Internal Control and Risk Management Database. FinTech application (Infintech) is measured using a text-mining approach, with the detailed lexicon provided in Appendix A Table A5. Environmental information disclosure (EID) is measured using a comprehensive disclosure quality index derived from the CSMAR Environmental Research Database. This index encompasses five primary categories—environmental management, environmental supervision and certification, disclosure channels, environmental liabilities, and environmental performance and governance—comprising a total of 30 secondary indicators. Each secondary indicator

is scored on a three-point scale: 0 for non-disclosure, 1 for qualitative disclosure, and 2 for quantitative disclosure. The scores are then aggregated within each primary category and summed to obtain the firm-level composite index. A higher value of this index indicates more detailed, standardized, and quantified environmental disclosure. The outcome variable is the firm's ESG score (esgscore). Robust standard errors are employed in all estimations.

Table 10 reports the causal mediation estimation results for all four channels. For the green innovation channel, the total effect of tax incentives on ESG performance is 0.278, statistically significant at the 1% level. The natural indirect effect is 0.011, also significant at the 1% level, indicating that tax incentives improve ESG performance by promoting green innovation. The natural direct effect is 0.267, suggesting that even after accounting for the green innovation pathway, a significant direct effect remains. The proportion of the total effect mediated through green innovation is 3.86%, statistically significant at the 1% level. Therefore, green innovation is an important transmission mechanism through which tax incentives affect corporate ESG performance.

Table 10. Causal mediation analysis of tax incentives on ESG performance.

Effect	(1)	(2)	(3)	(4)
	Rgpatent	ICI	Infintech	EID
Natural indirect effect (NIE)	0.011 *** (0.003)	0.048 *** (0.014)	0.032 *** (0.005)	0.043 *** (0.014)
Natural direct effect (NDE)	0.267 *** (0.059)	0.246 *** (0.060)	0.198 *** (0.057)	0.225 *** (0.056)
Total effect (TE)	0.278 *** (0.059)	0.295 *** (0.062)	0.230 *** (0.058)	0.268 *** (0.058)
DProportion mediated (%)	3.86% *** (1.304)	16.40% *** (5.263)	13.81% *** (3.792)	15.88% *** (5.511)
Observations	39,780	37,476	41,705	41,468

NIE, NDE, and TE denote the natural indirect, natural direct, and total effects, respectively. All models include controls, industry and year fixed effects. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Regarding internal control, the total effect is 0.295, statistically significant at the 1% level. The natural indirect effect is 0.048, significant at the 1% level, indicating that tax incentives enhance ESG performance by strengthening firms' internal control quality. The natural direct effect is 0.246, suggesting that after controlling for the internal control pathway, tax incentives still exert a significant direct effect on ESG performance. The mediation proportion is 16.40%, statistically significant at the 1% level. Therefore, internal control quality is an important transmission mechanism through which tax incentives affect corporate ESG performance.

For the FinTech application channel, the total effect is 0.230, statistically significant at the 1% level. The natural indirect effect is 0.032, significant at the 1% level, indicating that tax incentives promote ESG performance by facilitating the adoption and application of FinTech. The natural direct effect is 0.198, suggesting that after controlling for the FinTech pathway, tax incentives still exert a significant direct effect on ESG performance. The mediation proportion is 13.81%, statistically significant at the 1% level. Therefore, FinTech application is an important transmission mechanism through which tax incentives affect corporate ESG performance.

With respect to environmental information disclosure, the total effect is 0.268, statistically significant at the 1% level. The natural indirect effect is 0.043, significant at the 1% level, indicating that tax incentives improve ESG performance by enhancing firms' environmental disclosure quality. The natural direct effect is 0.225, suggesting that after controlling

for the environmental disclosure pathway, tax incentives still exert a significant direct effect on ESG performance. The mediation proportion is 15.88%, statistically significant at the 1% level. Therefore, environmental information disclosure is an important transmission mechanism through which tax incentives affect corporate ESG performance.

Overall, the causal mediation analysis confirms that all four channels—green innovation, internal control quality, FinTech application, and environmental information disclosure—serve as significant mediating mechanisms through which tax incentives improve corporate ESG performance. The mediation proportions range from 3.86% to 16.40%, with the internal control and environmental disclosure channels exhibiting relatively stronger mediating roles. These findings provide robust empirical support for the theoretical mechanisms posited in this study. The significant direct effects remaining in all specifications also suggest the presence of additional unobserved pathways through which tax incentives may affect ESG performance.

7. Conclusions and Policy Implications

This study systematically explores the impact of tax incentives on corporate ESG (Environmental, Social, and Governance) performance and delves into the underlying mechanisms through which this impact manifests. Based on an empirical analysis of A-share listed companies in China from 2009 to 2023, we find that tax incentives play a significant role in enhancing corporate ESG performance. Overall, firms receiving greater tax benefits exhibit superior performance in environmental responsibility, social responsibility, and corporate governance, and these findings are robust across multiple empirical tests. However, the extent of improvement varies across different ESG dimensions. The most notable improvements are observed in environmental performance and corporate governance, whereas the enhancement in social responsibility is relatively limited. This suggests that, compared to fulfilling social responsibilities, firms are more inclined to allocate tax benefits towards environmental investments and governance improvements, which yield more direct operational advantages. Further analysis reveals that the ESG-enhancing effects of tax incentives exhibit significant heterogeneity. State-owned enterprises (SOEs) are better positioned to leverage tax incentives for optimizing their sustainable development strategies, which is likely due to SOEs being subject to stricter government regulations and greater expectations regarding social and environmental responsibilities. Interestingly, the enhancing effects are more pronounced for firms with weaker financial performance and older (more mature) firms. This suggests that tax incentives play a more vital role in compensating for resource constraints faced by financially weaker firms—by alleviating financial burdens and providing additional discretionary funds, tax incentives enable these firms to invest in environmental protection, social responsibility, and governance improvements that would otherwise be beyond their reach. For older firms, their established organizational structures, greater institutional knowledge, and deeper institutional linkages enable them to better interpret and respond to policy signals, while their higher legitimacy pressures from regulators and stakeholders further motivate them to channel tax savings into systematic ESG improvements. In contrast, younger firms, though more flexible in decision-making, often face greater resource constraints and competing capital needs for survival and growth, resulting in a relatively weaker marginal impact of tax incentives on their ESG performance. These findings collectively indicate that tax incentives not only reinforce the sustainability efforts of well-resourced SOEs but also serve as an effective policy tool to narrow the ESG performance gap between resource-rich and resource-constrained firms. Moreover, our study identifies an inverted U-shaped relationship between tax incentives and ESG performance. While moderate tax incentives effectively stimulate firms to enhance their ESG engagement, the marginal benefits begin to diminish once tax incentives exceed a

certain threshold (approximately 85%). This phenomenon may stem from two primary factors. First, excessive tax incentives may weaken firms' intrinsic motivation to improve ESG performance, leading them to rely more on government subsidies rather than internal mechanisms for sustainable development. Second, some firms may redirect tax incentives towards short-term financial optimization rather than long-term ESG investments. Therefore, striking a balance between encouraging ESG initiatives and mitigating the diminishing marginal effects of tax incentives should be a key consideration for policymakers when designing tax policies.

Our mechanism analysis further elucidates the channels through which tax incentives enhance corporate ESG performance, primarily through fostering green innovation, strengthening internal corporate controls, promoting the application of financial technology, and improving environmental information disclosure. These mechanisms not only offer a more refined understanding of how tax incentives influence corporate sustainability but also provide policymakers with novel regulatory perspectives. The findings of this study deepen the understanding of the interaction between tax policies and corporate ESG engagement, offering solid empirical support for designing more precise and targeted green tax policies.

Based on the above findings, we propose the following policy recommendations to optimize the role of tax incentives in promoting corporate sustainable development. First, policymakers should refine tax incentive structures to prevent excessive dependence on subsidies. Given the inverted U-shaped effect of tax incentives on ESG performance, the government should establish a reasonable cap on tax benefits and implement a dynamic adjustment mechanism. This approach ensures that tax policies effectively stimulate ESG enhancement while preventing firms from becoming overly reliant on government incentives. Second, policymakers should further optimize the targeting and accessibility of tax incentive policies to ensure that resource-constrained firms can effectively leverage these benefits. Our findings indicate that while tax incentives generate greater ESG improvements for firms with weaker financial performance and older (more mature) firms, younger firms and those with limited institutional knowledge may still face informational and administrative barriers in accessing available tax benefits. Therefore, we recommend simplifying the application procedures for tax incentives, enhancing policy awareness through targeted outreach programs, and providing technical assistance to help younger firms and financially weaker enterprises navigate the qualification process. This would ensure that the firms most in need of financial support can fully benefit from existing preferential policies. Third, the integration of tax policies with green finance should be strengthened to create synergies between fiscal and financial incentives. Our study highlights the critical role of financial technology in linking tax incentives with corporate ESG performance. Thus, we propose that the government foster greater coordination between tax incentives and green financial policies. For instance, financial institutions should incorporate ESG performance as a key factor in credit evaluation and loan pricing, offering preferential financing terms to firms with demonstrable ESG improvements. Additionally, a "Green Taxation + Finance" mechanism could be established, wherein firms that achieve high ESG ratings receive both tax reductions and preferential access to green financial products, thereby reinforcing sustainable development incentives. Finally, a robust performance evaluation mechanism should be implemented to ensure the effectiveness of tax incentives. While tax incentives can promote ESG performance, their actual impact depends on whether firms genuinely allocate resources to sustainable initiatives. Policymakers should establish a performance-based tax incentive framework to enhance transparency and accountability. This could include requiring firms to disclose detailed environmental information, undergo periodic ESG audits, and adjust tax incentives dynamically based on long-term

sustainability performance. Moreover, firms that engage in “policy arbitrage” by superficially improving ESG indicators to obtain tax benefits should be subject to stricter scrutiny and potential penalties. This ensures that tax incentives are directed toward genuine and substantive ESG advancements rather than mere compliance-driven strategies.

Author Contributions: Conceptualization, L.G. and X.T.; data curation, X.T. and K.Y.; writing—original draft preparation, K.X. and L.G.; writing—review and editing, K.X. and L.G.; supervision, L.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy restrictions.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ESG	Environmental, Social, and Governance
SOE	State-owned enterprise
ROA	Return on assets
CSR	Corporate social responsibility
FinTech	Financial technology
IV	Instrumental variable
FE	Fixed effects
RBV	Resource-based view
CRedit	Contributor Roles Taxonomy

Appendix A

Table A1. Variable Definition.

Variable	Definition
$esgscore_{t+1}$	The overall ESG score of the firm in period $t + 1$, sourced from the Huazheng Database.
$esggrade_{t+1}$	The overall ESG rating of the firm in period $t + 1$, sourced from the Huazheng Database.
$escore_{t+1}$	The firm’s overall environmental governance score in period $t + 1$, sourced from the Huazheng Database.
$sscore_{t+1}$	The firm’s overall social governance score in period $t + 1$, sourced from the Huazheng Database.
$gscore_{t+1}$	The firm’s overall corporate governance score in period $t + 1$, sourced from the Huazheng Database.
$taxpre01$	A dummy variable indicating whether the firm has received tax incentives or tax refunds (Yes = 1, No = 0).
$taxpre$	The proportion of tax incentives and tax refunds received by the firm relative to its total tax burden.
$Infintech$	The firm’s level of financial technology application, measured using a text-mining approach.
$rgpatent$	The proportion of green patent applications in the firm’s total patent applications in the current year.

Table A1. *Cont.*

Variable	Definition
ICI	The firm's internal control quality score, sourced from the DIB Internal Control and Risk Management Database.
EID	The firm's level of environmental information disclosure, measured using a comprehensive disclosure quality index derived from the CSMAR Environmental Research Database.
lnsize	The natural logarithm of the firm's total assets.
lnage	The natural logarithm of the number of years since the firm's establishment.
cash	The firm's cash holdings ratio, calculated as (cash and cash equivalents + financial assets held for trading)/total assets.
roa	The firm's return on assets (ROA), measured as net profit divided by total assets (%).
leverage	The firm's asset-liability ratio
soe	A dummy variable indicating whether the firm is a state-owned enterprise (SOE) (Yes = 1, No = 0).
lnboard	The natural logarithm of the firm's board size.
dual	A dummy variable indicating whether the chairman of the board also serves as the CEO (Yes = 1, No = 0).
top1	The shareholding ratio of the largest shareholder.
indep	The proportion of independent directors in the firm's board of directors.

Table A2. First-stage regression results for the instrumental variable.

Variables	(1)	(3)
	First Stage: taxpre01	First Stage: taxpre01
taxiv	0.088 *** (0.016)	0.094 *** (0.016)
lnsize	0.053 *** (0.005)	0.054 *** (0.005)
lnage	−0.034 ** (0.015)	−0.035 ** (0.015)
cash	−0.001 *** (0.000)	−0.001 *** (0.000)
ROA	−0.001 (0.001)	−0.001 (0.001)
leverage	0.000 (0.000)	0.000 (0.000)
state	0.023 * (0.013)	0.024 * (0.013)
lnboard	−0.037 (0.029)	−0.036 (0.029)
duality	0.002 (0.009)	0.003 (0.009)
top1	−0.000 (0.000)	−0.000 (0.000)
indep	−0.000 (0.001)	−0.001 (0.001)
Constant	0.236 ** (0.104)	0.227 ** (0.103)
Observations	24,962	25,218
R-squared	0.212	0.217
Industry FE	Yes	Yes
Year FE	Yes	Yes
Cluster	Firm	Firm
First-stage F-statistic	29.10	33.56

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A3. Results with standard errors clustered at different levels.

Variables	(1)	(2)	(3)	(4)
	esgscore _{t+1}	esgscore _{t+1}	esggrade _{t+1}	esggrade _{t+1}
taxpre01	0.281 *** (0.105)	0.280 *** (0.099)	0.059 *** (0.020)	0.059 *** (0.020)
lnsize	1.158 *** (0.059)	1.158 *** (0.052)	0.230 *** (0.011)	0.230 *** (0.010)
lnage	−0.676 *** (0.129)	−0.676 *** (0.229)	−0.147 *** (0.026)	−0.147 *** (0.044)
cash	0.020 *** (0.003)	0.020 *** (0.003)	0.004 *** (0.001)	0.004 *** (0.001)
roa	0.150 *** (0.007)	0.150 *** (0.007)	0.026 *** (0.001)	0.026 *** (0.001)
lev	−0.040 *** (0.003)	−0.040 *** (0.003)	−0.008 *** (0.001)	−0.008 *** (0.000)
soe	0.703 *** (0.149)	0.703 *** (0.116)	0.121 *** (0.029)	0.121 *** (0.022)
lnboard	0.550 * (0.288)	0.551 ** (0.259)	0.113 * (0.060)	0.114 ** (0.053)
dual	0.143 ** (0.062)	0.144 * (0.079)	0.021 * (0.012)	0.022 (0.015)
top1	0.004 (0.003)	0.004 (0.003)	0.001 (0.001)	0.001 (0.001)
indep	0.059 *** (0.009)	0.059 *** (0.009)	0.013 *** (0.002)	0.013 *** (0.002)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Constant	56.909 *** (1.047)	56.907 *** (1.085)	0.920 *** (0.213)	0.919 *** (0.218)
Observations	41,705	41,693	42,037	42,025
R-squared	0.230	0.230	0.240	0.240

Robust standard errors are reported in parentheses, clustered at the industry level for columns (1) and (3) and at the city level for columns (2) and (4). Coefficient differences across column pairs are attributable to sample variations. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4. Results incorporating interaction fixed effects.

Variables	(1)	(2)	(3)
	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}
taxpre01	0.294 *** (0.096)	0.326 *** (0.108)	0.204 ** (0.100)
lnsize	1.179 *** (0.044)	1.143 *** (0.045)	1.196 *** (0.046)
lnage	−0.693 *** (0.142)	−0.189 (0.165)	−0.504 *** (0.150)
cash	0.020 *** (0.003)	0.033 *** (0.003)	0.022 *** (0.003)
roa	0.153 *** (0.006)	0.147 *** (0.006)	0.149 *** (0.006)
lev	−0.040 *** (0.003)	−0.030 *** (0.003)	−0.037 *** (0.003)
soe	0.713 *** (0.118)	0.581 *** (0.131)	0.770 *** (0.125)
lnboard	0.558 ** (0.258)	0.433 (0.291)	0.579 ** (0.268)

Table A4. Cont.

Variables	(1)	(2)	(3)
	esgscore _{t+1}	esgscore _{t+1}	esgscore _{t+1}
dual	0.148 * (0.086)	0.116 (0.094)	0.116 (0.089)
top1	0.005 * (0.003)	−0.001 (0.003)	0.005 (0.003)
indep	0.060 *** (0.008)	0.059 *** (0.010)	0.060 *** (0.009)
Industry-year FE	Yes	No	Yes
City-year FE	No	Yes	Yes
Constant	56.572 *** (0.938)	55.549 *** (0.978)	55.723 *** (0.979)
Observations	41,641	39,661	39,593
R-squared	0.280	0.272	0.362

The values in parentheses are robust standard errors clustered at the firm level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5. Fintech keyword library.

Dimension	Fintech Keywords
Artificial Intelligence	Artificial intelligence, robotics, machine learning, deep learning, neural networks, facial recognition, biometric recognition, voice recognition, pattern recognition, image recognition, facial payment, virtual reality, augmented reality, knowledge graph, smart, smart deposits, smart counters, smart finance, smart branches, smart credit, intelligent, intelligent banking, smart marketing, intelligent, intelligent risk control, intelligent finance, automation, and natural language processing.
lockchain	Blockchain, distributed ledger, supply chain, Internet of Things, near-field communication, quantum, quantum communication, data encryption, digital currency, and electronic currency.
Cloud Computing	Distributed, distributed storage, distributed computing, distributed architecture, distributed database, financial cloud, trusted computing, cloud adoption, private cloud, virtualization, privacy computing, cloud, cloud services, cloud service platform, cloudification, cloud computing, cloud architecture, cloud platform, cloud system, and cloud disaster recovery.
Big Data	Big data, big data analysis, big data services, big data technology, big data models, big data mining, data warehouse, data technology, data models, data mining, data governance, data center, digitization, digital transformation, digital finance, digital signature, digital ecosystem, digital credit card, digital bank, and digital marketing.
Online	E-commerce, electronic, electronic finance, electronic channels, e-commerce, e-banking, e-payment, Internet, Internet finance, fintech, digital technology, networking, Internet finance, online financial management, online financing, online consumer loans, online banking, online payment, online transactions, online banking, and online payment.
Mobile	Scenario-based finance, open platform, open banking, platformization, SDK (software development kit), mobile banking, mobile payments, barcode payments, mobile e-commerce, mobile Internet, mobile finance, mobile banking, mobile payments, digital payments, API (application programming interface), and direct sales bank.

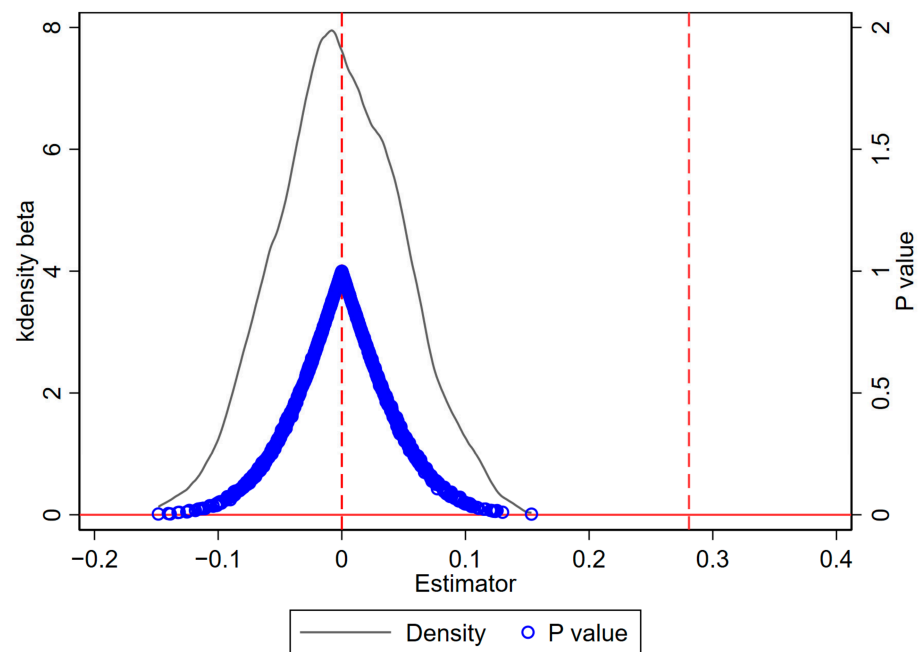


Figure A1. Placebo effect.

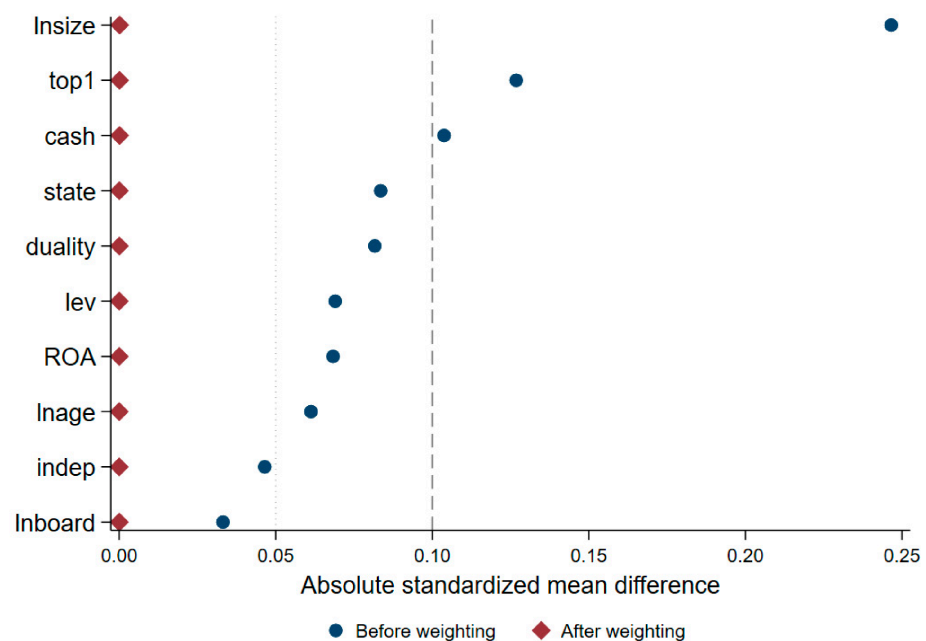


Figure A2. Entropy balance diagram.

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